SIDEA – Società Italiana di Economia Agraria
LIX Convegno annuale

Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza

Marina di Orosei (NU), 21– 22 settembre 2023

BOOK OF ABSTRACTS

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session A: Behavioural approach to consumer analysis

1. Nudging towards a greener future: the effects of dynamic social norms on parents' school menu selection
   Caso Gerarda, Vecchio Riccardo
2. The effect of nudges on food choices of socioeconomically disadvantaged individuals: a systematic literature review
   Sapio Silvia, Vecchio Riccardo
3. Effect of framing message to replace meat consumption with mushrooms and mushroom products
   De Cianni Rachele, Mancuso Teresina, Rizzo Giuseppina, Migliore Giuseppina
4. Analisi delle preferenze del consumatore per il kiwi a polpa rossa mediante un esperimento di scelta tra diversi paesi
   Bassi Ivana, Troiano Stefania, Mian Giovanni, Gori Enrico, Iseppi Luca
5. Plant the pot! Understanding consumers' WTP for sustainability in garden shops products
   Ruggeri Giordano, Mazzocchi Chiara
6. Exploring the environmental impact associated with the abandonment of the Mediterranean Diet, and how to reduce it with alternative sustainable diets
   Cavaliere Alessia, De Marchi Elisa, Frola Enrica Nadia, Benfenati Alessandro, Aletti Giacomo, Bacenetti Jacopo, Banterle Alessandro.

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session B: Behavioural approach to consumer analysis

1. Women's eating behavior through a food– related lifestyle model
   Hamam Manal
2. How information on improved working conditions in the farms affect consumers' preferences for chicken breast? An application of discrete choice experiment with participants from Emilia– Romagna region
   Maesano Giulia, Xhakollari Vilma, Canavari Maurizio
3. Fattori che influenzano l'intenzione di consumo verso il tartufo fresco e trasformato: un'applicazione del modello PLS– SEM
   Laganà Valentina Rosa, Di Gregorio Donatella, Nicolosi Agata Carmela
4. Measuring sustainability performances of Mediterranean olive ecosystems with Life Cycle approaches for SUSTAINOLIVE project
   De Luca Anna Irene, Falcone Giacomo, Iofrida Nathalie, Spada Emanuele, Gulisano Giovanni, Garcia– Ruiz Roberto
5. Nudge Theory, food, and the climate crisis: how behavioral economics can support sustainable choices
   Vecchiato Daniel, Bonardi Pellizzari Carolina, Penazzato Irene

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session C: Behavioural approaches to consumer analysis

1. Taste Matters More than Origin: An Experimental Economics Study on Consumer Preferences for Native and Foreign Varieties of Walnuts
   Raimondo Maria, Spina Daniela, D'Amico Mario, Di Vita Giuseppe, Califano Giovanbattista, Caracciolo Francesco
2. Behavioural and diet quality profiles of food consumers: Evidence from twelve African cities
   Marini Govigli Valentino, Alboni Fabrizio, Setti Marco
3. Using K– means cluster analysis for profiling citizens on perception of key factors of food security
   Facendola Rosalia, Ottomano Palmisano Giovanni, De Boni Annalisa, Acciani Claudio, Roma Rocco
4. Global Antibiotic Use in Animal Farming: An Estimation for Cattle, Poultry, and Pigs
   Ardakani Zahra, Aragrande Maurizio, Canali Massimo
5. Measuring Shopping– Out in Italian Remote Areas. A Natural Experiment
   Russo Carlo, Cardillo Concetta, Perito Mariangela

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session D: The role of sustainable attributes

1. The Water Footprint of the current Italian diet and how alternative low water–intensive diets can reduce it to tackle with future water scarcity scenarios
   Frola Enrica Nadia, Cavaliere Alessia, De Marchi Elisa, D'Alessandro Felice, Giacomo Aletti Alessandro Benfenati, Banterle Alessandro
2. Revealing perspectives towards health warning labels on wine: the Italian case
   Solfanelli Francesco, Mandolesi Serena, Cubero Dudinskaia Emilia, Silvestri Ileana, Naspetti Simona, Zanoli Raffaele
3. Economically valuing cultural ecosystem services: a review of the methods with a focus on green care
   Sealy Phelan Aisling Rachael, Rigo Alessandra, Pisani Elena, Secco Laura, Masiero Mauro
4. Consumers' preference for sustainable wines: an explorative analysis
   Stanco Marcello, Nazzaro Concetta, Lerro Marco, Marotta Giuseppe
5. Animal welfare and environmental sustainability in egg production. Consumer preferences for agroforestry farming models
   Rossi Eleonora Sofia, Fosci Lorenzo, Tardani Paolo, Martella Angelo, Blasi Emanuele

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session E: The role of sustainable attributes

1. How does health–related information impact willingness to pay for olive oil? An incentivised lab experiment among Moroccan and Tunisian consumers
   Piras Simone, Barlagne Carla, Clement Jesper, Mokhtari Noureddine, Thabet Chokri, Tura Matilde
2. Comparative assessment of the land footprint and regulating ecosystem services embodied in the Italian’s consumption of vegetable oils: an environmental trade–off analysis among substitute goods
   Bausano Giovanni
3. Dishes order as a game changer? A cluster randomized control trial in school canteens
   Petruzzelli Mara, Iori Elisa, Ihle Rico, Vittuari Matteo
4. Consumer Preferences for Circular Economy Products: a case study in Italy
   Pucillo Flavia, Cavaliere Alessia, De Marchi Elisa
5. The communication to consumers of the characteristics of dealcoholized and partially dealcoholized wines through company websites
   Seccia Antonio, Di Maria Giuliana, Viscecchia Rosaria, De Devitiis Biagia

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session F: The role of sustainable attributes

1. Understanding consumer preferences for potted plants: the role of phytosanitary diagnostics and eco–friendly cultivation practices
   Petrontino Alessandro, Frem Michel, Fucilli Vincenzo, Bozzo Francesco
2. Circolarità, sostenibilità e qualità del caffè venduto nei distributori automatici: cosa preferiscono i consumatori italiani?
   Bertossi Alberto, Troiano Stefania, Marangon Francesco
3. What determines short food supply chain purchases? Revealing the influence of beliefs about public effects versus private motivations
   Gerini Francesca, Contini Caterina, Casini Leonardo
4. Consumers' preferences for Pecan Nuts: exploring the Italian market via a multiple discrete continuous choice approach
   Franceschinis Cristiano, Thiene Mara, Scarpa Riccardo
5. Driving Better Choices: Understanding the Decision–Making Through the Lenses of Health, Sustainability, Naturalness, and Price in Atypical Situations
   Fantechi Tommaso, Contini Caterina, Casini Leonardo, Lähteenmäki Liisa

S.O.1 PROMOTING A LONG–TERM VISION FOR RURAL AREAS: PROJECTS, INITIATIVES AND TOOLS
Sessione organizzata da AISRe

1. The New Intelligent, Multilevel and Territorial Governance: Between Innovations and Regional Transitions
   Provenzano Vincenzo
2. Critical mass of innovation actors in revitalizing peripheral, non–urban areas: Insights from the COWORK4Youth Project
   Papageorgiou Antigoni
3. The role of collaborative spaces in promoting rural areas: evidence from Cost Action–CA18214 and CORAL–ITN projects
   Mariotti Ilaria
4. Strengthening the institutional capacity of local actors in rural areas and production territories: the role of evaluation
   Celano Serafino
5. The EC Startup Village Forum. Concept and analytical research
   Merida Martin Fernando
6. Social Innovation and youth participation in remote rural areas: evidence from a research action in Italian inner areas
   Storti Daniela

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session G: The role of sustainable attributes

1. Trade–off between interest in health and sustainability and the adherence to the Mediterranean Diet: Evidence from Italy
   Cammarelle Antonella, Viscecchia Rosaria, De Devitiis Biagia, Nardone Gianluca, Bimbo Francesco
2. Climate Change Impact on Agriculture in Italy: A Literature Review
   De Leo Simonetta, Di Fonzo Antonella, Giuca Sabrina, Lupia Flavio, Pulighe Giuseppe, Gaito Marco
3. Is local beef preference associated with health–related attitudes? A study on Italian consumers
   Testa Riccardo, Vecchio Riccardo, Rizzo Giuseppina, Vella Francesco, Schifani Giorgio, Migliore Giuseppina
4. Citizens–consumers' willingness to pay for sustainable functional foods: an explorative analysis in Italy
   Uliano Anna, Stanco Marcello, Nazzaro Concetta
5. The Empirics of Freshwater Ecosystems: a Global Meta–Regression Analysis
   Amatucci Achille, Ventura Vera

6. Freedom of choice – Italian consumers' preferences for labelled new genomic techniques in tomato paste
   Cubero Dudinskaya Emilia, Mandolesi Serena, Naspetti Simona, Cavallo Carla, Migliore Giuseppina, Zanoli Raffaele

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session H: New products acceptance

1. Beauty and naturalness: exploring consumer perspectives and purchase intentions of edible flowers
   Ricci Elena Claire, Del Giudice Teresa, Olivieri Giuseppina, Cicia Gianni, Cavallo Carla, Begalli Diego, Stranieri Stefanella
2. Innovative and sustainable solutions to increasing the shelf life of fresh meat industry and consumer acceptance
   Spada Emanuele, Di Vita Giuseppe, De Cianni Rachele, Mancuso Teresina
3. Natural wine and consumer awareness
   Tortonese Valentina, Benedetto Graziella
4. The current state of the insect industry within the context of a circular bioeconomy
   Hamam Manal
5. Consumers' awareness of animal welfare issue and livestock innovations: a PLS–SEM approach
   Mazzocchi Chiara, Ruggeri Giordano, Corsi Stefano, Bava Luciana
6. Consumers' preferences and acceptance towards traditional thistle–curdled cheeses
   Mandolesi Serena, Ozturk Emel, Cubero Dudinskaya Emilia, Solfanelli Francesco, Naspetti Simona, Zanoli Raffaele

S.P.1. FINAL CONSUMER, SUSTAINABILITY AND RESILIENCE
Session I: New products development

1. Methods, tools, and theories to assess the propensity to introduce innovations in the agrifood sector
   Tria Emanuela, Campobasso Adele Annarita, Petrontino Alessandro, Fucilli Vincenzo, Bozzo Francesco
2. Agricultural challenges for a more sustainable future: is the "green" consumer more willing to consume insect– based foods?
   Merlino Valentina Maria, Brun Filippo, Borra Danielle, Tarantola Martina, Mosca Oriana, Roma Rocco
3. Consumers' response to genetically modified food: an Italian case study

Demaria Federica, Gazza Laura, Nocente Francesca, Romeo Lironcurti Simona, Quarto Angelo

4. Cultivating Trust: Navigating Perceptions of RNAi Technologies in Agriculture After COVID–19 Vaccine Era
   Califano Giovanbattista, Pappalardo Gioacchino, Caracciolo Francesco, Spina Daniela, Raimondo Maria, D'Amico Mario
5. Would consumers buy upcycled foods? Evidence from a Discrete Choice Experiment in Italy
   Cavicchioli Daniele, De Marchi Elisa, Consonni Gabriella, Cappa Carola, Cavaliere Alessia, Rollini Manuela
6. Millennial consumer analysis of novel food purchasing attitudes: an application of the means–end chain (MEC)
   Calderoni Federica, Petrontino Alessandro, De Boni Annalisa, Ottomano Palmisano Giovanni, Roma Rocco, Bozzo Francesco

S.P.2. TERRITORIAL PRODUCTION SYSTEMS
Session A: Cooperation and resilience in territorial systems

1. New support for co–operation provided by Integrated Chain Projects in Emilia–Romagna Rural Development Programs 2014–2022
   Cisilino Federica, Giampaolo Antonio, Licciardo Francesco, Orlando Matteo, Tarangioli Serena
2. Food districts: a methodological proposal for territorial cooperation in agriculture
   Henke Roberto, Mazzocchi Giampiero, Cisilino Federica, Licciardo Francesco, Tarangioli Serena
3. Metodi e approcci per l'identificazione di obiettivi e priorità per la digitalizzazione della filiera ovina in Toscana: il caso del Caseificio di Manciano
   Ortolani Livia, Lai Maria Bonaria, Mignani Chiara, Ferrara Annapia, Silvi Alina, Brunori Gianluca
4. Crop Selection Tool for the resilience of the Salento area after the Xylella Fastidiosa outbreak: a Decision Support System for farmers
   Agnusdei Giulio Paolo, Miglietta Pier Paolo, Krstić Mladen
5. Co–progettazione di una filiera alimentare comunitaria come strategia per la rigenerazione e la resilienza alimentare delle aree interne
   Torquati Biancamaria, Stella Giordano, Giulietti Giacomo, Paffarini Chiara
6. Quality of life in inland areas
   Andreoli Maria, Cozzi Mario, Romano Severino, Viccaro Mauro

S.P.2. TERRITORIAL PRODUCTION SYSTEMS
Session B: Sustainability in territorial systems

1. Differences in sustainability outcomes between agritourism and non–agritourism farms based on robust case evidence from the Tyrol/Trentino Mountain region
Grillini Giulia, Sacchi Giovanna, Streifeneder Thomas, Fischer Christian
2. Exploring the sustainability of bioenergy systems through the land–water–energy nexus approach
Pulighe Giuseppe, Pirelli Tiziana, Lupia Flavio
3. Climate change and the quality of wine: a preliminary study on Collio whites
Carmeci Gaetano, Gallenti Gianluigi, Campisi Barbara, Bogoni Paolo, Carzedda Matteo, Millo Giovanni
4. Fostering farmers towards ecological transition through nudges. A systematic literature review
Vella Francesco, Migliore Giuseppina, Rizzo Giuseppina, Lombardi Alessia, Schifani Giorgio, Vecchio Riccardo
5. Assessing the role of agriculture in generating ammonia emissions by the analysis of manure–ammonia relationship. A case study in Lombardy, Italy
Maranzano Paolo, McConville Kelly, Otto Philipp, Carillo Felicetta
6. Indicatori di sostenibilità sociale per le imprese agro–alimentari: definizione, tipi di KPI e loro utilizzo
Briamonte Lucia, Pergamo Raffaella, Nazzaro Concetta, Salerno Chiara

S.O.2. DINAMICHE ORGANIZZATIVE E RELAZIONALI NELLA TRANSIZIONE AGROECOLOGICA E DIGITALE
Sessione organizzata nell'ambito delle attività di ricerca e di scambio relative al progetto Prin 2020 – ***Puzzling Out Smart Ruralities, Sound Knowledge And Rural (Agricultural/Agrifood) Entrepreneurial Ecosystem – SmARTIES***

1. Exploring the role of GIs for the twin transition: the case of the PDO Parmigiano Reggiano
Ciliberti Stefano, Martino Gaetano, Brunori Gianluca, Frascarelli Angelo
2. Governance in policy mix for sustainable transition: insights from a rural Region in Southern Italy
Di Santo Naomi, Del Giudice Teresa, Brunori Gianluca, Sisto Roberta
3. Digitalization and Artificial Intelligence for Sustainable Food Systems: operationalizing a new conceptual model for EU–funded case projects analysis
Gabellini Sara, Gerini Francesca. Casini Leonardo, Scaramuzzi Silvia

4. Territorial innovation and proximity economy for the regeneration of inner areas
   Nazzaro Concetta, Salvia Rosanna, Quaranta Giovanni, Sardaro Ruggero, Contò Francesco, La Sala Piermichele, Marotta Giuseppe
5. Contextualising digitalisation through ambidexterity and new territorial proximities
   De Rosa Marcello, Francescone M., Lioutas E., Charatsari C., Masi M., Vecchio Y.

S.P.3. FARMS AND ECONOMICS OF PRODUCTION
Session A: Innovation, sustainability, and economic performance

1. How to promote adoption of sustainable innovations by African smallholders? A randomised controlled trial approach
   Piras Simone, Kuhfuss Laure, Nchimbi–Msolla Susan, Mokhtari Noureddine, Kisakye Josephine, Setti Marco
2. Sustainability vs efficiency in the fishery sector: an analysis of the rapido fleet
   Ceccacci Alberto, Russo Elisabetta, Mulazzani Luca, Malorgio Giulio
3. Assessing the economic profitability of viticultural precision systems: some case studies in Italy
   Agosta Martina, Sofia Serena, Asciuto Antonio, Crescimanno Maria, Galati Antonino
4. Developing a taxonomy of costs and benefits for the digitalization of Agriculture and Rural Areas
   Vergamini Daniele, Lepore Fabio, Ortolani Livia, Brunori Gianluca
5. Performance assessment of Parmigiano–Reggiano dop dairies: a comparative analysis by altitude range and legal form
   Iotti Mattia, Bonazzi Giuseppe

S.P.3. FARMS AND ECONOMICS OF PRODUCTION
Session B: Sustainable farm management

1. A comparative Life Cycle Costing (LCC) analysis for economic sustainability assessment of three Mediterranean Crops
   Spada Emanuele, Falcone Giacomo, Iofrida Nathalie, Gulisano Giovanni, De Luca Anna Irene
2. The adoption of fungus–resistance grapevines: an analysis of producers approach in the Italian region of Veneto
   Maggio Elena, Bastioli Francesca, Fucile Franceschini Caterina, Pomarici Eugenio, Di Chiara Valentina

3. Sustainable pest management practices: an experiment on Apulian olive–growers
   Russo Ilaria, Vecchio Riccardo, Viscecchia Rosaria, Germinara Giacinto Salvatore, Cembalo Luigi, De Devitiis Biagia
4. Economic outputs of organic and conventional farms: effects of size on permanent crops
   Casolani Nicola, Chiodo Emilio, Coderoni Silvia, Perito Maria Angela
5. The contribution of economics to agroecology: a scoping review
   Fiore Vincenzo, Borrello Massimiliano, Carlucci Domenico, de Gennaro Bernardo Corrado, Giannoccaro Giacomo, Stemple Sarah

S.P.3. FARMS AND ECONOMICS OF PRODUCTION
Session C: Sustainability and efficiency in the animal production sector

1. Trade–off between the economic and environmental sustainability in the sheep farms using the FADN database
   Sau Paola, Arru Brunella, Cisilino Federica, Furesi Roberto, Pulina Pietro, Madau Fabio A.
2. Cost evaluation of internal biosecurity measures in the Italian pig sector
   Suprani Valentina, Romanelli Costanza, Aragrande Maurizio, Canali Massimo
3. Monitoring technical and economic indicator to improve farm economic sustainability
   Sechi Gian Simone, Cannas Antonello, Atzori Alberto Stanislao
4. How the digital readiness affects the economic profitability of livestock farms
   Righi Selene, Moretti Michele, Okoye Felicitas
5. The economic burden of the bluetongue disease for the sheep industry in Sardinia: an evaluation of private and public costs of the 2017 BTV–4 epidemics
   Canali Massimo, Romanelli Costanza, Aragrande Maurizio, Giovanni Savini

S.P.4. FILIERE E CATENE DEL VALORE ALIMENTARI
Sessione A: Sostenibilità

1. Exploring the path to sustainability in olive oil production: Stakeholder perspectives on the Tuscany supply chain
   Piracci Giovanna, Gerini Francesca, Casini Leonardo
2. The Cocoa Value Chain in Ghana: sustainability constraints and linkages to SDGs
   Romano Sara
3. Production contracts for the ecological transition in the agri–food supply chain: a best–worst scaling analysis of farmers' preferences
   Ciliberti Stefano, Frascarelli Angelo, Palazzoni Luca, Martino Gaetano

4. Reducing food waste at retail stores: Sales forecasting results from Machine Learning–based software in Italy
   Pietrangeli Roberta, Malefors Christopher, Svensson Erik, Eriksson Mattias, Nasso Marco, Cicatiello Clara
5. Agro–biodiversity oriented food systems: exploring the potential of the lentils value chain in Italy
   Verza Marta, Camanzi Luca, Malorgio Giulio, Rota Cosimo, Mulazzani Luca
6. Understanding the Determinants of Sustainability Strategies in the Beef Value Chain
   Marschner Stella, Orsi Luigi, Stranieri Stefanella

S.P.4. FILIERE E CATENE DEL VALORE ALIMENTARI
Sessione B: Competitività

1. Improving the transparency of the wine supply chain (WSC) with block chain technology (BCT)
   Rosa Franco, Mian G., Zironi A.

2. Strategie di cattura e di creazione del valore nella filiera mandorlicola siciliana: un'analisi di casi studio
   Borsellino Valeria, Galati Antonino, Varisco Michele, Mirabella Claudio, Schimmenti Emanuele
3. Sparkling wines throughout Europe. Studying their demand to characterize potential export markets
   Cei Leonardo, Rossetto Luca
4. Supporting the Apulian regional development through sustainable post xylella regeneration strategies: an ANP–ADAM approach
   Coluccia Benedetta, Tunno Vittoria
5. Adoption of technological innovation and farmers' perception in the bakery Italian supply chain
   Cappella Maria Teresa, Blasi Emanuele, Toscano Piero, Fosci Lorenzo
6. The foresight technique applied to the value chain of pasta filata cheeses in the central–southern Apennines: first evidences for an effective planning of rural development policies in remote and mountainous areas
   Belliggiano Angelo, Bindi Letizia, Bispini Sara, Ievoli Corrado

S.P.4. FILIERE E CATENE DEL VALORE ALIMENTARI
Sessione C: Filiere e catene del valore alimentari

1. The role of upstream actors in the management of fresh fruit & vegetables surplus and losses
   Nasso Marco, Alcon Francisco, Cicatiello Clara, Pietrangeli Roberta, Blasi Emanuele
2. Unearthing the determinants of intention to adopt blockchain: a preliminary study on the Italian wine sector
   Bentivoglio Deborah, Chiaraluce Giulia, Staffolani Giacomo, Santori Nicola, Finco Adele
3. Factors influencing the adoption of Blockchain technology based solutions in the wine and olive oil industry: evidence from Italian cases study
   Galati Antonino, Crescimanno Maria, Schimmenti Emanuele, Vella Francesco, Finco Adele, Bentivoglio Deborah, Contò Francesco, Chiaraluce Giulia, Staffolani Giacomo, Fiore Mariantonietta
4. La valutazione economica dei soprassuoli di castagno attraverso un modello geo–spaziale: prima applicazione in Valle di Susa
   Bruzzese Stefano, Galliano Fabio, Blanc Simone, Brun Filippo

S.P.5. ITALIAN FOOD SYSTEM
Session A: Italian food system

1. Indagine conoscitiva sulle strategie delle cooperative agroalimentari e della pesca per la ripresa dalla crisi provocata dalla pandemia da COVID–19
   Toccaceli Daniela, Ciliberti Stefano, Pacciani Alessandro, Martino Gaetano
2. Exploration of farmers' perception of urban food policies: the case of Bologna farmers' market Regulation
   Monticone Francesca, Samoggia Antonella
3. Women entrepreneurship in agriculture – a bibliometric analysis
   Vuciterna Rina, Manzella Sara, Mazzocchi Chiara, Corsi Stefano
4. Understanding how twin transition materializes in agrifood: an exploratory study
   Checchinato Francesca, Cinzia Colapinto, Vladi Finotto, Christine Mauracher, Chiara Rinaldi
5. L'approccio Living Lab nella transizione ecologica degli allevamenti: il caso della montagna abruzzese
   Forzoni L., Righi S., Riccioli F., Noretti M., Di Iacovo F.
6. Analisi delle strategie e delle politiche per rafforzare i sistemi di conoscenza e innovazione nel micro–AKIS del contesto ovino del sud della Toscana
   Mignani Chiara, Ferrara Anna, Brunori Gianluca

S.P.6. ROLE AND OBJECTIVES OF AGRICULTURAL POLICY
Session A: Food policy: public goals and market scenarios

1. Comparing Food Governance Networks in Rome and Barcelona: An Exploratory Study
   Gori Francesca, Castellini Alessandra
2. Future scenarios for insect protein production in Europe by year 2035
   Gambelli Danilo, Vairo Daniela, Zanoli Raffaele, Alleweldt Frank
3. What Europeans Want: Insights on Citizens and Research Debate on Nutri–Score
   Stiletto Alice, Cei Leonardo, Trestini Samuele
4. Food (in)security, Environmental Sustainability and Europe – Exploring future policy scenarios
   Paparella Antonio, Cembalo Luigi, Del Giudice Teresa, Freda Roberto
5. The role of research in the sustainability transition(s) in rural areas: a survey on Living Labs operated in EU– funded projects
   Arcuri Sabrina, Knickel Marina, Brunori Gianluca
6. Insights into consumer views on nutri–score labeling: a comprehensive analysis using q–methodology
   Rizzo Giuseppina, Mandolesi Serena, Testa Riccardo, Vella Francesco, Zanoli Raffaele, Migliore Giuseppina

S.P.6. ROLE AND OBJECTIVES OF AGRICULTURAL POLICY
Session B: Agricultural policy and ecological transition

1. The governance of the Common Agricultural Policy 2023–2027: analysing the role of partnership through Text Mining and Sentiment Analysis
   Pomponi Tommaso, Henke Roberto, Mazzocchi Giampiero, Monteleone Alessandro, Vassallo Marco, Sorrentino Alessandro
2. Exploring participation in eco–schemes on Italian farms: a qualitative analysis
   Martignani Federica, Cacchiarelli Luca, Sorrentino Alessandro
3. Economic and environmental outcomes of alternative economic policy tools to curb GHG emissions from Italian livestock sector
   Dell'Unto Davide, Coderoni Silvia, Cortignani Raffaele
4. Climate and environment: The directions of innovation studying Italian Operational Groups
   Menna Concetta, del Puente Francesco, Ugati Rossella, Lai Maria Bonaria, Del Giudice Teresa, Sapio Alessandro

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Improving the transparency of the wine supply chain (WSC) with block chain technology(BCT)

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Summary

The information efficiency of the wsc is under scrutiny since macroeconomic, financial and market interferences have destabilized the exchange system along the wine supply chain (wsc). This paper is dedicated to verify the hypothesis that the BCT could improve the wsc transparency by using innovative method of price reporting. The main conclusions are: i) BCT beside not yet very diffused yet among stakeholders of the wsc can improve consistently the wsc transparency by capturing unbiased information about peer to peer transactions and transmit unaltered to members of the wsc network; ii), larger and smaller operators, have different advantages; however the aggregation of smaller producers could contribute to achieve scale economies and make more accessible the BCT; iii), new profitable market segments could be realized.

Keywords: wine supply chain, transparency, block chain technology, market efficiency, quality control, customer satisfaction.

1 - INTRODUCTION

Scenario description – Many changes are occurring along the wsc: production, processing, marketing, logistic activities, the growing importance of traceability and sustainability functions in a growingly worldwide market contest (Cholette et al, 2005) are signing the transition from a prevailing family organization to a business oriented sector. The global wine business is projected to grow from $340.23 billion in 2021 to $456.76 billion in 2028 at an estimated CAGR of 4.30% in period, 2021-2028. The vineyards in the European Union (EU) is extended over 3.3 mha; the first five producers: French, Spain, France, Italy and Turchiye cover the 54,78 of the world area. World wine production, excluding juices and musts, in 2022 is estimated 258 mhl, a decrease of almost 3 mhl (-1%) compared to 2021. The trend remaining almost stable in the period 2007-2012 with cyclical changes afterword and a generalized decrease in 2022 compared to previous years. The major five countries covered the 64,41% of the total wine production, a slight increase compared to 63,8% of 2008. World wine consumption in 2022 was estimated at 232 mhl, a decrease of 2 mhl (-1%) compared to 2021; of this negative trend is mainly responsible the China's consumption (OIV,2021; Ohana Levi, 2023; Pomarici et al.,2021).

2 - THEORIES ABOUT MARKET EFFICIENCY CONDUCT AND PERFORMANCE

A solid theoretical background is provided by a number of theories regarding the market efficiency and transaction costs caused by incomplete/inefficient markets (Alchian et al, 1972; Craighead,

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2007). Here is reported a short review of the most relevant ones: the transaction cost theory, (Williamson, 1979) the resource based view (RBV), the market efficiency and the agent theory. (Stranieri et al, 2022; Williamson, 1991). The transaction cost is based on the market inefficiency that generate costs; RBV suggests that some idiosyncratic resources (e.g., strategic assets, competences, skills, knowledge, patent, brand, image) are valuable, rare, inimitable and non-substitutable can generate competitive advantage. (Barney, 1991; Treiblmaier, 2018). The efficient market theory is based on the assumption that the information released to the exchange is not completely shared among the all market participants (Fama, 1970; Kumar, 2021; Bouri et al., 2017); the agent theory suggests that the inequal distribution of information between principal and agent generates opportunistic games (Su et al, 2020).

3 – DESCRIPTION OF THE BLOCKCHAIN TECHNOLOGY

The BCT, is a kind of digital distributed ledger technology that uses the cryptography to transform any alfa-numeric data generated by transaction in digital encoded data records (ledger) secured with a hash function, to make transaction record authenticated, immutable, to be transmitted to a network of nodes by computers handled by the participants. (Buterin, 2015; Davidson et al, 2016; Catalini and Gans, 2016; Dressler et al., 2021; Biswas et al, 2017; Kapoor et al, 2021; Polvora, 2019; Cakic et al, 2021; Subramanian, 2017).

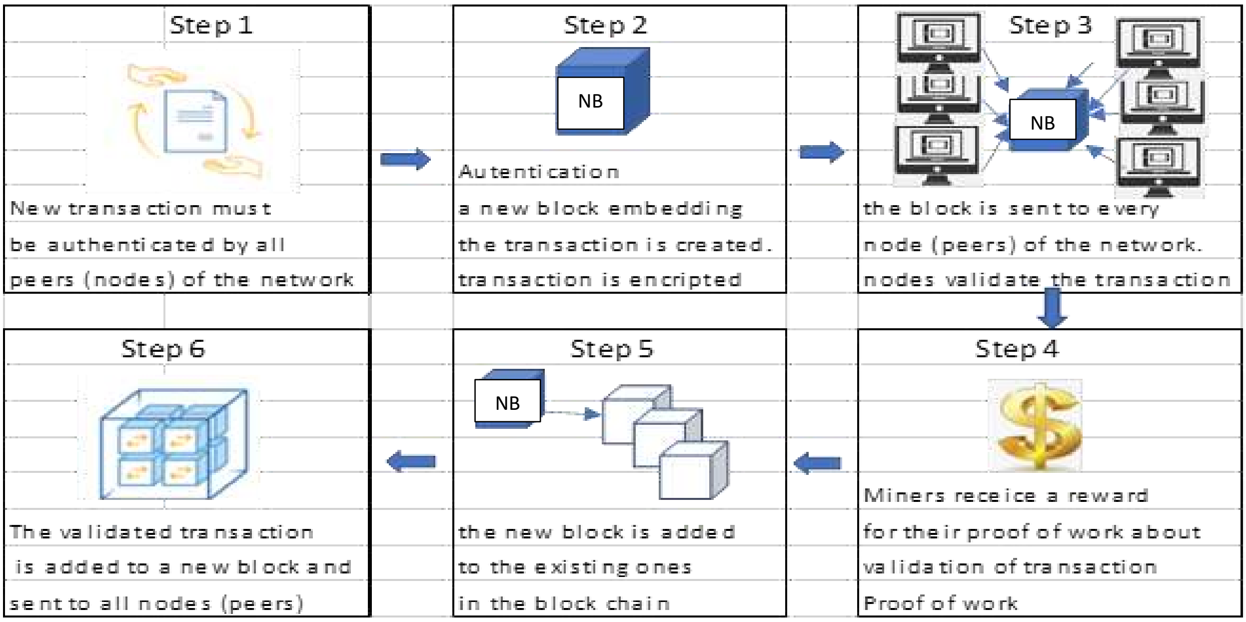
Most diffused applications of BCT in the wsc are:
i) tracing the product origin quality and authenticity for anyone involved in the life cycle of the wine product: grape producers, cooperatives, vine farmers, viticulturists, integrated wineries, storage companies and market intermediaries, amongst others. (Zhao et al,2019; Tian, 2016; Jian-Douang, 2020; Sidlovits et al., 2007).

ii) smart contracts using codes stored in a block-chain that allows a contract to be verified and enforced automatically, making it legally valid. Partners do not need to intervene to check the contract execution as it is operated by a block-chain (Aymo et al, 2020; Hilton et al., 2018; Kim et al., 2015).

iii) Non fungible token (NFT). It is the property of a non substitutable good i.e a bottle of wine of a given wintage,[2] or origin, that makes this product unique, to be traded in niche market to a profiled consumer at higher price.

[2] Vintage of wine is the year in which the grapes harvested. The vintage year is mentioned on the front of the wine bottle label to keep track of it all and are usually a great way to compare wines and to give higher value to the bottle.

Fig 1 - Six steps to update the transaction in block chain with BCT



4 - THE EMPIRICAL ANALYSIS: HYPOTHESES AND CONFIRMATION.

Here following are reported three hypotheses to be verified for the adoption of BCT in wsc.

H1 – Is the BCT contributing to improve the transparency of the wsc?

H2 – Is the BCT usable for markets segmentation?

H3 –BCT complexity could represent a burden to adopt it in the wsc?

The H1 hypothesis is ascertained with a brief exam of the wsc structure and evidences of positive contribution of BCT to improve the transparency, to avoid wine counterfeits and frauds (Ranken, 2014; Roberto, 2011; Saberi et al, 2019; Steiner, 2012; Galati et al, 2021)

The stages, operators of the wsc structure and the informational efficiency of the stages

A brief description of the wsc stages and operators at different stages of the wsc is following.

1 - Grape grower (Field operations). Grape production is the first stage of the wsc; grape growers are in charge to perform the best agronomic conditions for quality production and enter the information into an informatic system.

2 – Winemakers – (cellar operations). The thee stages of cellar operations: i) grape pressing and fermentation; ii) wine aging; iii) wine packaging and transport can be made by a single grape grower or associated in coops or in separate units.

3 - Wholesale Distributor - They are responsible for receiving wine from winemakers, blending , and sending the finished product to a transit cellar or packer. Wholesale distributors participate to the block-chain by entering data on transportation, storage, Information on processing, sampling, bulk wine analysis, and date of shipment; in case of mixing process is performed, this is also recorded in the block-chain.

4 - Transit Cellar operators - They are responsible for receiving, storing, shipping, processing, sampling, and analyzing wine in bulk. In essence, the role of the transit cellar is similar to that of the wholesale distributors.

5 Filler/Packer - Receive wine from a wholesale distributor or transit cellar and pour it into barrels, kegs, bottles, or bags. Transactions regard product identification and labeling.

6 Distributor of finished products. The wine is delivered to operators represented by wholesalers or retailers.

6.1 – Wholesalers - Receive boxes and pallets with wine and send them to retail stores. Transactions regard the storing conditions, shipping finished packaged products to end users as retail outlets, managing inventory in the form of bottles, cans, barrels, and cardboard boxes.

6.2 - Retailer - receives finished products: bottles, cans, barrels and cardboard boxes from the distributor of finished products or the wholesaler and sells them to final consumers. Transactions are for goods received, storage and sale. The sale must be logged so that the same identification tag cannot be reused.

6.3 – Importer and consumers. Importers receive wine from distributors and sell to consumers

This wsc configuration allows twenty one possible links or agreements among the different categories of operators distributed along the wsc, generating twenty one possible transaction groups. These links are: i) raw material suppliers and grape growers; ii) raw material suppliers and wine producers; iii) raw material suppliers and fillers/packers; iv) grape growers and wine producers; v) grape growers and fillers/packers; vi) grape growers and cellar door sales; vii) wine producers and bulk wine distributors; viii) wine producers and fillers/packers; ix) wine producers and freight forwarders; x) freight forwarders and freight operators; xi) freight operators and importers; xii) bulk wine distributors and transit cellars; xiii) transit cellars and fillers/packers; xiv) fillers/packers and finished good distributors; xv) fillers/packers and freight operators; xvi) finished good distributors and wholesalers; xvii) finished good distributors and retailers; xviii) finished good distributors and importers; xix) finished good distributors and customers; xx) retailers and end consumers; xxi) importers and customers **(**Saglietto et al., 2016; Adamashvili et al.,2021; Dressler et al., 2021; Garcia Alcaraz, et al., 2017; Stasia et al, 2016; Garcia et al, 2012).

5 - CASES SUPPORTING THE BCT TRANSPARENCY

The timestamp about any transaction is recorded on a smartphone and then transferred onto an NFC (Near Field Communication) chip, or other technologies like bar code, QR (quick response) code, RFID (Radio frequency identification), wireless sensors. This chip or QR code stores all the wine's data, from its birth in the winery to how it is transported, its distribution and transaction history and so on. With block-chain, it will become easier to track the wine's origin, making such instances as wine adulterations uncommon or even extinct

1 – The Winechain project, has been launched by Xavier Garambois, Amazon's former vice president of EU retail, by the end of 2022 with purpose to build a dynamic and interactive relationship between prestigious wineries and demanding consumers. Buyers have access to wines with a guarantee of authenticity bottles stored in the Wine-chain cellar until they are shipped. Collectors can sell NFTs wines.

2 - The "Big Four" professional services firm Ernst & Young (EY) has developed a block-chain platform for a firm that will help consumers understand the wines' quality, provenance, and authenticity. In 2019, the TATTOO Wine Platform has been developed for Block-chain Wine Pte. Ltd. by using EY's Ops Chain solution.

3 - The House of Roosevelt, an Asian wine cellar, has created a platform and use it to sell wines directly from vineyards to hotels, restaurants, cafés, and customers. According to Ernst & Young "Each bottle of wine is 'tattooed' with its own unique QR code. By scanning the QR code, participants

can access information such as vineyards' names and locations, details such as the types of fertilizers used to grow the crops, and how each batch is transported for processing and delivery. The platform concentrate on Asian markets where the demand for European wines is growing. More than 5,000 labels, including wines from France, Italy, Spain, Australia, New Zealand, South Africa, South America, and California, are traded with this platform using BCT.

4 - Vinsent (formerly VinX), a fast-growing Israeli blockchain technology startup, has also developed a supply chain network for trading wine future contracts, which enables wine collectors to buy a vintage while it's still in the barrel, a year or two before it's bottled, and made available to the public.[3]

5 - EY Ops Chain —. The project was created by consulting company EY (included in the Big Four along with Deloitte, KPMG and PwC) in collaboration with EzLab and is focused on protecting the quality of Made in Italy production and increasing market transparency. The development uses the winery LaVis. Traceability of the sales chain, P2P transactions and open access to information on the block-chain are also available.

6 – Development of a quality assurance scheme: Viticultures in Georgia have developped with the help of a panel of experts to evaluate the vintages, quality, and authenticate a wine's origins to ensure that wines meet the highest industry standards. Registering wine in the blockchain enhances a producer's anti-counterfeit systems, which will result in reducing fakes in the market and building brand value.

7 - Operational since 2010, several wineries in Spain have accepted the anti-fraud system of the "Centro Técnico Operativo del Vino (CTOV) 5 powered by SICPA, is to protect the product against possible fraud" as a formula to safeguard the prestige of their brand and to offer a safer product. The encrypted and sequential code linked to each bottle is activated when the wine is bottled.

8 – Cantina Volpone: With Ernst&Young (EY) partnership, EZ Lab has developed the first case of wine blockchain, designed for Cantina Volpone's wine production (Apulia, Italy). This is the first bottle of Bianco Falanghina traced from the vineyard to the bottle. It allows to explore a "Virtual Zero-Mile" product, enhancing the relationship between producer and consumer. Every wine-making process is tracked and registered, so the final consumer can learn the whole transformation process from grapes to wine bottles,

9). Since 2000, the Indices from The London International Vintners Exchange have been tracking the prices of the world's most traded fine wines, using the Liv-ex Mid Price independent, transaction based data.

10) Traceability An important application of BCT is to link identity, location, material attributes, certifications and audit information with a specific item or batch ID. The data is stored in an immutable and globally auditable format which protects identities by default, allowing for secure data verification.

6 - HYPOTHESIS 2 - BCT FOR MARKETS SEGMENTATION: NFT

Fungible' is a term used by economists to describe interchangeable 'goods or commodities: i.e. two barrels of crude oil can be changed with two bottles of good wine. However, the same wine Chardonnay can be produced in different territories that give to this wine different attributes: color, odor, taste, acidity and others that make the product unique or 'non fungible'. (Faye et al, 2015; Bisvas et al,2017)

[3]See "Why the Internet of Things will Lead to the Internet of Wines?"

. The main features of this platform are described as follow:

- A non-fungible token (NFT) is a piece of unalterable data, that can be sold and traded online.
- In the wsc NFTs can be used as a guarantee of wine for wine authenticity.
- By removing the middle man and including commissions on subsequent sale, NFTs may give producers extra ongoing income.
- Napa producer Yao Ming, Constellation and Château Angelus and others have adopted NFTs.

Evidences of NFT. Big groups as Constellation, Treasury Wine Estates and LVMH have all now bought into the idea of NFTs. In April 2021, NBA star and Napa Valley winery owner, Yao Ming auctioned 200 'Physical Twin' NFTs, in the shape of online tokens and bottles of the 2016 vintage of his top wine, The Chop.

The Constellation-owned Robert Mondavi winery offered another example of how NFTs can combine tangible asset and experiences with the launch of nearly 2,000 specially commissioned bottles of three unique blends. Buyers receive a limited-edition bottle designed and created by Bernard and an invitation to a tasting for four people at the "To Kalon vineyard" where the grapes were grown. Mondavi, like Penfolds when it offered a barrel of the 2021 vintage of its rare Magill Cellar 3 as an NFT, went directly to the consumer. This cutting-out of the middle man is an important part of the NFT story – for wine and art, and this can extend beyond the original sale.

1 - In November 2021, iconic Australian winery Penfolds sold a barrel of its Magill Cellar 3 Cabernet Shiraz 2021 to NFT for $130,000 for 12 sec. 10 hours.

2 - BitWine, in collaboration with sommelier Loren Weil, has developed a collection of 1,000 digital wines inspired by great real wines. Each of them is a unique work of art. BitWine sells NFT in blocks of 50 wines from different regions of production — there's even a $300,000 lot.

8 - H3 – BCT COMPLEXITY: A BURDEN TO ITS ADOPTION IN THE WSC

Currently block-chains show some limitations regarding scalability and performance of transaction encoding and reporting. Performance in BCT is related to the process and approval of an authentic transaction and the accuracy of the timestamp that indicates the moment of creation of the new block. The time to complete this process could range between 10 to 60 minutes.

Tab. 1 - Exponential increase of updating transaction time due to combination of nodes and transactions per node

	transaction per node							
Node	1	2	3	4	5	6	7	8
1	1	2	3	4	5	6	7	8
2	2	4	8	16	32	64	128	256
3	3	9	27	81	243	729	2187	6561
4	4	16	64	256	1024	4096	16384	65536
5	5	25	125	625	3125	15625	78125	390625
6	6	36	216	1296	7776	46656	279936	1679616
7	7	49	343	2401	16807	117649	823543	5764801
8	8	64	512	4096	32768	262144	2097152	16777216
…								
21	21	441	9261	194481	4084101	85766121	1,8E+09	3,78E+10

Furthermore, one block creation requires on average 10 minutes, and the transactions processed per second are from 5 to 7 (300-420 for one min.) this gap is a serious obstacle to the speed of transaction execution.[4] A limitation of block-chain is in the application to small smart devices (IoT), which, probably, are predominant in wsc; the block-chain contains all past data, so its usage requires substantial memory, and it is difficult to store and download all this information in devices with limited memory capacity (RAM, ROM). The twenty one nodes with eight transactions per node reported in table 2 assuming 400 transactions per min. would require 94557148 min. to be executed. Another strong/weakness point is the immutability of encoded digital records that could create problems in case of a correction is needed. This is an option with a built-in off-chain to store larger sets of data in an own database and share in the BC only the essential info.

8 - CONCLUSIONS

The data in the BCT are vulnerable to threats and attacks, which may hypothetically allow individuals or groups to change the records or reverse transaction.
Pros - In wsc the diffusion of digital ledger transactions[5] has facilitated the growth of the wine market intelligence and contributed to broaden the market area, the number of participants, by spreading knowledge about wine among all participants (OIV, 2021).
Cons the information about relevant attributes of wine disclosed in peer to peer transaction could be incomplete; ii) it is impossible to ascertain the loyalty of contractors; iii) the knowledge about market conditions can be incomplete and asymmetric information generate opportunistic games.

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[4] For example, Visa system has a frequency of processing of 3600 transactions per second on average, and can reach a peak of 65 000 transactions processed per second, a huge difference in performances, respect to those of the Bitcoin platform.
[5]Digital instruments as IoT, AI, LIDAR (laser image detection and ranging, GIS, block chain, digital transactions, E-label (Q-code), E-certification, smart storing) offers opportunities for the sector to gain efficiency, transparency, productivity, with new business opportunities, better market exchanges, improved sustainability of the wsc.

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UNDERSTANDING CONSUMER PREFERENCES FOR POTTED PLANTS: THE ROLE OF PHYTOSANITARY DIAGNOSTICS AND ECO-FRIENDLY CULTIVATION PRACTICES

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Keywords: Ornamental Plants, Sustainable cultivation techniques, Plant diagnosis, Consumer preferences, WTP, Choice experiment.

INTRODUCTION

The production of Mediterranean plants in nurseries represents a frontier for innovations due to the occurrence of different drivers and challenges, such as the emergence of destructive diseases, the impact of climate change and the increasing need for economic sustainability among producers. In this context, there is a crucial need for efficient plant disease diagnosis protocols, safe production processes and sustainable multiplication techniques to effectively address these significant issues.

Plant diagnosis is a scientific process that identifies the presence or absence of biotic stresses in plants, including bacteria, viruses, fungi, nematodes, insects, arachnids, and weeds. It involves detecting, identifying, and distinguishing these organisms at different taxonomic levels. Recently, the detection of Xylella fastidiosa (Xf), a destructive bacterium affecting numerous plant species, has gained significant attention. Xf has caused substantial economic, social, and ecological damage in the Salento area of southern Italy (Cardone et al., 2022). The outbreak has negatively impacted the Apulian plant nursery business, leading to export restrictions and mandatory inspections in demarcated areas. In this context, novel and fast plant diagnosis assays using serological and molecular tests have been developed by academic institutions, research centers and testing laboratories. These assays are crucial for regulatory decisions, reestablishing pest-free areas, trade purposes, pest eradication strategies, pest risk analysis, and addressing consumers' concerns. Indeed, due to the increasing concern for landscape transformations implied by Xf outbreak in Salento are (Frem et al., 2021) innovative solutions addressed to limit the spread of the disease can benefit nursery entrepreneurs by influencing consumers' perceptions and purchase decisions.

Sustainable cultivation techniques play a vital role in enhancing productivity, competitiveness and promoting the commercialization of ornamental plants while reducing environmental impacts. Producers, including plant nurseries, are increasingly adopting sustainable production practices to meet consumers' concerns and gain a competitive advantage. The use of bio-stimulators, such as auxins and seaweed extracts, aligns with sustainability goals by promoting balanced growth and root development in ornamental species. Consumers' preferences for environmentally friendly products also drive producers to adopt eco-friendly inputs and production methods (Grymshi et al., 2021). Previous research has explored consumer preferences for ornamental plants, focusing on attributes like physical appearance, local production, eco-friendly cultivation techniques, and price (Khachatryan, 2013; Wollaeger et al., 2015; Kalaman et al., 2022). However, limited research has investigated Italian consumers' preferences and estimated their WTP for specific attributes of ornamental plants. In this context, a research project called "ProDiQuaVi" aims to transfer protocols for quarantine and harmful organisms and improve sanitary materials for the Apulian nursery sector. As part of this project, a study was conducted with the aim of investigating the following research questions: A*re innovative potted ornamental plants able to command a price premium compared to conventional produced plants? Do consumers have different preferences related to these attributes? Which characteristics and which purchase and use habits do they have?*

Given the scope of the research, we conducted a study that, through hypothetical market scenarios, allowed us to investigate the product characteristics that give the greatest relative utility (Hensher et al., 2005; Train, 2000). In the frame of the theory of individual choices, the use of specific logit models (Latent Class Model) revealed the heterogeneity of consumers, filling a literature gap by exploring different plant attributes simultaneously and giving an idea of how heterogeneous are and how they behave.

The findings have implications for nursery growers and policy makers in planning production, marketing, and regulations related to plant health. Indeed, this study enhances understanding of consumers' choice behaviour for non-edible outdoor potted plants in Italy, aiding nursery growers in marketing strategies and policy makers in communication and compliance with EU regulations.

MATERIALS AND METHODS

A Discrete Choice Experiment approach was employed to elicit consumers' preferences and WTP for labelling information about plant diagnosis and cultivation techniques. Choice experiment, as a stated preference technique that provides valuable evidence of consumer preferences and inclinations, involves five key steps: attribute selection, experimental design, choice set construction, preference measurement, and econometric data analysis.

Three attributes were chosen based on input from local horticulture experts participating to "ProDiQuaVi" project. The first attribute focused on phytosanitary diagnosis in nurseries (DIA), with two levels representing the use of a novel diagnostic protocol versus conventional measures. The second attribute examined different cultivation techniques (SOS), with one level representing conventional methods and the other representing sustainable practices (Loconsole et al., 2021). The third attribute explored the price of the product (PRI), with four levels reflecting market ranges.

To design the choice experiment, a full factorial design was employed, resulting in 120 alternative scenarios. A D-efficient Bayesian design was utilized to improve data quality and precision while minimizing costs, time of the survey and cognitive burden for respondents.

The questionnaire was divided into three sections. The first section explored respondents' habits and propensity to purchase ornamental plants. The second section p presents an explanation scheme and eight purchase simulations, each offering two options of potted plants with different attributes and prices (an example in Fig. 2). Respondents could choose one option or decide not to buy any. The third section aimed to collect demographic and socio-economic information.

Figure 1 Example of a choice task

To gather data, a survey has been launched using a questionnaire made available online from June 2021 to June 2022. Valid responses have been collected from 464 participants, balanced on demographic parameters, such as age and gender.
To analyze the collected data, a preliminary multinomial logit model (MNL) was applied using NLogit software (version 5). Due to the limitations of the MNL (McFadden, 2001), a latent class model (LCM) was employed to analyse different behaviours among respondents. The LCM model allows us to group consumers into different classes based on their purchasing choices (Lazarsfeld and Henry, 1968). Since it is not possible to know with exact certainty which alternative “j” is most useful for the respondent, it is determined that the alternative “j” is more useful than the other alternatives considered. As a result of the selection of alternative j in the various purchase sets, the probability of consumer “i” to fall into class q is expressed by:

$$\pi_{ij|q} = \frac{\exp\,(\beta_q' x_{ij})}{\sum_{q=1}^{Q} \exp\,(\beta_q' x_{ij})} \tag{1}$$

Where: “xij” expresses a set of typical characteristics of the class; “βq” are specific coefficients relative to the classes to be estimated. To determine the optimal number of classes, criteria values such as maximum log likelihood, minimum Bayesian information criteria (BIC), and minimum Corrected Akaike Criteria (CAIC) were evaluated. By gradually increasing the number of classes, the model achieved improved fit and performance in terms of stability, sensitivity, and specificity.
Regarding the estimation of WTP that reflects how much consumers are willing to pay extra a price premium for a potted plant with specific characteristics, we used the following formula:

$$\mathrm{WTPa} = -\,\frac{\beta a}{\beta p} \tag{2}$$

Where: “WTPa” is the willingness-to-pay for attribute “a”; “βa” and “βp” are the estimated coefficients related to each attribute and price, respectively, according to the respondent’s membership to each class.

RESULTS AND DISCUSSION

Our sample results aligned with the Italian population structure in terms of age and gender. About 34% of the sample results to be under 30 years old, 31% up to 50 years old and 35% greater than 50 years old. Male and females results respectively with the following percentages 44% and 56%. The study level of our sample results to be more unbalanced with a prevalence of a high level of education, representing a possible bias of the findings. Looking at consumer behaviour, 31% of respondents preferred to acquire ornamental plants in nursery shops, followed by florists (30.00%) and shopping malls (16%). The aspects of the product that received the most attention during purchase is the state of health with 71%, absence of visible defects with 62%, plant luxuriance with 52%, care requirements with 51% and water requirements with 39%. In terms of care of the product once purchased, 49% of the respondents preferred to take personal care of the plants, without seeking external advice from specialists.
Starting from MNL elaboration, the analysis suggests that the choice behaviour is influenced by the intercepts for each attribute. The coefficients indicate the effect of each intercept on the probability of choosing a particular product. In particular, the ASC “OPTOUT” is negative and significant, showing a general propensity of respondents for purchasing the potted plants. Price (PRI), as expected, has negative coefficient, while both diagnosis techniques (DIA) and sustainable production methods (SOS) have positive influence on respondents’ choices. Potted plants produced with innovative diagnosis techniques have about 30% probability of being chose respect to that produced with sustainable techniques.

Regard to Latent Class results, the analysis was performed with different numbers of classes ranging from 1 to 6. For each number of classes, the log likelihood and information criteria were computed, including the Inf.Cr.AIC, AIC/N and Adjusted BIC. The results show that as the number of latent classes increases, the log likelihood decreases, indicating better model fit, but reducing the consistency of each class and complicating the overall model. It appears that the model with 5 latent classes (K=5) has the lowest log likelihood (-2979) and the best fit according to the information criteria. The percentage of the sample assigned to each of the five classes is provided, ranging from 8% to 31%. Log likelihood of the model with 5 classes compared to restricted one perform a significant chi-squared test and the McFadden pseudo R-squared indicate a moderate level of fit. Each class has different utility parameters for the predictor variables. Post-elaboration analysis allowed for the interpretation of the behavior and characteristics of each class based on the following table (Tab. 1) and the descriptive statistics of each class. The segmentation analysis was conducted by considering the covariates, resulting in significant differences across classes.

Tabel 1 Latent Class Analysis results

Class	Var.	Coefficients	St. Er.	z	Prob. |z|>Z*	95% Confidence Interval	
1	PRI	0.14830**	0.05815	2.55	0.0108	0.03433	0.26228
	DIA	3.34491***	0.3965	8.44	0	2.56778	4.12203
	SOS	1.46855***	0.30707	4.78	0	0.86671	2.07038
	OPTOUT	-0.02551	0.414	-0.06	0.9509	-0.83694	0.78591
2	PRI	-0.11389***	0.03094	-3.68	0.0002	-0.17454	-0.05325
	DIA	0.69281***	0.20196	3.43	0.0006	0.29698	1.08864
	SOS	1.11086***	0.15424	7.2	0	0.80855	1.41318
	OPTOUT	-1.79515***	0.32509	-5.52	0	-2.43232	-1.15797
3	PRI	-0.82441***	0.11607	-7.1	0	-1.0519	-0.59691
	DIA	0.88302**	0.34764	2.54	0.0111	0.20166	1.56438
	SOS	1.19945***	0.33337	3.6	0.0003	0.54605	1.85284
	OPTOUT	-4.16053***	0.45458	-9.15	0	-5.05149	-3.26957
4	PRI	-0.13416***	0.03921	-3.42	0.0006	-0.21102	-0.05731
	DIA	1.80417***	0.30992	5.82	0	1.19674	2.41159
	SOS	1.26312***	0.20934	6.03	0	0.85281	1.67343
	OPTOUT	1.20360***	0.229	5.26	0	0.75477	1.65244
5	PRI	-0.24909	0.3517	-0.71	0.4788	-0.93841	0.44022
	DIA	-0.14798	1.57975	-0.09	0.9254	-3.24423	2.94828
	SOS	-2.04314	1.72048	-1.19	0.235	-5.41523	1.32894
	OPTOUT	2.90442***	1.00348	2.89	0.0038	0.93764	4.87121

Note: ***, **, * ==> Significance at 1%, 5%, 10% level.

Sociodemographic and consumer habits variables were not included in the initial LCM to avoid overcomplicating the model. A post-hoc test of significance was performed on the variation of these variables after the respondents had been assigned to each class. Only variables that had a significant impact on the class membership were included in the final class description that results as follow.

The first class, comprising 21% of respondents, showed a positive price coefficient and a high frequency of purchase. They preferred buying from nurseries or direct producers and placed high importance on quality

aspects, but not on price. They personally cared for plants and predominantly lived in houses with private green spaces. This class consisted of educated individuals with a medium-high income.
The second class, comprising 30% of respondents, had a medium-high willingness to pay for both attributes and preferred sustainable cultivation techniques. They made moderate purchases from florists and garden centers, emphasizing care and absence of defects. They had private green spaces, higher education, and medium income.
The third class accounted for 19% of the sample and showed a positive but limited willingness to pay. They were occasional buyers who did not prioritize a specific place of purchase and primarily sought low prices. They disregarded cultivation methods, care, and water requirements of plants. Their education level was medium-high, and they did not predominantly live in contexts with private green spaces.
The fourth class, representing 20% of the sample, consisted of relatively rare buyers who occasionally preferred florists over nurseries. Despite not expressing clear attention to specific aspects, their willingness to pay was high, likely influenced by the low frequency of their purchases. They showed a preference for phytosanitary diagnosis techniques rather than sustainable cultivation techniques.
The fifth and smallest class, comprising 8% of respondents, demonstrated a strong aversion towards the product. They had a high and positive coefficient related to non-purchase, indicating no willingness to pay for the considered attributes. They rarely made purchases, did not care for plants at home and lacked houses with green spaces. This class had the lowest proportion of individuals with a diploma, indicating lower education and income levels compared to other classes.
Our study aligns with findings from existing literature, reinforcing key insights from previous research (Khachatryan, 2013; Wollaeger et al., 2015; Kalaman et al., 2022). These studies provide further support to our research findings and contribute to a broader understanding of consumer behaviour in the context of ornamental plant purchases.

CONCLUSIONS

The importance of phytosanitary diagnostics for ornamental plants has increased for Apulia nurseries due to global plant trade restrictions caused by the outbreak of Xylella fastidiosa (Xf) since 2013. This study aimed to assess consumers' perceptions of sustainable practices in ornamental plant cultivation, including optimal plant stimulator use, resource efficiency, and reduced inputs.
Providing clear labelling information about plant health and eco-friendly cultivation methods can significantly influence consumers' preferences and raise awareness about plant health and production. Nurseries, garden centers and plant retailers that effectively provide this information are better positioned to drive sales of ornamental species especially towards specific consumer groups, more sensitive regarding one or both product characteristics. Indeed, the segmentation of the potted plants resulting from the latent class would help nurseries and distributors to better assign, were applicable, a premium price according to the product allocation and to worthy compensate the increased costs deriving from diagnostic, sustainable cultivation techniques and communication needs.
Further research involving specialists is needed to understand the impact of novel plant disease diagnostics and sustainable cultivation methods. Engaging plant societies through social media can also ensure effective dissemination of information.

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AGRICULTURAL CHALLENGES FOR A MORE SUSTAINABLE FUTURE: IS THE "GREEN" CONSUMER MORE WILLING TO CONSUME INSECT-BASED FOODS?

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Consumer preferences, intention-to-eat, food consumption, sustainability

Introduction

Consumers are increasingly aware of environmental challenges and concerned about the impact of the food production chain (Boncinelli *et al.*, 2017; Hoek *et al.*, 2017; Ma and Chang, 2022). Globally, there is an increasing need to recycle or reuse waste materials or by-products from agri-food supply chains in a circular economy perspective (Chiaraluce *et al.*, 2021). In addition, the use of new ingredients or the introduction of new foods is also growing, in order to maximise the efficiency of the production system (Carla *et al.*, 2020).

Insects have come to market as a source of protein or fat for feeding farm animals, but also as food. Several obstacles still interfere with the large-scale expansion of this supply chain as food: low consumer acceptability and low economic sustainability of a supply chain still in its early stages are the main barriers (Caparros Megido *et al.*, 2018; Cicatiello *et al.*, 2016). However, it seems that insects will soon become part of consumers' diets as food substitutes for conventional animal proteins derived from production systems that, in some intensive realities, seem to be responsible for negative environmental impacts in terms of CO_2 and water footprint (Niva and Vainio, 2021).

In this context, the aim of this research was to identify patterns of choice of insect-based foods based on the attitudes of individuals towards environmental issues.

Materials and methods

A web-based survey was developed and submitted at national level. A structured questionnaire was designed considering the following sections: the first one was dedicated to the socio-demographic characteristics of the respondents, the second to individual attitudes towards environmental concerns and the third and last section to the intention to consume insects-based foods. In particular, this latter variable was measured using a visual approach: respondents were asked to choose which of 10 different insect-based food dishes they would be willing to consume.

First, a descriptive analysis of the sample was made. Then, responses on the preferences expressed towards different statements about the environmental concern of food production were analysed using Principal Component Analysis (PCA) to obtain different consumption patterns. In particular, combining different items of two scales dedicated to the environmental sustainability aspects of the food supply-chain, a total of 14 items (Cronbach's Alpha was equal to 0.899) were used in the PCA.

The loadings of the new principal components were used as dependent variables in a Cluster Analysis, to obtain clusters of individuals based on their attitudes towards the environment. First, the k-means technique, based on hierarchical cluster analysis and Euclidean distances, was used to cluster consumers according to their attitude patterns. Then each cluster was explored and compared in terms of socio-demographic variables and intention to consume insect-based foods. Finally, among consumers willing to eat insects, attention to the visual aspect of insect-based food was also explored.

Results

A total of 1402 respondents filled the questionnaire correctly. The PCA resulted in 3 principal components that together explained the 69% of the total variance (Table 1).

Tabel 1 – Principal Component Analysis

	Sustainable supply-chain	Balance with the environment	Alternative production patterns
Organic production method	0.708		
Use of alternative energy	0.837		
Biodegradable or recyclable packaging	0.771		
Carbon footprint certification (for low CO2 emissions)	0.876		
Water footprint certification (for limited water use)	0.866		
Short supply chain	0.826		
Local origin	0.696		
Reduced use of chemical compounds (e.g., pesticides)	0.692		
Preventing pollution: protecting natural resources		0.851	
Respect the earth: harmony with other species		0.850	
True human progress can only be achieved by maintaining ecological balance		0.751	

Eating meat or cold cuts every day (or almost every day) poses a health risk to people.			0.839
Eating meat or cold cuts every day (or nearly every day) poses a risk to the environment			0.849
The negative environmental consequences of eating meat or cured meats affect only those places where production is industrial (e.g. from intensive livestock farms)			0.484
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Kaiser-Meyer-Olkin Measure of Sampling Adequacy= 0.885; Bartlett's Test of Sphericity - Approx. Chi-Square= 13485.548; Sig.= 0.000			

The first component (47.3% of the total variance) was named "sustainable supply-chain" as it defined a consumption model based on the attention towards the sustainability approach of production systems, the principles of circular economy and on the low-impact supply chain. The second component (12.7% of the total variance), named "balance with the environment" is characterised by a choice model oriented toward maintaining a balance with the environment and ecosystems. The last component "alternative production patterns" accounted for the 9% of the total variance and identified a consumption model focused on choosing alternative production patterns to traditional intensive systems. The cluster analysis allowed the definition of 4 different consumer groups (Table 2).

Tabel 2– Consumer Clusters definition

Principal component	Clusters			
	1	2	3	4
Sustainable supply-chain	-0.49084	0.27407	-0.05774	0.1559
Balance with the environment	0.14769	0.19425	-0.49423	0.2393
Alternative production patterns	0.11060	1.00623	-0.30807	-0.8817

The components "balance with the environment" and "alternative production models" weighed simultaneously positively in defining the model of choice for cluster 1, which was also the most representative of the entire sample (51 %). Therefore, these individuals were oriented toward choosing foods from sustainable, traditional supply chains, linked to land-based production systems, where the human-environment-animal balance is maintained and preserved.

In the second cluster (24%) individuals were oriented to sustainable food choices, directing their choices toward production systems in alternatives in order to ensure the sustainability of food systems. Cluster 3 (15%) was represented by individuals whose food choice orientation is not dictated by pro-environmental attitudes, maintaining scepticism toward alternative food systems. Finally, the last cluster (10%) was represented by individuals who showed a positive attitude toward sustainable food production models displaying, however, a discordant attitude toward alternative systems suggesting a positive approach toward traditional, land-related systems in which the connection between human-animal and environment is emphasized.

The number of selected insect-based food dishes for each cluster are reported in Table 3.

Tabel 3 – number of insect-based dishes selected by each obtained cluster of consumers.

Cluster	Selected insect-based dishes (n.)	%
1	155	25%
2	314	50%
3	89	14%
4	66	11%

Cluster 1 and 4 were the least oriented toward insect consumption; in fact, among the total disagreements obtained from the question "which of these insect foods would you eat?", 50% of the "none" responses were obtained from cluster 1. On the contrary, cluster 2 was the most inclined to consume insect-based products.

However, considering the only positive answers towards the insect-based food alternatives, the number of insect foods selected by consumers in the 4 groups did not differ significantly. In fact, on average, out of 10 types of foods proposed to respondents, the 4 groups chose 4 dishes. Specifically, the main foods chosen by respondents were those in which the insect was not visible and, above all, a sweet product (muffins with 683 agreement). In contrast, among the products with the insect visible, the one most chosen was fried crickets. In addition, 542 intercepted respondents indicated that they were willing to consume pasta with insect flour, while only 172 spaghettis with visible insects.

Conclusions

This research identified different profiles of insect food choice as a function of individuals' attitudes toward environmental sustainability. Different orientations and perceptions of environmental issues in the food sector influence the choice of insect-based foods, but not the extent of inclusion of insect-based products in the diet. The visual aspect in product development in emerging markets resulted as a discriminating factor in future consumer choice, even for traditional national products such as pasta. This study contributes to the existing literature by defining how concerns toward the environmental sustainability of food systems affect the availability of insect foods for consumption. In addition, the authors added to the empirical evidence on the importance of the visual appearance of dishes, especially in novel food cases. Future research will include the analysis and characterization of clusters including how the individuals' socio-demographic variables as well as their food styles affect the intention to eat insects-based foods.

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Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
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Circolarità, sostenibilità e qualità del caffè venduto ai distributori automatici: cosa preferiscono i consumatori Italiani?

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PAROLE CHIAVE
Caffè; sostenibilità; preferenze; consumatori

INTRODUZIONE

Il caffè è una delle merci più scambiate a livello globale e una delle bevande più consumate al mondo, soprattutto nell'Unione Europea (ICO, 2022). Esso viene distribuito tramite diversi canali, tra cui quello del vending. Il settore del vending può essere definito come un servizio annidato nelle fasi a valle della filiera e che fornisce caffè a basso costo per il consumo immediato attraverso i distributori automatici. Tale settore in Europa è un mercato alimentare e delle bevande in crescita, con un fatturato totale di 17,2 miliardi di euro nel 2019, la maggior parte dei quali deriva dal consumo di caffè (Bertossi et al, 2023). Tuttavia, l'intero settore e il mercato del caffè sono stati pesantemente colpiti dalla crisi COVID-19 sia per la chiusura dei canali di vendita (ad esempio aziende, scuole, università, uffici) sia per il blocco delle esportazioni di caffè dai Paesi produttori. Nonostante la recente, seppur lenta, ripresa economica, la crisi della COVID-19 ha messo in evidenza la staticità e la fragilità dell'industria della distribuzione automatica (Bertossi et al., 2023b) e della filiera del caffè di fronte a squilibri su larga scala (ICO, 2020). Questa condizione di instabilità è ancora più evidente se si considerano le sempre più frequenti variazioni climatiche (ICO, 2020; Pham et al., 2019) e gli impatti ambientali e sociali lungo la filiera (Barreto Peixoto et al., 2023; Sachs et al., 2019). Per far fronte a questo scenario è necessario un impegno condiviso da parte di tutti gli attori della filiera del caffè a partecipare alla definizione delle future tendenze di produzione e consumo in linea con gli Obiettivi di Sviluppo Sostenibile (Sachs et al., 2019). A livello europeo, il settore della distribuzione automatica intende rispondere a questa sfida sviluppando una strategia "dal campo alla tazzina" con l'obiettivo di offrire ai consumatori non solo caffè prodotto nel modo più sostenibile e della massima qualità possibile, ma anche servito in tazze progettate secondo i principi dell'economia circolare (EVA, 2021). Il consumatore di caffè è lo stakeholder più importante per il settore e i recenti cambiamenti nelle sue preferenze obbligano il servizio a orientare la propria offerta tenendo conto di questi aspetti e a valutare se l'offerta soddisfa le sue aspettative. Infatti, il modo in cui i consumatori valutano e "vivono" il caffè è un aspetto fondamentale per lo sviluppo sostenibile del mercato del caffè (Barreto Peixoto et al., 2023).

Sebbene la letteratura dimostri che i consumatori sono sempre più attratti dal caffè sostenibile e dalle tazze ecologiche (Barreto Peixoto et al., 2023), attualmente non esistono studi che abbiano indagato se questo interesse si traduca in un comportamento di acquisto coerente quando il caffè viene erogato dai distributori automatici. Il presente studio si inserisce in questo contesto e mira a colmare questa lacuna esaminando, attraverso un esperimento di scelta, l'ipotetica decisione di acquisto e la disponibilità a pagare dei consumatori per il caffè con determinati attributi sostenibili erogato dai distributori automatici. La ricerca è stata condotta in Italia e ha preso in considerazione un campione di 1009 consumatori.

MATERIALI E METODI

L'esperimento di scelta si concentra sull'acquisto di un caffè erogato da un distributore automatico. Sono stati preparati sei scenari, ciascuno contenente quattro alternative: tre che mostravano il tipo di caffè con una specifica combinazione di attributi e un'opzione di non acquisto (Figura 1). I cinque attributi e i livelli corrispondenti utilizzati sono il risultato di un processo di discussione con i responsabili della "European Vending and Coffee Service Association" (EVA), che è l'organizzazione europea di riferimento per gli standard e i dati sull'industria del vending e il committente dello studio.

Il primo attributo considerato è il tipo di tazza che contiene il caffè, identificato da tre livelli: tazza di plastica monouso compostabile e riciclabile, tazza di carta monouso biodegradabile e tazza riutilizzabile. I tre livelli rappresentano le alternative attualmente in fase di valutazione sul mercato per l'industria della distribuzione automatica, che soddisfano i requisiti tecnici e legislativi. Il secondo e il terzo attributo si concentrano sulla sostenibilità della filiera del caffè e si differenziano per le fasi considerate. Il primo riguarda la fase di coltivazione e comprende tre opzioni relative al metodo di produzione utilizzato: biologico, convenzionale e integrato. Il secondo, invece, estende il concetto di sostenibilità in tutte le sue forme (non uso di fertilizzanti e pesticidi, riduzione delle emissioni di anidride carbonica, aumento dei diritti dei lavoratori, riduzione dell'uso dell'acqua, ecc.) lungo tutta la filiera. Il quarto attributo è legato alla qualità del caffè, più precisamente alla presenza/assenza della certificazione DTP 114 high-quality, che è una certificazione di qualità italiana che definisce parametri per la qualità funzionale del chicco di caffè (contenuto di ossigeno e umidità, presenza di crepe, dimensione del chicco e assenza di corpi estranei) superiori a quelli già definiti per legge. L'ultimo attributo scelto è il prezzo del caffè, identificato da tre livelli: 1) 0,60 euro; 2) 0,75 euro; 3) 0,90 euro. I livelli corrispondenti sono stati fissati in base ai prezzi medi italiani del caffè erogato da un distributore automatico.

Figura 1 - esempio di scenario

SCENARIO 1	A	B	C	D
Prezzo a bevanda	0,60 €	0,75 €	0,90 €	Nessuna delle alternative proposte
Tazza	Nessuna (usa la tua tazza personale)	Monouso (plastica, compostabile, RiVending)	Monouso (carta, biodegradabile, raccolta tradizionale)	
Metodo di produzione del caffè	Agricoltura biologica	Agricoltura integrata	Agricoltura convenzionale	
Filiera controllata	Si	No	No	
Certificazione del caffè di alta qualità	No	Si	No	
Scegli l'alternativa che preferisci	☐	☐	☐	☐

Per l'esperimento, a marzo 2023 è stato inviato un questionario diviso in due parti a 1009 consumatori italiani, utilizzando un servizio di terze parti che si è occupato sia della sua preparazione che della raccolta dei dati. La prima parte del questionario mirava a ottenere dati socio-demografici (sesso, età, condizione lavorativa), mentre la seconda parte era incentrata sull'esperimento di scelta. Prima della compilazione, i consumatori sono stati informati sull'obiettivo dell'indagine. Per l'esperimento di scelta, ai consumatori è stato chiesto di immaginare di trovarsi nel luogo in cui potrebbe esserci la massima possibilità di acquistare un caffè da un distributore automatico e di scegliere l'alternativa con la combinazione di attributi che preferivano. Per aiutarli nel processo decisionale, prima dell'esperimento è stata fornita loro una breve spiegazione di ogni attributo e dei livelli corrispondenti. I dati CE sono stati poi analizzati con il software Nlogit6©, basandosi sia su un modello logit multinomiale (MNL) sia su un modello a classi latenti (LCM). La definizione del miglior numero di classi è un processo esogeno e gli studiosi sono soliti basarsi sul confronto tra il criterio informativo di Akaike (AIC), il criterio informativo bayesiano (BIC), il valore della funzione di log likelihood (LL) e il McFadden Pseudo R-squared (MF R2) per diversi modelli di classi latenti. Considerando il fatto che, tra diversi modelli, questi criteri non hanno fornito un risultato univoco e la difficoltà di comprendere il significato dei risultati nel caso di un numero elevato di classi, si è optato per un modello a 3 classi con indice AIC pari a 2.056, indice LL pari a -6203,22, indice MF R2 pari a 0,261 e indice BIC pari a 2.056.

RISULTATI

Il campione considerato nello studio mostra un'equa distribuzione dei partecipanti in termini di sesso e di età (Tabella 1). Diverso è il caso dell'occupazione: quasi il 50% del campione è costituito da impiegati (Tabella 1).

A fini esplorativi è stato dapprima stimato il modello MNL. Osservando i risultati (Tabella 2), sembra che i principali driver di acquisto per i consumatori italiani, in ordine decrescente di importanza, siano l'alta qualità del caffè (0,86***), la presenza di monitoraggio e riduzione degli impatti ambientali e sociali lungo la filiera (0,38***), l'utilizzo di tecniche di agricoltura biologica durante la fase di coltivazione (0,20***) e la fornitura di un bicchiere di carta biodegradabile monouso (0,14***). Il dover utilizzare il proprio bicchiere (-0,30***) sembra essere l'attributo meno apprezzato. Il prezzo ha segno negativo, rispettando così la razionalità del comportamento del consumatore. Per quanto riguarda gli attributi con tre livelli, l'uso del bicchiere monouso in plastica compostabile e riciclabile è secondario rispetto ai bicchieri di carta ed entrambi sono preferiti all'alternativa riutilizzabile; l'agricoltura integrata e convenzionale, pur non discostandosi tra loro in maniera significativa, sono secondarie rispetto all'agricoltura biologica.

Osservando i risultati della LCM (Tabella 2), come per l'MNL, l'elevata preferenza e l'interesse per la certificazione di alta qualità del caffè del DTP 114 sono confermati per tutte e tre le classi di intervistati, così come la scarsa attrattività (soprattutto) della prospettiva di utilizzare la propria tazza personale. L'interesse per l'alta qualità si traduce in una forte disponibilità a pagare un premio soprattutto per la classe 1, mentre è inferiore per gli intervistati della classe 2 e della classe 3. D'altra parte, questa propensione positiva si inverte bruscamente quando si considera la prospettiva di utilizzare la propria tazza personale. Per quanto riguarda gli altri attributi, si nota una certa somiglianza di preferenze per le classi 2 e 3, che si comportano in modo opposto alla classe 1. Ad esempio, la presenza di un piano di monitoraggio e riduzione degli impatti ambientali e sociali lungo la filiera è molto apprezzata dagli intervistati di queste classi, mentre è completamente ignorata da quelli della classe 1. La stessa situazione si riscontra per quanto riguarda l'utilizzo di tecniche di agricoltura biologica. La classe 1, infatti, sembra preferire o percepire una maggiore utilità dall'utilizzo di tecniche agricole convenzionali/intensive per le quali sarebbe disposta a pagare un premio di 0,19€. L'uso del bicchiere di carta biodegradabile, invece, vede risposte analogamente negative nelle classi 1 e 3, mentre positive nella classe 2. Ciò significa che per la classe 2 la soluzione del bicchiere di carta biodegradabile monouso è la preferita, mentre le classi 1 e 3 preferiscono il bicchiere di plastica compostabile monouso riciclabile.

Tabella 1 - caratteristiche socio-demografiche dei rispondenti

Sesso	N	%
Uomo	501	49,6%
Donna	508	50,3%
Età		
18-29	161	15,9%
30-39	148	14,7%
40-49	204	20,2%
50-59	227	22,5%
Over 60	270	26,7%
Occupazione		
Studente di scuola superiore	13	1,3%
Studente universitario	64	6,3%
Impiegato	481	47,6%
Libero professionista	117	11,6%
Disoccupato	170	16,8%
In pensione	165	16,3%

DISCUSSIONE E CONCLUSIONI

Dai risultati emerge con forza l'importanza della qualità del caffè: infatti, la presenza della certificazione DTP 114 si è rivelata l'attributo più rilevante nell'influenzare la scelta del consumatore. Questo dato conferma la tendenza già avviata in passato che vede i consumatori sempre più attenti a questo aspetto. Pertanto, investire nel mantenimento della qualità fisica dei chicchi è qualcosa che può portare a un aumento delle vendite e della soddisfazione dei consumatori. Gli attributi di sostenibilità, invece, sono secondari, ma comunque importanti. In generale, gli intervistati sembrano rispondere bene al monitoraggio e alla riduzione degli impatti ambientali e sociali lungo tutta la filiera del caffè, così come all'uso di tecniche di coltivazione biologica e integrata (anche se in misura minore). Tuttavia, mentre l'interesse per la qualità è comune a tutti gli intervistati, non si può dire lo stesso per la sostenibilità. Infatti, molti vedono ancora la sostenibilità come uno svantaggio o come qualcosa che può diminuire la qualità del caffè o della tazza contenente la bevanda (Lee and Bateman, 2021). È possibile che queste persone non considerino (ancora) la sostenibilità una priorità. Per quanto riguarda la tazza, si tratta di un argomento molto dibattuto sia a livello politico che industriale. L'Unione Europea ha lanciato qualche anno fa una strategia per ridurre la dipendenza dalla plastica monouso, incoraggiando l'adozione di soluzioni alternative. Attualmente, le soluzioni più adottate per le bevande calde servite nei distributori automatici sono i bicchieri monouso in plastica compostabile e riciclabile con RiVending, i bicchieri monouso in carta biodegradabile o i bicchieri riutilizzabili. Secondo diversi studi (UNEP, 2021) le tazze riutilizzabili sembrano essere le più ambientalmente sostenibili delle tre soluzioni, anche se questo non è sempre vero. Infatti, sembra che in alcune occasioni i bicchieri di plastica riciclabili abbiano un impatto uguale o addirittura leggermente inferiore a quello dei bicchieri riutilizzabili (UNEP, 2021). La scelta del tipo di bicchiere per i distributori automatici non deve considerare solo gli aspetti ambientali, ma anche l'opinione dei consumatori. Il fatto che, secondo il nostro studio, le persone non sembrano essere favorevoli ai bicchieri riutilizzabili potrebbe orientare l'industria del vending e i responsabili delle decisioni verso l'adozione di soluzioni monouso riciclabili o biodegradabili (garantendo allo stesso tempo una riduzione dell'impatto ambientale). Tuttavia, la riluttanza dei consumatori al riutilizzo può essere generata dalla percezione della difficoltà di mantenere questo comportamento nel tempo. In letteratura esistono studi (Keller et al, 2021) che dimostrano che è possibile rendere l'uso di una tazza riutilizzabile un'abitudine.

Tabella 2 - risultati esperimento di scelta

Variabile	MNL	LCM					
	Coeff. (S.E.)	Class 1		Class 2		Class 3	
		Coeff. (S.E.)	WTP (€/bev)	Coeff. (S.E.)	WTP (€/bev)	Coeff. (S.E.)	WTP (€/bev)
ASC	-3.39 (0.11) ***	-4.14 (0.46) ***	/	-4.59 (0.15) ***	/	-4.51 (0.91) ***	/
Prezzo bevanda	-0.03 (0.00) ***	-0.03 (0.00) ***	/	-0.03 (0.00) ***	/	-0.10 (0.01) ***	/
Tazza di carta biodegradabile monouso	0.14 (0.04) ***	-0.39 (0.16) **	-0.13	0.21 (0.05) ***	+0.07	-0.88 (0.39) **	-0.09
Tazza riutilizzabile	-0.30 (0.05) ***	-2.84 (0.47) ***	-0.94	0.04 (0.09) ns	/	-1.86 (0.47) ***	-0.18
Monitoraggio sostenibilità lungo la catena di fornitura	0.38 (0.05) ***	-0.31 (0.22) ns	/	0.50 (0.09) ***	+0.16	0.73 (0.39) *	+0.07
Certificazione di qualità DTP 114	0.86 (0.00) ***	2.69 (0.40) ***	+0.89	0.50 (0.13) ***	+0.16	1.29 (0.64) **	+0.13
Agricoltura biologica	0.20 (0.04) ***	-0.38 (0.24) ns	/	0.36 (0.06) ***	+0.12	0.98 (0.49) **	+0.10
Agricoltura convenzionale	0.02 (0.05) ns	0.57 (0.21) ***	+0.19	0.04 (0.10) ns	/	0.35 (0.49) ns	/
Probabilità di classi latenti stimata		0.324		0.582		0.093	
Indici statistici		LL -6203.22	AIC 2.056	MF R^2 0.261	BIC 2.056		

Nota: L'asterisco singolo, doppio e triplo (*, **, ***) indica la significatività statistica rispettivamente al livello del 10%, 5% e 1%. n.s. indica non statisticamente significativo.

Il presente studio contribuisce allo sviluppo della letteratura in tema di caffè considerando per la prima volta il servizio di distribuzione automatica. I dati ottenuti potranno costituire il punto di partenza per promuovere diverse iniziative per far evolvere il settore verso un percorso di sviluppo sostenibile. Nonostante la rilevanza e l'importanza dei risultati dell'indagine per il settore della distribuzione automatica, lo studio non è privo di limiti. Innanzitutto, l'esperimento ha preso in considerazione solo alcuni attributi di sostenibilità e quello relativo all'intera filiera è stato presentato agli intervistati in modo piuttosto generico, senza alcun riferimento a certificazioni specifiche. In secondo luogo, i risultati dell'indagine riguardano solo il mercato italiano e non possono essere estesi ad altri Paesi europei, dove vigono altre dinamiche. Infine, per l’analisi ci si è basati sulle opinioni autodichiarate dagli intervistati, non avendo quindi garanzia che quanto dichiarato corrisponda alla realtà, soprattutto quando si considera la WTP. Pertanto, sono necessari ulteriori studi nella vita reale e in contesti che utilizzino un approccio più qualitativo.

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HOW DOES HEALTH-RELATED INFORMATION IMPACT WILLINGNESS TO PAY FOR OLIVE OIL? AN INCENTIVISED LAB EXPERIMENT AMONG MOROCCAN AND TUNISIAN CONSUMERS

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Extra virgin olive oil; laboratory experiment; North Africa; sensory characteristics; consumer preferences.

Introduction
Olive oil is a key food product in Mediterranean countries. Nevertheless, local consumers show limited awareness of its benefits, particularly in Northern Africa. This is shown, for instance, by the low incidence of olive oil on oil consumption in Tunisia: 7.4 kg out of 25.7 kg in 2015 (Tunisian National Institute of Statistics, 2015), even if this country represents one of the main olive oil producers in the world (Ben-Hassine *et al.*, 2022). Furthermore, healthier olive oils contain a higher quantity of polyphenols, resulting in bitter taste and more pungent mouthfeel sensation which, according to the extant literature, tend to be disliked by most consumers, at least in Western countries (Barbieri *et al.*, 2015; Vitaglione *et al.*, 2015; Delgado & Guinard, 2011). Therefore, if consumption choices are based exclusively on sensory characteristics, consumers would miss the opportunity to consume healthier oils. This points to the need of increasing awareness through the provision of clear and concise information.

Research question and objectives
Given the above mismatch between consumers' preferences for the sensory characteristics of olive oil and its actual health benefits, we test if providing information about the relationship between polyphenol content, pungency/bitter, and healthiness impacts consumers' willingness to pay (WTP) for different olive oil brands. We hypothesise that consumers have lower WTP for pungent/bitter oils before receiving health-

related information (H1); introducing labels about polyphenols has no significant impact on WTP while labels about local origin increase it (H2); providing information about the relationship between polyphenols and health benefits increases WTP for pungent/bitter oils relative to delicate/sweet ones (H3); and this relative increase persists even when consumers experience the bitter/pungent sensory characteristic (H4). Indeed, the extant literature shows that consumers are willing to pay for different nutritional standards (Ran *et al.*, 2017) as well as for the origin of products (Barlagne *et al.*, 2015). We advance current studies (for instance, Mtimet *et al.*, 2013) by eliciting real preferences through an incentivised experiment, and by doing so in two Northern African countries comparatively.

Methodological approach

Although stated preferences are very useful to explore consumers' decisions in a range of situations, they are subject to hypothetical and social desirability biases: revealed preference are a better proxy of what would happen in real life situations (Levitt and List, 2007; Lusk and Fox, 2003). Hence, we elicit consumers' real preferences (with WTP as a proxy) through an incentivised lab experiment. We apply a novel protocol which combines an auction mechanism known as the 'Becker–DeGroot–Marschak procedure' (Becker and DeGroot, 1974), adapted by Barlagne *et al.* (2015), with the measurement of biometric data using an eye-tracker (Clement *et al.*, 2013). Participants were asked to evaluate four olive oils along five stages,[1] and to state their WTP for each of them at each stage. To avoid the hypothetical bias, at the end of the procedure one product profile, one stage, and a random price were extracted: if the consumer's WTP for the extracted oil profile was equal to or greater than the extracted price, then they had to purchase the oil at the extracted price using part of their show-up fee. Two binary attributes were selected in order to generate a full factorial design with four oils: the origin (local *vs* non-local) and the polyphenol content (low *vs* high). We only test national, non-imported olive oils; therefore, 'local' means from the regions where the experiment was implemented, 'non-local' from elsewhere in the country. Polyphenol content is a proxy for pungency/bitter and for healthiness. Ten olive oils per country were tested for being 'extra virgin' (i.e., without sensory defects) and for the bitter taste and pungent mouthfeel sensation by a certified panel of experts,[2] who also selected the oils to be used in the experiment. At each stage, additional information was disclosed, with the aim of assessing its impact on WTP: the taste (via actual tasing) at stage 1; the origin and the polyphenol content at stage 2; the link between polyphenols, bitter/pungent, and healthiness at stage 3.[3] All this information was linked together at stage 4 through a second round of tasting. We randomised the order of the oils between stages, to ensure that the WTPs were independent between stage 1 and the following stages, as well as between consumers in different days, to prevent order-related bias.

Data and empirical approach

We recruited samples of urban consumers in the cities of Meknès (Morocco) and Sousse (Tunisia). The samples are representative of the cities' populations in terms of age and gender. The respondents were filtered based on consuming olive oil regularly, engaging in grocery shopping at least from time to time, and knowing the price of one litre of olive oil with good approximation. The procedure required the consumers to sit in front of a computer. The iMotions software,[4] linked to an eye-tracker, was used to record consumers' facial and eye movements and to register their WTP. Two questionnaires (initial and final) were set up in the

[1] The last stage was aimed at testing the impact of the real labels by showing the images of the bottles on the screen. This is out of the scope of this article; therefore, in the following we only use and discuss data from stages 1 to 4.

[2] Professional Committee for the Sensory Analysis of Virgin Olive Oils of the Department of Agricultural and Food Sciences of the University of Bologna (Italy), recognized by the Italian Ministry of Agriculture in 2006.

[3] This three-way relationship was communicated using layperson language without technical details: '*Pungent or bitter taste of olive oil indicates a higher content of polyphenol. Olive oil polyphenols are good for your health. Therefore, healthier olive oils are likely to be more bitter and more pungent.*'

[4] iMotions is a platform that integrates and synchronises multiple biosensors (https://imotions.com/about-us/).

online data collection platform Qualtrics,[5] and embedded in the iMotion interface, to provide the instructions, test consumers' understanding, collect socio-demographic and other variables, and to implement the auction proper. The experiment took place in September 2022 in Meknès and in October-November 2022 in Sousse. Testing one consumer required about 30 minutes, and two consumers were tested at a time in different rooms. The final sample sizes are 230 in Meknès and 208 in Sousse, i.e., 4,600 and 4,160 instances of WTP across all the oils and stages, respectively.

We estimated separate models for Tunisia and Morocco after converting the WTP in $PPP (Purchasing Power Parity Dollars; World Bank, 2023) for comparability reasons. Since the WTP is censored at zero, we used random-effect Tobit models (Goldberger, 1964), clustering standard errors at individual level. We include socio-demographics controls to reduces observed heterogeneity. The empirical model takes this form:

$$WTP_{i,s,o} = \beta_0 + \boldsymbol{\beta_{s,1}} + \beta_2 r_o + \beta_3 p_o + \boldsymbol{\beta_{s,4}} r_o + \boldsymbol{\beta_{s,5}} p_o + \beta_6 r_o p_o + \boldsymbol{\beta_{s,7}} r_o p_o + \beta_8 c + \beta_9 t_o + \beta_{10} g_i + \beta_{11} a_i + \beta_{12} y_i + \varepsilon_i \qquad (1)$$

where $WTP_{i,s,o}$ is the WTP of consumer i at stage s for olive oil o; r_o is a binary variable indicating the origin (local or national); p_o is a binary variable for the polyphenol content (low or high). The control variables are c, a dummy for the computer and thus the 'room context;' t_o, the order in which the oil was shown according to the randomisation plan; g_i, i's gender; a_i, i's age; and $\boldsymbol{y_i}$, a vector of income levels. ε_i are individual error terms, independently and identically distributed. The β's are the coefficients of the model, $\boldsymbol{\beta_s}$'s being vectors of stage-specific coefficients.

Results

In this section, we first present stated preference results from the survey, then we discuss our hypotheses using the values of the WTP. The biometric variables detected by iMotions, namely fixation counts and duration, and emotions based on facial responses (anger, disgust, joy, engagement, surprise, etc.) were found not to differ significantly across olive oil attributes, and are not discussed further.

48% of the consumers in Tunisia and 49% in Morocco stated that they prefer olive oils that are 'slightly pungent/bitter'; 40% and 33%, 'bitter/pungent' or 'very bitter/pungent'. Moreover, 79% of the consumers in Tunisia and 83% in Morocco declared (after the experiment) that they were already aware of the link between pungency/bitter and healthiness, but only in Morocco this was associated with significantly higher WTP for high-polyphenol olive oils.[6] Taste preferences and knowledge of the link are significantly correlated in both countries ($t(3{,}278) = 7.61$, $p < 0.001$ in Tunisia; $t(3{,}630) = 25.85$, $p < 0.001$ in Morocco).

The experimental results show that, opposite to the current literature, our consumers tended to prefer pungent oils: the average WTP along all stages was 13.31 $PPP for non-pungent and 15.17 $PPP for pungent oils in Tunisia ($t(3{,}320) = -9.94$, $p < 0.001$); 23.84 $PPP and 27.23 $PPP in Morocco ($t(3{,}661) = -5.99$, $p < 0.001$). Pungent oils were also preferred by the consumers who stated not to like pungent/bitter olive oils or to like 'slightly pungent/bitter' olive oils (13.35 $PPP *vs* 14.97 $PPP, $t(1{,}948) = -6.59$, $p < 0.001$ in Tunisia; and 23.43 $PPP *vs* 26.40 $PPP, $t(2{,}421) = -4.03$, $p < 0.001$ in Morocco), and by those unaware of the health benefits of high-polyphenol oils (14.41 $PPP *vs* 15.82 $PPP, $t(686) = -2.91$, $p = 0.004$ in Tunisia; 20.97 $PPP *vs* 23.48 $PPP, $t(622) = -1.87$, $p = 0.062$ in Morocco). Thus, our H1 is not verified.

Table 1 reports the results of the Tobit models for both countries. At stage 2, the WTP for olive oils with high polyphenol content increases significantly in Tunisia ($t(414) = 7.23$, $p < 0.001$) but not in Morocco ($t(459) = 1.01$, $p = 0.312$). In Tunisia, the WTP for the oils with low polyphenol content increases too ($t(413) = 3.45$, $p < 0.001$). The consumers previously unaware of the link between bitterness and health benefits show significant increase for all the olive oil profiles ($t(171) = 3.65$, $p < 0.001$ in Tunisia; $t(155) = 4.37$, $p < 0.001$

[5] Qualtrics is an experience management platform including an online survey tool (https://www.qualtrics.com/).

[6] In Tunisia, the WTP for high-polyphenol oils was 15.00 $PPP among aware consumers and 15.82 $PPP among the others ($t(1{,}659) = -2.46$, $p = 0.014$); in Morocco, the WTP was 28.00 $PPP and 23.48 $PPP, respectively ($t(1{,}831) = 3.66$, $p < 0.001$).

in Morocco), but larger for high-polyphenol oils in Morocco and for low-polyphenol oils in Tunisia. Hence, introducing a label about 'polyphenol content' does not have a univocal effect. In turn, our hypothesis about origin (H2) is not verified: the relative label *does not* attract higher WTP when introduced at stage 2 ($t(829) = -0.38$, $p = 0.352$ in Tunisia; $t(913) = -0.34$, $p = 0.366$ in Morocco). This result confirms what found by Mtimet *et al.* (2013) for Tunisia using stated preferences methods. In Morocco we even observe a higher WTP for the non-local oil with high-polyphenol content.

Table 1. Tobit models for WTP for extra virgin olive oils in Morocco and Tunisia.

WTP	Tunisia	Morocco
Stage 2 (baseline: Stage 1)	0.219 (0.466)	-0.390 (0.814)
Stage 3 (baseline: Stage 1)	-0.812* (0.464)	-0.175 (0.774)
Stage 4 (baseline: Stage 1)	-0.080 (0.444)	0.738 (0.722)
Local origin (baseline: National)	-1.375*** (0.437)	0.887 (0.610)
Stage 2 # Local	1.380*** (0.484)	0.059 (0.827)
Stage 3 # Local	1.802*** (0.474)	-1.102 (0.687)
Stage 4 # Local	1.019 ** (0.452)	-0.908 (0.718)
High polyphenols (baseline: Low)	-0.365 (0.463)	1.049 (0.692)
Stage 2 # High	1.295** (0.549)	1.356* (0.818)
Stage 3 # High	3.689*** (0.552)	4.093*** (1.041)
Stage 4 # High	2.524*** (0.535)	4.098*** (0.981)
Local # High	1.832*** (0.520)	-0.441 (0.752)
Stage 2 # Local # High	-1.574*** (0.572)	-0.773 (1.032)
Stage 3 # Local # High	-1.789*** (0.564)	2.573 (2.801)
Stage 4 # Local # High	-0.989* (0.539)	-0.045 (0.993)
Computer 2 (baseline: Computer 1)	-0.044 (0.628)	3.463** (1.667)
Order of the oil 2nd (baseline: 1st)	-0.162 (0.164)	0.913 (0.728)
Order of the oil 3rd (baseline: 1st)	0.170 (0.173)	0.544 (0.392)
Order of the oil 4th (baseline: 1st)	0.317 (0.187)	1.164*** (0.361)
Gender female (baseline: Male)	0.445 (0.600)	9.203*** (1.754)
Age in years	0.010 (0.234)	0.064 (0.060)
Mid-low income (baseline: Low)	-1.444 (0.977)	4.416** (2.134)
Middle income (baseline: Low)	-1.839*** (0.674)	4.418* (2.524)
Mid-high income (baseline: Low)	-2.960*** (0.688)	1.941 (3.374)
High income (baseline: Low)	-3.472*** (1.036)	1.468 (3.423)
Constant term	15.147*** (0.881)	11.099*** (3.587)
Sample size	3,322	3,663
Pseudo R-squared	0.0128	0.0129

Notes: Standard errors in parentheses. 'Computer' indicates the computer and room, and is a proxy of contextual factors. 'Order of the oil' indicates the order in which the oil was presented to the consumer in that day and round. The sample size is smaller than the total number of consumers, rounds and oils due to the removal of the last stage and of outliers that were probably due to data entry errors.

After providing information about health benefits, the WTP for high-polyphenol oils increases significantly in both countries (1.47 $PPP, $t(828) = 3.94$, $p < 0.001$ in Tunisia; 4.09 $PPP, $t(911) = 2.76$, $p < 0.001$ in Morocco). We even observe a decrease in WTP for low-polyphenol oils, significant only in Tunisia (-0.82 $PPP, $t(828) = -2.33$, $p = 0.020$ in Tunisia; -0.38 $PPP, $t(911) = -0.44$, $p = 0.661$ in Morocco). As shown by the coefficients for the interaction between stage 3 and high polyphenols in Table 1, this increase is much larger than at other stages. In Tunisia, the increase in WTP for high-polyphenol oils is 1.7 times larger among previously unaware consumers, compared to those who declared to be aware ($t(412) = 2.27$, $p = 0.024$), and in Morocco 1.6 times larger ($t(452) = 0.74$, $p = 0.462$). Consequently, the gap in favour of high-polyphenol oils grows from 1.01 $PPP ($t(829) = 2.88$, $p = 0.004$) to 3.30 $PPP ($t(827) = 8.80$, $p < 0.001$) in Tunisia, and from 1.74 $PPP ($t(913) = 2.01$, $p = 0.045$) to 6.20 $PPP ($t(906) = 4.18$, $p < 0.001$) in Morocco. Therefore, in line with our H3, providing health-related information increases WTP for healthy oils.

Finally, at stage 4, when consumers tasted again the oils and were able to link the taste with the rest of the information, we register a significant increase in the WTP for high-polyphenol olive oils in both countries (compared to stage 1 as a baseline, as shown by the coefficients for the interaction between stage 4 and high polyphenols in Table 1). The difference in the WTP for these oils between stages 3 and 4 is negative in both countries but not significant in Morocco (-0.40 $PPP, $t(413) = -2.80$, $p = 0.005$ in Tunisia; -0.57 $PPP, $t(453) = -0.52$, $p = 0.604$ in Morocco). The gap in favour of pungent oils decreases from 3.30 $PPP to 2.53 $PPP in Tunisia ($t(830) = 6.85$, $p < 0.001$), and from 6.20 $PPP to 4.88 $PPP ($t(918) = 4.96$, $p < 0.001$) in Morocco, but despite this slight rebound effect, the positive impact of the information persists, confirming our H4.

Conclusions and policy implications

We have presented the results of an experimental auction aimed at detecting consumers' preferences for national olive oils with different characteristics. Based on data from Meknès (Morocco) and Sousse (Tunisia), we found that consumers tend to prefer pungent/bitter oils, which are also healthier, and are willing to pay more for these oils compared to delicate ones. Providing a concise message about the health benefits of polyphenols increases the gap further. The impact of the message persists, net of a small rebound effect, even when consumers experience again the sensory attributes (pungent/bitter) of the oils. Such patterns are similar in both countries. Finally, we also found that a label about local origin does not result in higher WTP.

Our results allow to draw recommendations for the promotion of healthier and more diverse local diets among urban consumers in Southern Mediterranean countries. First, consumers have limited awareness of what constitutes a 'good' olive oil if discussed in theoretical terms (i.e., definition of 'extra virgin'), particularly in Tunisia.[7] However, they can appreciate quality when tasting the products. This is a solid basis to build upon for advertising high-quality food. Second, 'localness' does not seem to be a value added, at least for olive oils and in the cities considered. Even if we did not compare national with imported oils, 'national origin' was appreciated in the same measure of 'local origin.' This can be a challenge when trying to link local producers with their close urban market but also suggests that consumers may equally appreciate products from other regions in their country. Third, a concise message about health benefits is effective in driving consumers' preferences and the effect persists even after the consumers are confronted with additional (sensory) information that could push in opposite direction. We decided not to use the official EU health claim,[8] which may have limited or no meaning to a layperson, and we suggest that the same approach is followed in advertising. Finally, in the questionnaire, 'trust' emerged as an important element for appreciating olive oil.[9] Hence, there must be efforts for building trust between producers and consumers: this is even more relevant since many consumers produce their own oil, or obtain it from friends and relatives. These recommendations apply to both countries; however, slightly more efforts are probably needed in Tunisia, where WTP is lower on average.

[7] In Morocco, 54% of the respondents declared to know the difference between 'virgin' and 'extra virgin' olive oil, but when asked to indicate the right difference, only 41% answered correctly. In Tunisia, 44% declared to know the difference, but only 14% were actually knowing it.

[8] The EU health claim is: '*Olive oil polyphenols contribute to the protection of blood lipids from oxidative stress. Health relationship: protection of LDL particles from oxidative damage.*'

[9] Out of 14 elements for appreciating the quality of olive oil, ranked on a five-point Likert scale, 'trust' for the producer was the second most important in Tunisia, after 'taste' ($M = 4.48$, $SD = 0.75$), and the third most important in Morocco, after 'taste' and 'packaging' ($M = 4.42$, $SD = 0.75$).

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Comparing Food Governance Networks in Rome and Barcelona: An Exploratory Study

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KEYWORDS

Urban Food Governance, Food movement; Power reconfiguration; Food policy

INTRODUCTION

In the global urban agenda, creating sustainable urban food systems has become a pressing concern. Municipalities have been given the responsibility to support, address, and align food system challenges with the use of municipal tools, leading to the rise of "new municipalism", where municipalities have taken on a strategic role in promoting progressive transformation, democratic processes, multiscale solidarity networks, and opposing neoliberal dynamics.

The urban governance approach is part of the innovation and change needed to transform the food system into a more sustainable one, and to develop an urban food strategy. A governance network is used to describe a new policy paradigm, oriented towards a more democratic mode of governance, based on the involvement of stakeholders and civil society, public and private bodies in formulating and implementing policy (Cruz et al., 2018: Blanco et al., 2011). Considering food dimensions, we define urban food governance as interconnected systems including different agencies, actors and organizations engaged in food governance, promoting programs, and food public policy in the urban setting (Santo, R., 2019). Cities are becoming laboratories to experiment with co-participatory processes to develop urban food strategies, and places to test innovative and democratic pathways for a sustainable transition of the food system (Rossi et al., 2019).

Shifting to collaborative governance means moving towards a network structure typology that is more horizontally organized. In urban food governance, the role of civic society and food movements seems to be central: food movements are taking on new roles in governance networks by participating in public participation strategies and engaging in food system governance to achieve their goals (Clark et al., 2019; Giambartolomei et al., 2021). Governance networks will typically differ due to the context in which they are formed, the internal relationships established, and perhaps most importantly, the level of citizen engagement. This can range from being informed to being fully empowered (Bradley et al., 2022). Thus, while it is true that the food movements have taken their place in the governance space, it is also true that their actual power and recognition in the governance space should not be taken for granted (Brons et al., 2022). In the process of exercising power, food movements will encounter both closed and invited spaces and spaces within it is easier or harder to claim power (Gaventa et al., 2006). Participation in food movements is conditioned by local dynamics that are filtered through their respective roles and interests and powers (Andrees et al., 2019; Andreola et al., 2021).

Research has shown that contextual elements such as socio-cultural context, political dynamic, participatory culture in the community, power relations, food movement orientation and ideologies, local issues, and resources, influence the pathway and the structure of the governance network, the inclusivity or exclusivity of actors, and policy outcomes.

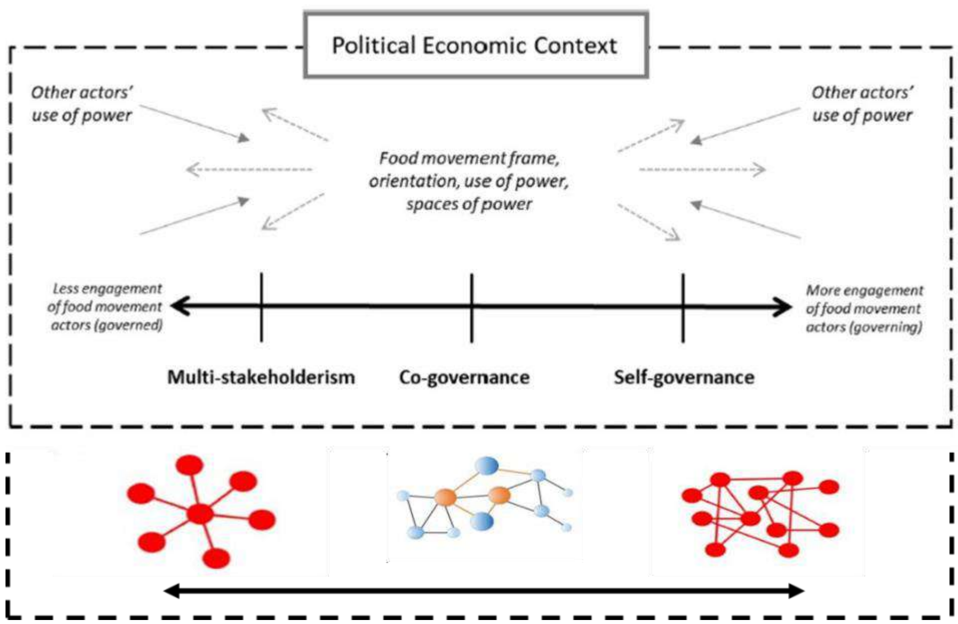
A growing literature examines the engagement of social movements in governance processes (Clark et al., 2019). The role of food movement actors actively involved in decision-making in the urban food policy dimension is less studied, and an analysis that looks at their power in the governance network is useful for understanding the redefinition of public-private relations in urban food governance, and how governance systems move towards more collaborative governance.

Considering the "governance engagement continuum" framework integrated by governance theory shown in Figure 1, this study takes into consideration factors that could have influenced food governance pathways in Barcelona and Rome, focusing on food movements that attempt to wield power within specific governance arrangements or create new governance arrangements. The framework helps conceptualize the relationship between contextual factors, food movement engagement and network governance.

An exploratory analysis of the relationship between networks governance and food movement participation was carried out, with the aim to understand :(i) the weight of food movement participation in the governance networks, (ii) the contextual factors influencing the variety of experiences of participation in food governance, and what kind of factors explain the variability on the patterns and quality of food movement participation.

To address this goal, an exploratory analysis of two case studies, Barcelona and Rome, was considered. Both cities initiated a participatory process to develop their urban food strategy. The analysis explores governance networks, the exercise of power and the role of food movements.

Figure 1 – Governance engagement continuum (Our elaboration based on Clark et al., 2019)



METHODOLOGY

This work uses an exploratory approach with two case studies, Barcelona, and Roma. Exploratory case studies contribute to identify emerging characteristics of the process, context, and development of policy (Yin, 2009).

The research process was based on different phases:

a) **Literature review**: A revision of the literature was conducted on governance theory and the role of food movements. This helped build the framework and structure the methodology and interviews.

b) **Definition of case studies:** Roma and Barcellona have been selected as case studies according to the following criteria: a) cities with a significant history of alternative food experiences and movements; b) Mediterranean cities that have initiated an urban policy process carried out in a participatory manner.

c) **Sample design and data collection:** A convenience sample was used, and semi-structured interviews were conducted from June to September 2022 with key actors from the urban food system of both cities. Interviews included six open-ended questions to identify the main discourse on food policy governance, seeking evidence of governance structures, the exercise of power, role of food movements and network structure. Table 1 provides an overview of the participant's sectors, with a total of 20 people interviewed for 40-60 minutes each.

d) **Data Analysis:** All interviews were carried out face to face or by Microsoft Teams® and were recorded, transcribed, and analyzed by the software NVivo. For qualitative analysis, a basic codebook according to literature has been identified (Eberhard et al., 2017)

e) **Visualization and interpretation of results:** A presentation of the overall analysis of the emerging evidence on the evolution of urban food governance and the reconfiguration of the power of food movements was provided.

Table 1 – Sectors represented by the interviewees

Role	Rome	Barcelona
City Council	1	2
Academia	2	2
Farmers	2	-
Food Movement	4	5
Catering	1	1
Total	**10**	**10**

PRELIMINARY RESULT

Table 2. provides an overview of the preliminary results from the analysis of the interviews. As the table shows, the governance process in the two cities follows two different paths leading to two different network structures and changes in the role of the actors and food movements involved.

Table 2- Comparative analysis of the governance network structure of the two cities

City	Case	Role of FM and Power	Governance authority	Governance arrangement	Governance networks
Roma	Urban food policy	Balanced Power; High influence	Food movement, and Municipality	Co-governance	Decentralized network,
Barcelona	Urban food policy	One of many stakeholders; Low influence	The municipality with stakeholder consultation	Multi-stakeholder	Centralized network,

In detail, the preliminary results will be illustrated for each case study.

Rome's food governance arrangements can be identified as co-governance; characterized by a bottom-up process and recognized by the municipality and state actors. In this case, the food movements are co-producers of governance outcomes, and power and resource asymmetric across actors are recognized (Ansell & Gash, 2008). Food movements have created a deliberative space involving governmental and non-governmental actors, civil society, market actors, academia, and institutions. The power between actors is balanced and different actors work for a common vision for the food system. The participative process for developing a food policy is ongoing. A food council as an instrument of governance has been created. In this case, success can also be defined as the repositioning of actors in government positions and within the relational field in a way that benefits them. This is an important success factor because organizations' goals were not just about policy outcomes, but changes in governance processes that resulted in a seat at the table.

The food policy process emerges as the creation of a new ecosystem of ad hoc actors and the solidification of the existing network. Indeed, prior to 2018, the organizations had no formal relationships with the local government, and the food movement network was also fragmented. However, through a process that ensued, a 200-member collaborative network was formed, which led to a reconfiguration of governance networks. This network is participant governed and decentralized, with a shared vision among its members resulting in a horizontal governance arrangement.

Barcelona governance follows a different dynamic from that of Rome. Barcelona's Council used its power in determining the agenda (structure) of the process, and starting a multi-stakeholder process, where the municipality and State retained primary control of the process. A multi-stakeholder process with different sessions has been carried out; different mechanisms to engage have been incorporated and a wide range of non-government and private stakeholders have been involved (academies, civic society, private actors) as well as market actors as agri-business corporations. As the literature suggests, these governance modes are characterized by imbalanced power dynamics among actors, where non-governmental stakeholders typically have limited decision-making authority, while market actors have more power or have not relinquished power to stakeholder networks. Food movements have participated in the process, providing a consultative role but lacking significant power to effect change (Ansell et al., 2008). Hence, various actors collaborate in implementing public food policies, with varying power imbalances within governance. Barcelona's food policy was passed but did not fully use the deliberative governance tools desired by social movement organizations. In this case, the efforts of social movement organizations or in the food policy co-production were reduced to an agricultural paragraph to keep it manageable for governance.

Governance structures are characterized by multiple and diverse actors, with different power, different interests, and without a common vision of the food system. It can therefore be defined as a more centralized network, in which the central actor remains the municipality. There is no reconfiguration of networks after the food policy process.

CONCLUSION

In the context of challenges to food system sustainability, food movements are actively seeking to create fair and more sustainable food systems by addressing systemic issues through direct engagement with governance. By drawing on government theory and applying a governance engagement continuum framework, we analysed the exercise of power, the engagement of food movements, and evidence of outcomes in different collaborative governance processes to determine if there is a trend "from government to governance" that reflects a loss of state authority.

We compared two urban food participatory processes and found that not all such processes necessarily replace traditional hierarchical governance systems or reflect a loss of state authority. Instead, successful processes recognize the power of civil society and create networked governance. Our study reveals two different participatory process trajectories: Rome's participatory process led to collaborative, horizontal and more networked governance, replacing traditional hierarchical governance. In contrast, while Barcelona adopted more deliberative governance, it showed elements of centralization of power, and continued hierarchical process. In the latter case, social movement organizations' efforts in food governance output were reduced to an agricultural focus.

It is important to emphasize that this study is not intended to evaluate the policy outcome and efficiency of urban food policies in the field of sustainable transition of food systems. Collaborative governance does not always prove efficient: different contexts need hierarchical governance to create more efficient policies, just as the opposite is true (Rode 2017: Rudnik et al., 2019). This study aims only to evaluate different pathways of participatory food governance and the role of food movements through an exploratory approach.

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HOW TO PROMOTE ADOPTION OF SUSTAINABLE INNOVATIONS BY AFRICAN SMALLHOLDERS? A RANDOMISED CONTROLLED TRIAL APPROACH

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Keywords
Innovation dissemination; field experiment; smallholder farmers; incentive; methodological protocol.

Introduction

The creation of sustainable food systems which also provide dietary and nutritional benefits is key to achieving the Sustainable Development Goals, particularly in developing countries of Africa. This requires the adoption of agricultural innovations by smallholder farmers, who represent the bulk of food producers in these regions. However, smallholder farmers tend to be adverse to the risks that innovation may imply, and prefer short-term financial rewards over the long-term benefits of pro-environmental innovations, e.g., addressing climate change. Therefore, innovation dissemination is a challenge, and research is needed to envisage efficient strategies. In the framework of an international project focusing on food supply chains in Northern and Eastern Africa, we implement randomised control trials (RCTs) to assess, on the one hand, the impact of different incentivisation approaches on the uptake of innovations by small producers and, on the other hand, the impact of these innovations on farm performance and household wellbeing. This paper illustrates the research protocol: data collection is ongoing.

Case studies

Among tens of technological innovations and innovative practices developed within our project, and tested in 14 different rural areas, we selected three regions and related innovations on the basis of Technology Readiness Level, generation of clear environmental and nutritional benefits beyond profit, feasibility of sampling, and coverage of different countries. In each case study area, we implemented a preliminary survey to characterise the farming population.

The first case study region is Ait Ouallal Bittit / Ait Yazem in Morocco, where farmers grow potatoes, onions, and other vegetables requiring large amounts of water. Almost all the production is sold, representing an important source of income. Here the innovation is a mobile application providing farmers with precision irrigation and fertigation parameters, and early warnings for precision protection against potato late blight. Besides economic gains (better yield) that require 'optimal use' to be achieved, the app generates environmental benefits (water saving). Because the installation of the app is a trivial, zero-cost task, its use along the year is monitored to identify the farmers who make a 'minimum acceptable use' or an 'optimal use.'

The second case study region consist of Kajjansi, Masaka, and nearby districts in Uganda, where the focus is on fish farmers, who generate sizeable environmental externalities. Based on the survey, 83% grow tilapia and 59% catfish, mostly in ponds (94%). The median value of product is 2,596 $PPP but the average is 8,328 $PPP, virtually all for sale. Given such earnings, fish farmers can potentially adopt costly innovations. The innovation consists in integrating fish and vegetable productions through a recirculating system that allows reuse of nutrients from aquaculture wastewater for irrigating select high-value and high-demand vegetables. The benefits include better growth and quality of vegetables but also reduced contamination of waste bodies through effluents. The layout of a mini-irrigation system from the ponds to the plots was developed. Due to the relatively high cost, the farmers are provided with the outline of the system and if interested, they can develop a 'business plan;' if the plan is approved, they receive an incentive to purchase the equipment, whose installation is also verified.

The third case study area is a village of the Mvomero district (Tanzania). Based on a previous survey, 53% of the farmers there grow beans, the second more widespread crop after maize, which is key for local livelihoods. The median production is 226 kg, worth 445 $PPP, and the median share sold 86%. The innovation proposed is two new bean varieties combining high levels of iron and zinc and other agronomic traits such as a good yield with shorter cooking time and attractive colours facilitating sales. Therefore, the benefits are nutritional and health-related (mineral-rich diet), economic (better saleability), and environmental (less fuel consumption). Adoption consists in the purchase of seeds of one or two varieties, or their exchange with already owned seeds or maize. The land area actually sowed is monitored.

Methodology

We use two methodological tools: Randomised Controlled Trials (RCTs) and Propensity Score Matching (PSM). Indeed, our objectives are twofold: assessing the impact of different dissemination and incentivisation strategies on innovation uptake; and assessing the impact of innovations on farmers' wellbeing. These goals require the creation of comparable groups which differ only for having received the treatment. To meet the first objective, the farmers are randomly allocated to different treatments in terms of innovation dissemination and incentivisation strategies. However, since adoption is correlated with farmers' characteristics, to meet the second objective we create a counterfactual through PSM. Initial and final questionnaires are used to measure various indicators before and after adoption (or before and after one farming year for the control groups). The impact of the innovations is assessed through a difference-in-differences approach, whereby the change in the value of the indicators between the baseline and the post-adoption questionnaire is compared between the treated and control groups (Abadie, 2005).

RCTs are described as the gold standard for impact evaluation, and have helped development economists better understand which interventions are likely to have a positive impact on populations (Duflo, 2020). A representative sample of the targeted population is randomly split into a treated group that receives the intervention and a control group that does not. Thanks to randomisation, the only difference between the groups on average is the fact of receiving the treatment, and the difference in behaviour measures the causal effect of the intervention. Following Gerber and Green (2012), we develop a protocol to be implemented in parallel between the groups (same questionnaires in the same period of the year), ensuring non-interference, i.e., that the treatment received by a group does not affect farmers belonging to others (by creating groups that are geographically distant or have little chances to interact). However, since interferences are difficult to fully prevent, we include control questions in the final questionnaire.

When RCTs cannot guarantee full randomisation, PSM can help estimate causal treatment effects by selecting, amongst the non-treated, a group with as close as possible observable characteristics to those of the treated. A 'propensity score,' reflecting farmers' propensity to adopt the innovations based on their observable characteristics (determinants of adoption) is estimated for each farmer (Gertler et al., 2016). Then, adopters are 'matched' with one or more non-adopter(s) with the closest propensity score, which are used to produce an estimate of the counterfactual. PSM relies on the requirement that for each treated unit, at least one non-treated unit with similar propensity score exists (common support), thus we include a control group to which the innovation is not proposed. Furthermore, we assess potential bias from unobserved characteristics through sensitivity tests (Rosenbaum, 2002).

Data collection

In each case study area, we involve at least 400 farmers net of attrition, who are assigned to one of four treatments. Treatment 1 is always a control group to which no innovation is proposed. The farmers assigned to Treatment 2 are informed of the innovation, and receive 'basic training.' This group is used to assess how financial incentives or additional information, provided to the other two groups, impact adoption. Assuming that the proportion of adopters in the baseline group is 0.5, when comparing two samples of 100 farmers the minimum difference between proportions detectable with a power of 0.8 and at 0.05 significance level is 0.2, which decreases to 0.1 for proportions close to 0 or 1.

To ensure that the four groups are comparable before the treatment, we implement 'stratified randomisation' (Oliver et al., 2010; Suresh, 2011; Olofsgård, 2014; Gertler et al., 2016), i.e., each farmer is assigned to a stratum, and the four groups have the same composition in terms of incidence of the strata. Relying on data from the preliminary surveys, we identified three (binary) variables that explain a significant share of the variance of other observed variables, and obtained eight strata by cross-tabulating them. The farmers involved in the preliminary surveys are pre-assigned to the treatments. If some of them refuse to take part in the trials or further recruitment is necessary to achieve the required sample size and balanced groups, local researchers and NGOs will recruit new farmers using lists provided by local institutions. These farmers are asked questions to categorise them, and if they belong to an underrepresented stratum for a specific treatment, they are invited to take part in the appropriate training session, until filling up all the strata.

The randomisation procedure varies slightly between countries due to different logistic conditions but the principles remain the same. In Morocco, participant farmers must grow onions, potatoes, or carrots with irrigation. The stratification variables are farm size, age of the farm manager, and household size. To reduce spill-over effects, farmers belonging to the same associations are assigned to the same treatment. In Uganda, to prevent spill-over effects or envy between incentivised and non-incentivised farmers, each district (or pair thereof) is assigned a specific treatment, and we recruit new farmers to ensure similar composition between the treatment groups. The stratification variables are membership of associations, having received credit or loans for aquaculture in the past year, and ownership of the pond(s) used for production. In Tanzania, all the farmers come from the same village, thus the sessions are run in a short period of time and farmers are asked to make their adoption decision (purchasing bean seeds) right after the training, to minimise spill-overs. All farmers must have grown beans in the last three years, and the stratification variables are age of the farmer, gender, and whether they sell more or less than half of their production.

Treatments

After having identified innovation characteristics that could represent challenges or opportunities for adoption, we defined dissemination strategies to be used within training sessions. A first approach consists in providing information related to non-financial benefits which would be ignored by purely profit-maximising, risk averse, short-sighted farmers. A second one consist in financial incentives with additional constraints.

Information provision can increase the salience of innovation characteristics which are not immediately visible or whose individual payoffs are small and delayed in time. The impact of information on innovation has been extensively tested through experiments. For instance, Beltramo et al. (2015) assess the impact of health-related messages on willingness to pay for fuel-efficient cooking stoves in Uganda but find no significant effect; Lopes et al. (2023) use environmental awareness to promote avoidance of residue burning in India, finding a positive but small effect. Despite these mixed results, given the limited cost of information provision compared to financial incentives, we decided to test this approach for innovations generating health or environmental benefits and whose cost is limited. Treatment 3 in Morocco includes training about climate change and its local impact; Treatment 3 in Tanzania includes detailed information about health benefits of the bean varieties. In both cases, these treatments are compared with no information provided.

The literature on adoption of pro-environmental practices has provided evidence that the timing of the support received matters. In an RCT, Duflo et al. (2011) find that offering *small* discounts during a limited period of time is efficient in nudging uptake of fertilisers in Uganda. Research also shows that relative poverty tends to lead to more risk averse behaviour (Gloede et al., 2015) and to more impatience (Tanaka et al., 2010; Ashraf et al., 2006; Clot and Stanton, 2014), potentially hindering adoption of innovations perceived as risky. An ex-ante payment may mitigate this effect. This is tested in Treatment 3 in Uganda (15% upfront coverage of cost), and in Treatment 4 in Tanzania (10% more seeds than the quantity which could be purchased at the prevalent price in the village: comparable to a small discount). In both cases, the baseline is represented by absence of payments, and we expect an increase in uptake among farmers receiving the incentive.

A recent development in the design of Payments for Environmental Services schemes consists in conditioning the payment to an actual improvement of the environment (Herzon et al., 2018). Such result-based schemes can potentially be more cost-effective; however, they can also be perceived as riskier, since achieving the objective may also depend on external factors (Tanaka et al., 2022). Payments by result are tested in Treatment 4 in Uganda, where a small, 5% upfront payment is complemented with a further 25% payment if water quality objectives are achieved through the recirculation system; and in Treatment 4 in Morocco, where the goal is to reduce water consumption. Both treatments are compared to no payment.

The effectiveness of collective and conditional payments in promoting smallholders' virtuous practices have been explored using experiments. If environmental outcomes are difficult to monitor, payments can be conditioned on participation levels that would enable satisfactory environmental improvement. In Colombia, Moros et al. (2019) find that this approach crowds-in social motivation and promotes cooperation. In Peru, Midler et al. (2015) find that it is most effective when coupled with *individual* payments. In Treatment 4 in Morocco, the flat-rate reward is provided to all farmers in a training group who have used the app if at least 50% of the group make an 'optimal use' of it. We use a participation threshold due to the difficulty of monitoring water savings in the absence of meters. While adoption might be higher than in the non-incentivised treatment, the actual rate depends on the interplay between social commitment and free-riding tendencies.

Evaluation

To test the impact of the innovations on wellbeing, we compare the difference in the values of various indicators *before adoption* (baseline) and *after adoption* (final questionnaire) between *adopters* and comparable *non-adopters* (group with no innovation proposed) using PSM. Although the innovations require time to generate an impact, due to project constraints the final questionnaire are administered after just 12 months, to include one full agricultural year or aquaculture production season. To ensure enough time after adoption, the farmers are given a deadline after which the incentive is not paid and they cannot receive any assistance. In all case studies, households' and farm incomes and expenses are recorded both for the year preceding the baseline questionnaire and for the year preceding the final one. This allows calculation of the change in farm profit, food expenses, perceived food security, and total household income, including in-kind. Equally, *ex-ante* and *ex-post* information is collected on input quantity and cost (seeds, fertilisers, pesticides, fungicides, labour, water and energy, if relevant). We complement these data with subjective assessments of the changes and of whether these changes are due to the innovations. Indeed, smallholders rarely keep books, and make their innovation decisions based on perception.

In all the regions, smallholders are asked about their level of satisfaction with the innovation, and the likelihood to keep using it or to adopt it in the future, if not yet adopted. We also collect innovation-specific indicators. In Morocco, these include occurrences of late blight outbreaks, and improvement in IT skills. In Uganda, we control for transfer of resources to other farmers whose plots neighbour the pond(s), *ex-ante* and *ex-post* expenditure for using and discharging water, frequency of discharging wastewater in the water bodies, and households' dietary diversity and vegetable consumption. Finally, in Tanzania, input quantities, expenses, yields and, if relevant, selling prices, are registered for each bean variety separately (traditional and new), and we also monitor changes in nutrition and health (namely whether the household have experienced specific nutrition-related diseases), frequency of bean consumption, cooking time, and use of fuel.

Implementation and preliminary findings

The baseline questionnaire, followed by the training sessions, was administered in late spring 2023 in Uganda, achieving a sample size of 311 fish farmers which will be integrated during the autumn. Preliminary results show that 69% of the farmers who were proposed the result-based payment (Treatment 4) have filled in a business plan, compared to 3% of those who were proposed the 15% ex ante payment (Treatment 3), and 23% of those who receive no incentive (Treatment 2). However, these numbers refer to intentions rather than actual adoption, and the deadline for delivering the plan has not expired yet.

The baseline questionnaire and the training sessions are foreseen in early autumn in Morocco, and in spring 2024 in Tanzania, where the multiplication of the bean seeds is ongoing. The final questionnaire, when the innovations are also proposed to the smallholders in the baseline group for ethical (fairness) reasons, will be administered 12 months later.

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Consumers' response to genetically modified food: an Italian case study

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Introduction

The world population growth expected in the next years inevitably will lead to an increase in food demand which is forecast by 35% to 56% between 2010 and 2050 (van Dijk, et al., 2021), consequently, an intensification of the pressure on natural resources will occur. These aspects are extremely linked to climate change which impacts agriculture and the sustainability of global food systems (Anders et al., 2021; Dhankher & Foyer, 2018). The use of new breeding techniques (NBTs), namely genome editing and cisgenesis, could open promising scenarios both for the improvement of production and product quality and for environmental sustainability.

While only a few applications of gene editing have been translated to agricultural production thus far, many studies across the world have demonstrated that genome editing may offer various environmental benefits such as more efficient land use, less GHG emissions and biodiversity losses, more efficient use of water, and more resistance to pests and climate changes (Karavolias et al., 2021; Ferrari et al., 2021; Beghin et al., 2021 Lassoued et al., 2018), resulting in an increased yield to the tune of 22% and an implicit benefit on cost reduction (Smith, 2021, Sendhil et al., 2022). One of the most striking and achievable examples is linked to improving the environmental sustainability profiles of the traditional varieties of Italian viticulture, reducing the use of pesticides without altering the organoleptic characteristics of the wines. Interesting perspectives in the zootechnical sector, also on animal welfare (e.g., the introduction of the absence of horns in the most productive dairy lines, useful for the safety of animals and operators), on the enhancement of the dairy and meat production could be developed. In this case, it is about improving the efficiency of farms by reducing their environmental impact and limiting emissions, inserting genetic resistance to diseases, reducing the use of antibiotics and the onset of resistance to them, modifying the composition of some products (e.g., milk with no allergenic proteins) to make innovative products available to the industry but also respectful of traditions.

Clearly, the definition of a regulatory framework, the timing, and implementation methods of the various formal steps to obtain authorizations and carry out checks are needed.

The biotechnology behind the NBTs is substantially different from that which generates GMOs and should be treated differently, as EFSA claims. However, the ruling C-528/16 of July 2018 (Confédération paysanne a.o. against the French Minister for Agriculture, the Food Processing Industry and Forestry) of the European Court of Justice established that all mutagenic techniques give rise to GMOs and that only organisms obtained with conventional mutagenic techniques and with a history of use and have a long safety record are excluded from the application of EU Directive 2001/18, which regulates the diffusion of GMOs. The possible negative impact of this ruling on commercial and technological development in Europe, in the field of genetic innovation, and the technical impossibility of distinguishing products derived from genome editing from those obtained with traditional mutation, prompted the European Council to ask the Commission for a new study and a subsequent intervention plan.

The EFSA (European Food Safety Authority) studies recognized, among other things, that it is necessary to overcome the rigidity of the current legislation which fails to ensure adequate risk assessment and creates a legislative disproportion between products obtained with different techniques but with similar risks. Also, in the light of the Green Deal, the Farm to Fork, and Biodiversity strategies, the Commission has therefore launched a political initiative to propose a new legal framework in the sector, and a public consultation is expected at the end of 2023.

The EU has the strictest regulations on GMOs, in fact, the acceptance of new technologies in agriculture is among the lowest in the world (Woźniak-Gientka et al., 2022). At the national level, Draft Law A.C. 3310 aims to introduce a simplified procedure for experimentation in the open field for scientific and research purposes of plants obtained through targeted mutagenesis and cisgenesis, modifying legislative draft 224 of 2003.

Expressions of fear of biotechnologies come from public opinion (Caputo et al., 2020; Bain et al., 2020; Sheldon, 2002; Qaim, 2020; Bunge et al., 2018), and it is necessary to enhance a correct knowledge of new technologies benefits, highlighting their close links with environmental sustainability and demonstrating that innovation and tradition are not antithetical concepts, but a single way to promote and defend agriculture productions both in terms of quantity and quality.

Consumers' response is largely influenced by the decision of the governments to ban or approve GM crop cultivation. Public support increases when the potential benefits of the technology are well articulated, consequently, trust in the government and belief in science increases as well (Sendhil, 2022).

The purpose of the present study is to investigate the consumers' attitudes towards genetically modified foods and crops (including new biotechnologies), both concerning food safety and environmental improvement. To this purpose, we propose an analysis based on an Italian survey sample with questions related to self-assessment concerning GM crops knowledge and or genetic editing; environmental and food sustainability and food safety; the role of information tools used to catch up with new challenges; finally, the consumers' purchase behavior as well. The regression analysis investigates the willingness of Italian consumers to purchase GM products.

Data and research methodology

To conduct our research question, we conducted an online survey completed by a sample of 564 participants enrolled in an online panel maintained by the Appinio research agency using a CAWI methodology (Computer Assisted Web Interviewing). The surveys were distributed online

– via e-mail or through the Appinio App - to the pool of respondents, through a random probability sampling in December 2022.

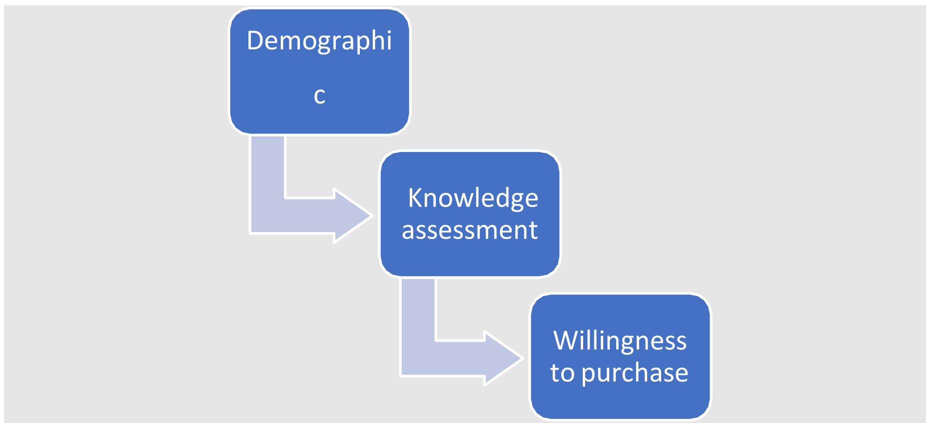
48.8 percent of the survey sample was comprised of males and 51.1 of females, 53.9 percent held a bachelor's degree and 17.4% were enrolled in a master's degree while only 4.7% held a doctoral degree. The age of participants ranges between 18 and 65 years old located in Italy and they were pre-screened by gender, education, household, region, and income, to ensure the sample was representative of the Italian population and reflected the statistics population. This distribution was based on the latest (2022) census data provided by ISTAT (The Italian National Institute of Statistics). Descriptives statistics of participants' characteristics are in Table 1.

Table 1: Characteristics of participants

Gender	**Freq.**	**Percent**
Male	275	48.7
Female	288	51.1
No response	1	0.2
Total	***564***	***100***
Income	**Freq.**	**Percent**
0-15,000 Euros	160	28.3
15,000-30,000 Euros	249	44.3
30,000-50,000 Euros	99	17.6
>50,000 Euros	55	9.8
Total	***564***	***100***
University Degree	**Freq.**	**Percent**
Doctorate Degree	27	4.8
Master	98	17.4
First Degree	77	13.7
High school diploma	304	53.9
Middle school diploma	55	9.8
No qualification	3	0.4
Total	***564***	***100***
Number of family members		
1	85	15.1
2	158	28.0
3	175	31.0
4	115	20.4
5	27	4.8
+6	3	0.5
No response	1	0.2
Total	***564***	***100***

The questionnaire was divided into three sections as described in figure 1. The first stage of the questionnaire regarded demographic questions. The second step includes a knowledge assessment and questions related to real NBT and GMO knowledge with questions related to GM purposes. The third section comprises some questions related to the willingness to purchase GM products.

Figure 1: Survey Structure



The descriptive analysis suggests that the most known genetic improvement methods are the GMO (68%) and in vitro culture techniques (47%). Furthermore, more than half of the sample (57%) state that there are differences between the GMO techniques and new breeding techniques (NBTs), but only 15% know what these differences are. In contrast, 2.8% claim there are no differences between the two techniques.

Concerning food safety issues, 34% of respondents consider GM foods safe to eat. Interestingly, a certain degree of skepticism towards GM food by the Italian people is confirmed as the literature pointed out (Wolf et Al, 2012). But when they are interviewed about the possible GM crop's purposes/benefits on the environment, their opinion improves. 38% of the sample judge GM productions are fairly or very safe for the environment, while more than half of the sample (55%) state that GM productions could contribute to environmental sustainability, whereas 27% of respondents are still vague.

Relating to environmental issues, resistance to insects, diseases, and herbicides is recognized as the main purpose of genetic modification (48%), followed by adaptation to climate change.

Focusing on the tools used for self-knowledge assessment, the results of the survey highlight that only 33% of respondents use scientific and popular publications, selected more by highly educated citizens. Not quite surprisingly the most used information tool is the Press/Television and social media (84%) which, for sure, suggests an obstacle in the genetic improvement techniques acceptance (Ishii & Araki, 2015). On the other hand, social media plays an intermediate role and is more popular among young people.

Survey results show that 4 over 10 Italians would buy a GM product mainly coming from Western Europe (61%), followed by North America (49%). In contrast, respondents display lower confidence for African (21%) and Asian (24%) products.

Empirical Model

In the quantitative section, we study the predisposition to purchase products deriving from genome editing and whether and how much consumers know the techniques of genetic modification for instance. In modeling the willingness to pay and the role of information related to environmental sustainability and food safety issues we use a Multinomial Logit Model (MNL).

The Logit model for multiple choice problems takes the following form:

$$Pr\{Y_i = j\} = \frac{\exp\,(x_i\beta_j)}{1+exp\{x_i\beta_2\}+exp\{x_i\beta_3\}+\cdots+exp\{x_i\beta_M\}}; j = 1,2 \ldots M \quad (1)$$

Where x_i is a K-dimensional vector containing the characteristics of individual i (including an intercept term) and β_j denotes a vector of alternative-specific coefficients. We estimate K-1 slope coefficients plus an intercept term for all but one of the alternatives.

The marginal effects, that is the effect of changing a regressor by one unit on the probabilities of choosing each alternative, are:

$$\frac{\partial \Pr\,(Y_i = j)}{\partial x_i} = \Pr(Y_i = j|x)\,(\beta_{jk} - \sum_{j=1}^{M} \beta_{jk} * \Pr\,(Y_i = j|x)) \quad (2)$$

Where the term $(\beta_{jk} - \sum_{j=1}^{M} \hat{\beta}_{jk} * \Pr\,(Y_i = j|x))$. The sign of the marginal effects may or may not correspond to the sign of the coefficient estimated itself. In our analysis, several robustness tests will be used to validate the results of the estimations.

Based on the questionnaire response we have generated several variables by transforming some of the qualitative responses into quantitative ones (level of objective knowledge, and willingness to buy products from the main world blocs). The variables that capture the willingness to purchase GM products and the level of presumed knowledge are based on a Linkert scale.

The multinomial regression examines the determinants that influence the probability of consumers buying GM products. The dependent variable is a discrete variable ranging between 0 and 2, where the value of 0 indicates “None at all”, 1 is for “I do not know” and 2 is for “Most of it”. Specifically, the independent variables included in the regression model as determinants are gender, age, education, income, perception of food safety and environmental sustainability, media tools used for searching for information regarding GM products, and the product’s origin.

Table 2 reports the variables description used in the regression analysis.

Table 2: Variables description

Variables names	**Description**	**Details**
w_buyGMpr	The dependent variable ranges between 0 and 2.	Willingness to purchase GM products.
Food_gm_s	A score ranging between 1 and 3. (1=unsafe; 3 safe)	Consumers' perception of Food GM sustainability
Envir_gm_s	A score ranging between 1 and 3. (1=unsafe and risky; 3 safe and no risky)	Consumers' perception of Environmental GM sustainability
selfass_kn	Score on Linkert scale (1= None at all; 5= Most of it)	Level of presumed GM knowledge
r_kn	Scores ranging from 1 to 5	Level of objective knowledge
I_tools	Scores ranging from 1 to 4	Number of Information Tools Used
w_buyGMpr_area	4 Dummy variables if the origin of the product is America or Europe, or Asian o Africa	Willingness to buy GM products from different areas
Gender	Dummy variable: 0 if male, 1 if female	Control variable
Areas/regions	Score =1 if North-east; =2 if North-west; =3 if center, = 4 if South	Control variable
Age	Age of respondents ranges between 18-65	Control variable
F_memb	Number of family members	Control variable number of family members
Income level	Scores ranging from 1 to 4	Control variable level of income

Discussion of results

Preliminary results are in Table 3, columns 1 and 2 report results for the consumers classified in the "I do not know" group; while columns 3 and 4 display results for consumers grouping in "Yes, at all"; the reference group is "None, at all". There is no significant effect on marital status, education, objective knowledge, and perceived knowledge. Education is negative and significant in the "Yes, at all group". The more educated consumers are the more unlikely to buy GM products in both groups. Additionally, income level does not affect the willingness to buy GM products. Consumers' perception of food safety and environmental risk shows a positive effect both in the "I do not know group" and "Yes, at all group". Even if some differences are emerging: the coefficient size of environmental risk and sustainability is lower than food safety. According to the number of information tools used by consumers, when consumers use different tools, the possibility of being classified into the "I do not know group" increased at the 10% significance level. More interesting are the results of the variable "product origin"; both groups display positive and significant coefficients for European countries and American ones. Finally, being female increases the probability of being classified in both groups. The knowledge of the product's origin is relevant both for consumers who belong to the group of "I don't know" and "Yes, at all".

Table 3: MNL regression results

	Beta	SE		Beta	SE	
	(1)	(2)		(3)	(4)	
w_buyGMpr	**I don't group**			**Yes, at all**		
Selfass_kn	-.387	.182	**	-.413	.127	***
R_kn	-.017	.171		.019	.123	
Food_gm_	2.098	.330	***	1.114	.236	***
Envir_gm_s	1.957	.366	***	.895	.245	***
I_tool	.490	.256	*	-.138	.197	
American C	.838	.431	*	-.032	.336	
European C	.916	.440	**	1.024	.340	**
Asian C	.600	.412		.321	.325	
African C	1.123	.540		.954	.455	
Education	-.339	.267		-.441	.221	**
Income	.349	.232		.199	.177	
Marital_status	.0450	.190		.137	.151	
F_member	.124	.173		.119	.136	
Gender	1.373	.398	**	.751	.296	**

Notes: Reference group = None at all; −2Log likelihood = - 312.19677; Chi-square = 191.43, N.obs 500, Pseudo R2 =0.43

Main conclusions

The new challenges launched by the spreading biotechnology in agriculture target optimizing the production factors by limiting the use of inputs and resources given their saving and efficient use.

The empirical evidence has demonstrated that such technologies are at least as safe as traditional breeding technologies. Innovations based on these new research techniques provide substantial economic benefits and environmental improvements in critical ecosystems with overall important contributions towards sustainable development (Smith, 2021).

Our work is part of the recent literature dealing with consumer preferences and their attitude toward NBTs. Our preliminary results (survey and regression analysis) follow what the empirical evidence indicates. Consumers have a more sensitive view of food safety in comparison to environmental issues. Education is a key variable in the "Yes, at all" group; this result implies that consumers with lower education feel less confident despite high objective knowledge; more educated consumers are overconfident about their knowledge with a negative effect on the willingness to buy GM products. Scholars suggest that more education in terms of quality information would allow consumers to make purchasing decisions that accurately reflect their belief sand (Wunderlich, 2019). Indeed, consumers who lack education and proper knowledge regarding GM foods may have a distorted perspective about them and this could explain the not significance of “objective knowledge”. Objective knowledge needs to be delivered through transparent information.

Consumers’ attitudes and purchase intentions are affected by their knowledge level: if consumers are biased or confused about GM foods, they may have a kind of prejudice and therefore may hesitate to choose GM products.

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
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NEW SUPPORT FOR CO-OPERATION PROVIDED BY INTEGRATED CHAIN PROJECTS IN EMILIA-ROMAGNA RURAL DEVELOPMENT PROGRAMS 2014-2022

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KEYWORDS: Integrated Supply Chain Projects; Agro-industrial chain; European Agricultural Fund for Rural Development; Farm Accountancy Data Network; Welch-t-test

INTRODUCTION

The Integrated Supply Chain Projects (ISCP) are formal agreements between agro-industrial actors (Tarangioli, 2019) promoted under the framework of the European Agricultural Fund for Rural Development (EAFRD). In Italy, Tuscany, Emilia-Romagna and Lazio are the three regions that have focused more than others on Integrated Design (2014-2022 Rural Development Programs RDPs) (Licciardo *et al*., 2022).

The Emilia-Romagna Region has identified the supply chain projects as a tool to increase farms' competitiveness to enhance production, distribution, marketing and supplying of agri-food products, starting from agricultural production to sales and consumers (Deliberazione di Giunta regionale n. 227/2017). Furthermore, the Rural Development Program 2014-2022 provides for the implementation of some specific measures and/or operations that can take place through the activation of single calls for tenders both by "single" and "package" measures' approach.

Among the measures/operations promoted by Emilia-Romagna there are:

- 1.1.01 Support for professional training and acquisition of skills.
- 4.1.01 Investments in farms by single and package measures' approach.
- 4.2.01 Investments aimed at agro-industrial companies by single and package measures' approach.
- 16.2.01 Pilot projects and development of innovation. (Reg. (UE) n. 1305/2013).

The aim of this work is to give evidence of the cooperation between different actors and how this can generate positive effects by considering the differences in terms of the economic performance between farms that applied for integrated projects (treated) and those that did not (non-treated).

MATERIALS AND METHODS

The sources are twofold: on one hand a description of the main information regarding the Integrated Supply Chain Design is provided by the Italian Rural Network database (https://www.reterurale.it/PIF), collected by the Council for Agricultural Research and Economics, Research Centre for Agricultural Policy and Bioeconomy (CREA - PB). On the other hand, the Italian Farm Accountancy Data Network (FADN) dataset is used to process quantitative data. In fact, it runs useful information to investigate structural and economic characteristics of subsidized farms. The analysis is based on the regional FADN; a three-year period is considered (2018-2020). The sample consists of 2,251 farms, outliers excluded. The ISCP beneficiaries (treated) included in the FADN sample are 128.

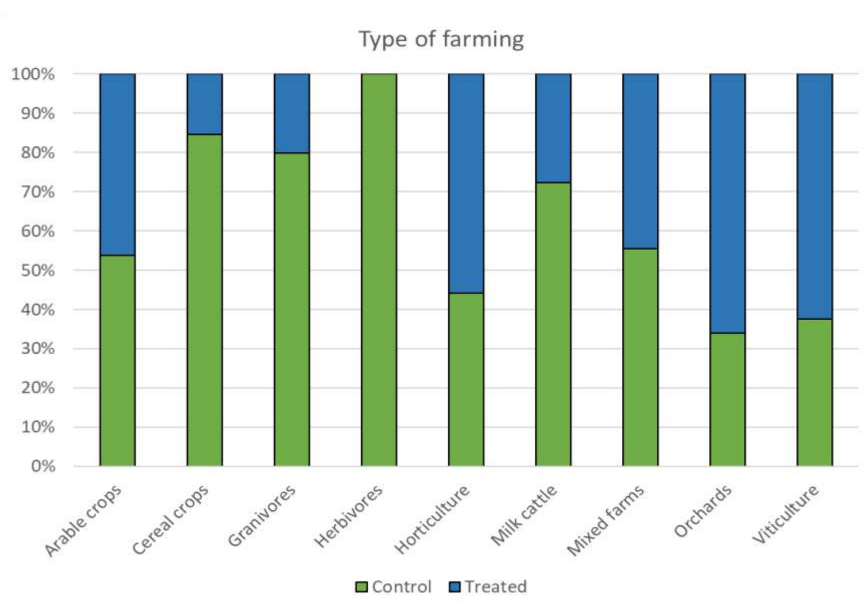
The tables and figures show the main characteristics of treated and non-treated farms, considering the following variables: Economic dimension, organic or conventional farming, diversified or non-diversified farms, youth-led and women-led farms, Farm Net Value Added, Current Costs and some Balance sheet indexes.

The statistical analysis carried out compares treated and non-treated farms (the control group), using the Welch-t-test, for independent unpaired samples (Agarwala *et al*., 2022). Structural variables, such as Utilized Agricultural Area (UAA) and Agricultural Work Units (AWU) were considered to assesses the differences on the economic variables such as Net income, Costs and Capital.

RESULTS

The analysed farms mainly belong to orchards, arable crops, viticulture, horticulture, milk cattle and mixed farms, as reported in Figure 1.

Figure 1 - Treated and control farms by type of farming (2018-2020)



Source: own data processing on FADN data

Table 1 shows the main structural and labour variables of both groups of farms. High-level of significance was found in the total area and utilized agricultural area as far as the treated group is concerned.

The area-size has also an impact on work variables such as mechanization and work units. These results are probably mainly due to the agricultural sectors involved (orchards, arable crops, viticulture, milk cattle and mixed farms) where many of the cultivation and livestock operations are carried out manually or with the aid of facilitating machines.

Table - Main structural and labour variables: treated and control farms (2018-2020)

	Control		Treated		Statistical Analysis
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**Welch-t-test**
Farm Structural Variables					
Total Area - Large Farms - [ha]	31.89	57.69	86.27	206.35	***
Utilised Agricultural Area (UAA) - [ha]	25.92	31.20	78.06	193.64	***
Labour Variables					
Machine power expressed by KW per Utilised Agricultural Area [KW/UAA]	16.16	16.24	13.80	11.68	**
Agricultural Working Units [AWU]	1.52	1.59	2.78	3.85	****

Statistical significance at p <0.1; p<0.05; p<0.01; p<0.001

Source: own data processing on FADN data

Table 2 shows the main Balance sheet variables. Treated: The integrated supply chain projects mainly affect the asset variables. In fact, farms show higher agricultural capital and new investments. This allows for the modernization of both the business structure and the production process, according to the objectives outlined in the various measures under the regional program. The issue of cooperation would thus seem to have a positive impact on economic variables.

Table 2 - Main Balance sheet variables: treated and control farms (2018-2020)

	Control		Treated		Statistical Analysis
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**Welch-t-test**
Economic variables					
Farm Net Value Added/UAA - [Euro/ha]	3,567.10	10,960.67	3,901.69	3,171.96	ns
Net Income/UAA - [Euro/ha]	2,138.10	3,511.99	2,916.77	2,832.03	***
Net Income/AWU - [Euro/ha]	22,789.82	20,780.32	33,072.88	21,541.94	****
Variables Costs/UAA - [Euro/ha]	3,923.01	26,414.00	2,567.24	1,591.60	**
Value Added/UAA - [Euro/ha]	3,830.52	10,613.60	4,244.79	3,371.82	ns
Patrimonial Variables					
Agricultural Capital/UAA - [Euro/ha]	1,107.65	2,112.19	1,990.83	3,173.49	***
Agricultural Capital/AWU - [Euro/AWU]	13,616.15	25,578.49	25,268.36	36,508.81	****
EU Help funding/UAA - [Euro/ha]	308.47	250.08	302.35	178.23	ns
New Investments/UAA - [Euro/ha]	*149.82*	*711.77*	*565.93*	*1,723.51*	***

	Control		**Treated**		**Statistical Analysis**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**	**Welch-t-test**
New Investments/AWU - [Euro/AWU]	*114.55*	*593.61*	*5,645.52*	*16,791.44*	****

Statistical significance at ns (non-significance); p <0.1; p<0.05; p<0.01; p<0.001

Source: own data processing on FADN data

CONCLUSIONS

Agricultural associations and the development of co-operative processes play a strategic role both in the European view and in the national one. For this reason, and especially in the latest CAP 2014-2022, the European legislator has indicated the cooperation between farms as the main tools for achieving the objectives of competitiveness.

Italian agriculture still needs to aggregate supply to support market dynamics and remain internationally competitive, especially for the more niche and quality products that characterize Made in Italy, on which it has always relied. In this regard, Emilia-Romagna has focused considerably on promoting integration processes along the agri-food and forestry supply chain and supporting the development processes of rural territories. This is aimed at creating stable and transparent relationships among rural actors, as well as focusing resources on shared and plural goals. In this study, the results suggest how ISCP represents a valuable tool for supporting agri-food products. The role of co-operation as a system is expected to have an impact on the individual farm, which, by maintaining a certain autonomy in business decisions, can optimize its resources by entering into a shared process with quality at its core. Through funding, farms included in a larger system could thus help generate the economic, social and capital development of rural communities.

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Differences in sustainability outcomes between agritourism and non-agritourism farms based on robust case evidence from the Tyrol/Trentino mountain region

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PAROLE CHIAVE
Farm tourism, multi-region survey, propensity score methods, Italy, Austria, South Tyrol

TESTO

Agritourism is a form of tourism that involves agricultural activities and operations that attract visitors to a farm. The types of agritourism activities can range from farm tours and wine tastings to pick-your-own produce and overnight stays in farmhouses. The concept of agritourism has gained popularity in recent years as a way to diversify farm income and promote sustainable rural development (Streifeneder, 2016; Chiodo, Fantini, et al., 2019). With the increasing demand for authentic and unique travel experiences, agritourism has become an attractive option for travelers seeking to connect with nature, culture, and local communities (Palmi and Lezzi, 2020).

From this perspective, a deep understanding of agritourism farms' social, economic, and environmental impacts could have numerous advantages both for them and their stakeholders and could also help in the promotion of more ethical and sustainable practices in the tourism sector. In terms of environmental protection, social responsibility, and farm profitability, this deep understanding might first assist in identifying best practices and further areas for development. Additionally, this understanding could contribute to the development of trust and credibility among stakeholders, such as visitors, residents, and governmental organisations. Finally, such insight knowledge could increase the agritourism sector's long-term viability along all sustainability dimensions in many territories in the post-pandemic era.

On these premises, this study aims at identifying sustainability differences between agritourism and non-agritourism farms of the Tyrol-South Tyrol-Trentino Euroregion. This helps to understand if and how agritourism activities affect traditional farming. By this comparison the research aims at answering the following research questions:

RQ1.: Are agritourism farms more sustainable in economic, social, and environmental terms than non-agritourism farms?

RQ2.: How do agritourism activities effect the traditional farming and operational activities of farms?

Based on the relevant literature, the following hypotheses have been developed. With agritourism:

- H1: agricultural income and income satisfaction increase (Mastronardi et al., 2015; Nematpour and Khodadadi, 2021).
- H2: investments made in agriculture decrease (Ammirato and Felicetti, 2014; Stotten et al., 2019).
- H3: traditional farming activity decreases, i.e., agricultural output (Fischer, 2019; Arru et al., 2021; Montefrio and Sin, 2021).
- H4: farm family life improves (Chase, Kuehn and Amsden, 2013; Chiodo, Adriani, et al., 2019; Ciolac et al., 2020).
- H5: the presence of women running and operating in the farm increases (Annes and Wright, 2015; Halim et al., 2020; Savage, Barbieri and Jakes, 2020).
- H6: the nature of neighbor and community relations is affected (Yang, 2012; Naidoo and Sharpley, 2016; Paniccia and Baiocco, 2020).
- H7: the farm animals' composition and handling are affected (Hansen and Østerås, 2019; Stotten, 2020).
- H8: organic production methods are adopted (Kuo, Chen and Huang, 2006; Mastronardi et al., 2015; Shen, Chang and Liu, 2020).
- H9: sustainable practices are adopted (Barbieri, 2013; Mastronardi et al., 2015; Giurea et al., 2018).

The study utilized an online survey to collect data from agritourism and non-agritourism farms in our focus area. A convenience sample of individuals was recruited through various sources, including professional associations and social media platforms. Participants were sent an email invitation between April and July 2022 that included a description of the study and a link to the online survey questionnaire. An email with the survey was sent to 3790 farmers and the total number of respondents was 670, equal to a 25% response rate. After data cleaning, the final sample consisted of 493 completed surveys, which were then analyzed using the statistical software STATA in order to perform the Propensity Score Matching and Weighting analysis.

Propensity score methods (PSM) are widely used in observational studies to control for the effects of confounding variables on the relationship between treatment and outcome. The fields of application are diverse, including medicine, psychology and economics. In agricultural economics, it has been recently used to understand the impacts of cooperative membership (Mojo, Fischer and Degefa, 2015, 2017) and in agritourism studies (Joo, Khana and Mishra, 2013; Schilling, Attavanich and Jin, 2014). These methods are based on the idea of estimating an individual's likelihood of receiving treatment, given a set of baseline covariates, referred to as the propensity score (Austin, 2011). The propensity score is modeled using a parametric function, such as a logistic regression model, and is used to balance the baseline covariates between treated and untreated individuals in the study population. The sample is composed of 229 (46%) agritourism and 264 (54%) non-agritourism farms. For each of the three dimensions, economic, social and environmental, several variables were identified; those found to be significant from the analysis are described below.

The PSM estimations for the economic sustainability indicators reveal the presence of positive statistically significant effects of agritourism activity on income change. On the other hand, it shows negative statistically significant effects on production quantity change and production value (€) change.

Income has a higher significant increase in agritourism farms, this result is in line with the several scientific studies stating that agritourism has proved to be an important additional source of income that creates room for manoeuvre for the farms to activate their adaptive capability (Schmitt, 2014; Giaccio, Giannelli and Mastronardi, 2018; Stotten, 2020; Nematpour and Khodadadi, 2021).

Both production quantity and production value change have a higher decrease in agritourism farms, this result supports the few studies on it suggesting that farmers who engage in agritourism may divert resources away from traditional farming activities to focus on tourism-related activities (Fischer, 2019; Arru et al., 2021; Montefrio and Sin, 2021).

As far as social sustainability indicators are concerned, the analyses reveal the presence of negative statistically significant effects of agritourism activity on free time, a partner's job outside the farm and the interaction with local community. On the other hand, it shows a positive statistically significant effect on the partner involvement in farm activities. Free time for agritourism operators decreases significantly compared to those not running an agritourism activity. This is consistent with the literature emphasizing the burden of being on duty all day long and the importance of establishing personal space. The added responsibilities that come with running an agritourism operation, such as hosting guests and providing tours, could take up additional time and limit the amount of free time available for agritourism farm operators (Sharpley and Vass, 2006; Kordel, 2016; Fischer, 2019). Despite this decrease in leisure time, satisfaction remains the same for both groups of farms.

The self-perception of farmer identity is not significant between agritourism and non-agritourism operators. This finding is consistent with existing literature which suggests that farmers have a strong sense of identity and attachment to their occupation, regardless of the scale or nature of their farming practices. Farmers often see themselves as stewards of the land and caretakers of their communities, which is an important part of their identity. Even if they are not engaged in farming as their primary source of income, farmers may still feel a strong connection to their land and way of life (Brandth and Haugen, 2011; Stotten et al., 2019; Stotten, 2020).

Partner involvement in farm activities is significantly higher in agritourism farms compared to non-agritourism farms. This finding is in complete agreement with the existing literature, which has found that agritourism farms tend to rely more heavily on family labor, including the involvement of partners and children in farming activities (Brandth and Haugen, 2011; Annes and Wright, 2015; Arroyo et al., 2019; Stotten et al., 2019; Halim et al., 2020; Savage, Barbieri and Jakes, 2020). Consequently, fewer partners of agritourism farm operators have jobs outside of the farm, which further emphasizes the importance of family labor in these operations. This is also consistent with previous research (Arru et al., 2021; Holland, Khanal and Dhungana, 2022), which has found that agritourism farms often prioritize the use of family labor over hiring outside labor.

The interaction with the local community decreases significantly for agritourism farmers. Even if the literature shows a good influence at the community level (Yang, 2012; Chase, Kuehn and Amsden, 2013; Naidoo and Sharpley, 2016; Paniccia and Baiocco, 2020), agritourism farmers may have less free time to engage with the community due to the demands of running their businesses, managing visitors and maintaining their properties. In addition, on average, agritourism farms have families with a higher number of children, and this, as well, may be contributing to the decrease in time available.

Finally, for environmental sustainability indicators, the analysis reveals the presence of positive statistically significant effects of agritourism activity on the use of organic production, renewable energies, active reduction of waste, and renewable energies satisfaction.

There is a statistically significant difference between the adoption of organic production in agritourism farms compared to non-agritourism farms. This implies that agritourism farms are more likely to engage in organic production than non-agritourism farms, in consistent agreement with the literature (Kuo, Chen and Huang, 2006; Mastronardi et al., 2015; Shen, Chang and Liu, 2020). This finding could suggest that agritourism farms are more likely to prioritize sustainable and environmentally friendly practices, which could be attractive to consumers who are interested in supporting these values. In addition, it may indicate that there are synergies between agritourism and organic production, as visitors to agritourism farms may be more interested in purchasing organic products.

Overall, agritourism farms appear to be more sensitive to environmental issues associated with agriculture: for all the variables of sustainable techniques, agritourism and non-agritourism farms are on equal level or the first outperforms the second. In more details, agritourism outperform non-agritourism farms on: (i) renewable energies: this refers to the use of sustainable energy sources, in particular solar power; (ii) active reduction of waste: this refers to efforts to minimize waste generation and promote recycling and reuse; (iii) renewable energy satisfaction: this refers to the level of satisfaction that farmers feel with their use of renewable energy sources. These findings suggest that agritourism farms are more likely to prioritize sustainable practices and environmental conservation than non-agritourism farms, in good agreement with the literature (Carlsen, Getz and Ali-Knight, 2001; Choo and Jamal, 2009; Lanfranchi and Giannetto, 2018).

Taken together, the evidence from the study suggests that agritourism offers sustainability advantages. However, a differentiated assessment is necessary. Economically, farm incomes increase but agricultural output decreases. Socially, farmer partners find more work on the farm but the relations with the farm community may suffer. Environmentally, some farming practices become more sustainable while others do not. Our findings suggest that agritourism is not a general farm sector or rural development solution. Agritourism has both benefits and drawbacks that need to be understood and taken into consideration when policy decisions on public support measures are taken. In other words, the promotion of agritourism should be aligned with regional or national overall rural development policy objectives while taking also into account that agritourism promotion may adversely affect global food security and/or the production of local food.

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Analisi delle preferenze del consumatore per il kiwi a polpa rossa mediante un esperimento di scelta tra diversi paesi

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PAROLE CHIAVE
Preferenze, consumatori, esperimento di scelta, kiwi rosso

INTRODUZIONE
Il kiwi (Actinidia spp.), originario della provincia di Cina-Sichuan (valle del fiume Yang Tze), è diventato un frutto di largo consumo (Ferguson, 2011). Secondo le statistiche della FAO, negli ultimi 10 anni i tassi di crescita della superficie e della produzione mondiale di kiwi sono stati rispettivamente del 71,25% e del 55,58% (Mu et al., 2018). Nonostante la coltura stia affrontando importanti problemi fitoiatrici (Mian *et al.*, 2022a) che ne limitano la diffusione, la domanda di tale frutto è in aumento (Mian *et al.*, 2022b), ciò significa che i consumatori mostrano un interesse crescente per questo frutto. Il kiwi ha un mercato molto dinamico, avendo un ruolo fondamentale nel commercio della frutta fresca. Tuttavia, nonostante il costante aumento dei flussi commerciali, l'offerta è ancora molto concentrata. Il 75% della produzione mondiale fa capo a tre paesi: Italia, Nuova Zelanda e Cile (Bano e Scrimgeour, 2011).
L'Actinidia spp. comprende numerose specie (circa 65) (Kisaki *et al.*, 2018), tutte commestibili, ma il suo mercato si è concentrato per oltre 30 anni sulla coltivazione di una sola varietà a polpa verde Hayward (Actinidia deliciosa) (Mian *et al.*, 2022a, 2022b; Huang *et al.*, 2002). Fondamentalmente, le varietà possono essere suddivise in varietà a polpa verde, a polpa gialla e a polpa bicolore (Jaeger *et al.*, 2003). Mentre la polpa verde e quella gialla sono normalmente riconosciute dai consumatori, un nuovo tipo si sta affacciando sul mercato, quello a polpa rossa. Tra le varietà a polpa rossa (Actinidia chinensis), la cultivar Hongyang è la più coltivata e commercializzata. È stato rilevato che questa cultivar di kiwi è adatta al consumo fresco grazie al suo elevato rapporto zuccheri/acidi (10,39), un aspetto importante per i consumatori (Liang *et al.*, 2021). In ogni caso, nonostante la polpa rossa non sia ancora ampiamente commercializzata né coltivata, sta assumendo un ruolo importante nell'intera filiera del kiwi, essendo nuova e quindi attirando l'attenzione dei consumatori. Per indagare quindi le preferenze dei consumatori nella scelta di acquisto del kiwi rosso e per definire la loro "disponibilità a pagare" per alcune caratteristiche di questo frutto, è stato utilizzato il metodo degli "esperimenti di scelta" (CE) (Baselice, 2014; Bano e Scrimgeour, 2011). Questo ha permesso di valutare non solo la disponibilità degli intervistati a pagare per una determinata caratteristica, ma anche di comprendere le relazioni di esistenti tra i diversi attributi valutati.

MATERIALI E METODI

Nell'ambito dello studio condotto sulle preferenze dei consumatori per il kiwi rosso si è applicato l'iter metodologico tipico del CE. Infatti, dopo aver identificato gli attributi rilevanti attraverso l'organizzazione di focus group, sono stati definiti i rispettivi livelli per consentire una scelta completa e ponderata del kiwi rosso. (Bovenkerk *et al.*, 2023). La combinazione dei diversi livelli ha permesso di predisporre il disegno sperimentale e la costruzione dei gruppi di scelta per l'individuazione delle preferenze degli intervistati (Tait *et al.*, 2019). Poiché è possibile identificare numerose combinazioni dei suddetti attributi e dei loro livelli, è stato generato un disegno ortogonale fattoriale frazionario utilizzando il software SPSS® (Alili e Krstev, 2019). Agli intervistati sono stati somministrati sei set di scelta, ciascuno contenente tre alternative, ossia tre "tipi" di kiwi rosso caratterizzati da diversi livelli degli attributi identificati, compreso quello monetario (prezzo). La possibilità di "non scelta" è solitamente inclusa tra le alternative, tuttavia, in questo lavoro, siamo stati interessati solo ai consumatori di kiwi, in quanto si tratta di un prodotto particolare e la valutazione si basa su questo frutto, poiché non si tratta di un confronto tra diversi frutti, ma di una sola specie. Si presume che l'intervistato, in base agli assiomi di razionalità e monotonicità delle preferenze, scelga l'alternativa che ritiene migliore, cioè quella in grado di fornirgli la maggiore utilità o grado di soddisfazione. Nel presente studio sono state considerate cinque caratteristiche/attributi del kiwi rosso (Tab. 1) con i rispettivi livelli degli stessi. Per quanto riguarda l'area di origine, nel contesto italiano è stata scelta una sola regione. Questo perché la regione italiana è la più rilevante all'interno del settore italiano sia per la produzione che per il consumo di kiwi, quindi la più valida e affidabile per lo studio intrapreso.

Tabella 1 – Attributi e livelli dei kiwi rossi usati nell'esperimento di scelta

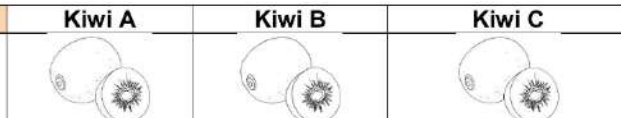
Attributi	Livelli degli attributi
Prezzo al chilo	€ 4,00 € 8,00 € 10,00
Zona di provenienza	Friuli Venezia Giulia altre regioni italiane estero
Marchio	impresa leader internazionale impresa locale
Metodo di produzione	integrato biologico
Certificazione (qualità prodotto, sostenibilità ambientale)	presente assente

La ricerca ha quindi richiesto l'elaborazione di un questionario (Tab. 2) per la raccolta di informazioni specifiche sul comportamento dei consumatori, integrate dalle informazioni socioeconomiche del campione analizzato. Prima di condurre l'esperimento di scelta agli intervistati è stato chiesto di immaginarsi in una situazione in cui dovevano valutare l'acquisto di kiwi rossi in base alle loro preferenze e al loro budget. Gli attributi e i loro livelli sono stati spiegati agli intervistati prima che procedessero con la scelta. I diversi tipi di kiwi rosso sono stati presentati agli intervistati utilizzando tre modelli identici, di base e incolore. Le diverse alternative di kiwi rossi sono state presentate agli intervistati utilizzando tre disegni identici, di base e incolori. A ogni intervistato sono state presentate sei serie di scelte, ciascuna composta da tre alternative più l'opzione "nessuno dei kiwi proposti". Un esempio di set di scelta è mostrato nella Figura 1.

Tabella 2 – Questionario somministrato al campione

Compri frutta fresca	si/no		
Se si;	Solo per te	Solo per gli altri	Per te e gli altri
Quanto spesso mangi frutta fresca (una sola risposta)? più volte al giorno regolarmente, come spuntino regolarmente, di solito ai pasti di tanto in tanto Mai			
Compri kiwi?	si/no		
Se si;	Solo per te	Solo per gli altri	Per te e gli altri
Se sì, dove preferisci acquistare i kiwi (una sola risposta)? presso l'agricoltore/coltivatore nei negozi specializzati al supermercato/discount al mercato locale altro			
Quanto spesso mangi i kiwi (una sola risposta)? più volte al giorno regolarmente, come spuntino regolarmente, di solito ai pasti di tanto in tanto Mai			
In quale stagione mangi solitamente i kiwi (una sola risposta)? tutto l'anno preferibilmente in estate preferibilmente in inverno altro			
Conosci i kiwi biologici?	si / no		
Se sì, li compri?	si / no		
Conosci i kiwigialli?	si / no		
Se sì, li compri?	si / no		
Conosci i kiwi rossi?	si / no		
Se sì, li compri?	si / no		

Figura 1 – Esempio di set di scelta

Gruppo 1	Kiwi A	Kiwi B	Kiwi C	D
				Nessuno dei kiwi proposti
Prezzo al chilo	€ 4,00	€ 8,00	€ 10,00	
Zona di provenienza	Friuli Venezia Giulia (Nord Est dell'Italia)	Altre regioni italiane	Estero (Non Italia)	
Marchio	Impresa leader internazionale	Impresa locale	Impresa leader internazionale	
Metodo di **produzione***	Integrato	Integrato	Biologico	
Certificazione (qualità prodotto, sostenibilità ambientale)	assente	assente	presente	

La rilevazione dei dati è stata affidata ad un provider internazionale di first-party data. Il numero di questionari raccolti, compresi sei set di scelta per ogni questionario e 1202 intervistati, ammonta a 7.212. I dati CE sono stati analizzati con Nlogit 6.0®, attraverso il quale è stato sviluppato un modello logit multinomiale di base. Questo modello presuppone l'omogeneità delle preferenze degli intervistati. Per considerare l'esistenza di eterogeneità delle preferenze si è fatto ricorso anche a un modello a classi latenti. Le scelte effettuate dagli intervistati consentono di individuare la funzione di utilità, cioè di capire quali

caratteristiche e quali livelli della loro presenza nel bene/servizio scelto sono ritenuti dal consumatore in grado di aumentare o diminuire il suo grado di soddisfazione.
La funzione di utilità considerata per entrambi i modelli è la seguente:

$$U(xi) = ASC + b1 * FVGi + b2 * LOCALEi + b3 * CERTi + b4 * BIOi + b5 * PREZZO \quad (1)$$

dove: FVG è una variabile dummy per la regione di origine Friuli Venezia Giulia; LOCALE è una variabile dummy per il marchio di un'azienda locale; CERT è una variabile dummy per la presenza di una certificazione di qualità o sostenibilità per il kiwi rosso; BIO è una variabile dummy per la coltivazione biologica; PREZZO rappresenta il prezzo del kiwi rosso espresso in €/kg; ASC è una variabile dummy per "nessuno dei kiwi proposti". Quest'ultima variabile è stata inclusa per tenere conto dell'utilità derivante dalla non scelta o da altre variabili non incluse nell'analisi.

DISCUSSIONE E CONCLUSIONI

I coefficienti della funzione di utilità (da b1 a b5) possono essere considerati come utilità marginali di ciascun attributo della funzione di utilità stessa. Prima di descrivere i risultati delle classi latenti, è utile conoscere anche i risultati del modello di base, che ci permette di evidenziare quali sono le caratteristiche mediamente più rilevanti per le scelte dei consumatori, che guidano anche le strategie delle imprese del settore. Tutti i coefficienti ottenuti attraverso il modello logit multinomiale di base sono statisticamente significativi. I segni dei coefficienti sono coerenti con le aspettative: il prezzo ha un segno negativo, indicando che gli intervistati chiedono una quantità minore di kiwi all'aumentare del prezzo, in linea con la razionalità che caratterizza i consumatori (Fig. 2).
I risultati evidenziano che l'attributo più importante nella scelta del kiwi rosso da parte degli intervistati è il marchio di un'azienda locale. Infatti, gli intervistati sembrano apprezzare particolarmente questa caratteristica quando acquistano un kiwi rosso. Seguono per importanza associata agli intervistati la coltivazione biologica del kiwi rosso e, anche se con minore importanza, la presenza di una certificazione di qualità o di sostenibilità del prodotto.
L'utilità marginale più bassa è ottenuta dalla regione di origine Friuli Venezia Giulia, che è ovviamente legata alla presenza tra gli intervistati di non residenti nella suddetta regione. La variabile "ASC" è statisticamente significativa e negativa, indicando che gli intervistati traggono maggiore utilità dalla scelta di uno dei kiwi proposti.

Figura 2 – Modello logit multinomiale

SCELTA	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
ASC|1	-1.95593***	.04865	-40.20	.0000	-2.05129	-1.86057
PREZZO|1	-.30659***	.00720	-42.60	.0000	-.32069	-.29248
FVG|1	.08457**	.03350	2.52	.0116	.01891	.15023
LOCALE|1	.37223***	.04835	7.70	.0000	.27746	.46699
CERT|1	.17868***	.03893	4.59	.0000	.10239	.25498
BIO|1	.31933***	.03849	8.30	.0000	.24389	.39477

***, **, * ==> Significance at 1%, 5%, 10% level.

È interessante notare che la presenza di un marchio legato a un'azienda che opera a livello locale e non internazionale è una caratteristica importante per gli intervistati nella scelta di un kiwi rosso. Allo stesso modo, viene sottolineata la rilevante attenzione dei consumatori nei confronti della coltivazione biologica. In particolare, si evidenzia come l'interesse degli intervistati possa essere rivolto agli effetti positivi che questo metodo di produzione può generare.

L'utilità marginale più bassa la consegue la zona di provenienza Friuli Venezia Giulia. Il risultato è legato alla presenza tra gli intervistati di persone non residenti nella citata regione. La variabile "ASC" risulta statisticamente significativa e negativa, a segnalare il fatto che gli intervistati traggono maggiore utilità dalla scelta di uno dei kiwi proposti rispetto alla "non scelta".
Dai risultati ottenuti con il modello di base emerge che la presenza di un marchio apposto da un'impresa che opera a livello locale e non internazionale è per gli intervistati una caratteristica importante nella scelta di un kiwi rosso. Similmente, si sottolinea la rilevante attenzione dei consumatori per la coltivazione biologica. Per superare la criticità relativa alla non eterogeneità nelle scelte tra gli intervistati in Figura 3, si riporta il risultato della stima dei parametri del modello logit a classi latenti. Tale modello evidenzia l'esistenza di tre classi latenti, con una probabilità di appartenenza dei rispondenti a ciascuna di tali classi pari, rispettivamente, a 19%, 45% e 36%. Il modello possiede una buona abilità di interpretazione del fenomeno in questione, infatti il MacFadden Pseudo R-quadro ottenuto (pari a 39%) può essere considerato decisamente buono, data la tipologia di modelli qui considerata.

Figura 3 – Stima dei parametri del modello logit a classi latenti

SCELTA	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Random utility parameters in latent class -->> 1..................					
ASC|1	.45918	.37017	1.24	.2148	-.26635	1.18470
PREZZO|1	-.50282***	.05986	-8.40	.0000	-.62014	-.38549
FVG|1	.48766**	.19647	2.48	.0131	.10259	.87273
LOCALE|1	.27934	.31312	.89	.3723	-.33437	.89305
CERT|1	.55352**	.24395	2.27	.0233	.07538	1.03165
BIO|1	.45542*	.24114	1.89	.0589	-.01722	.92805
	Random utility parameters in latent class -->> 2..................					
ASC|2	-2.52131***	.13350	-18.89	.0000	-2.78297	-2.25965
PREZZO|2	-.11480***	.00947	-12.13	.0000	-.13335	-.09624
FVG|2	.02813	.04189	.67	.5019	-.05398	.11024
LOCALE|2	.60896***	.05625	10.83	.0000	.49871	.71921
CERT|2	.05758	.05176	1.11	.2660	-.04387	.15902
BIO|2	.39494***	.04442	8.89	.0000	.30789	.48200
	Random utility parameters in latent class -->> 3..................					
ASC|3	-7.79972***	1.21685	-6.41	.0000	-10.18471	-5.41473
PREZZO|3	-.92416***	.05019	-18.41	.0000	-1.02252	-.82579
FVG|3	.02704	.18905	.14	.8863	-.34349	.39757
LOCALE|3	.05033	.27528	.18	.8549	-.48921	.58986
CERT|3	1.12892***	.32252	3.50	.0005	.49678	1.76105
BIO|3	.38913*	.23094	1.69	.0920	-.06350	.84177
	This is THETA(01) in class probability model.......................					
_ONE|1	-.76032***	.17886	-4.25	.0000	-1.11088	-.40976
_FEMAL|1	.50131***	.17314	2.90	.0038	.16195	.84066
_ET25_|1	.35508	.29553	1.20	.2295	-.22414	.93431
_ET18_|1	-1.06630**	.49107	-2.17	.0299	-2.02877	-.10383
_ITALI|1	.20259	.20572	.98	.3247	-.20062	.60580
_FRU_D|1	-.30696*	.17454	-1.76	.0786	-.64905	.03513
	This is THETA(02) in class probability model.......................					
_ONE|2	-.20179	.13862	-1.46	.1455	-.47348	.06990
_FEMAL|2	.31123**	.14068	2.21	.0269	.03550	.58696
_ET25_|2	1.00465***	.21566	4.66	.0000	.58197	1.42733
_ET18_|2	.85445***	.24574	3.48	.0005	.37281	1.33608
_ITALI|2	.41918**	.17007	2.46	.0137	.08584	.75252
_FRU_D|2	-.09169	.14355	-.64	.5230	-.37304	.18967
	This is THETA(03) in class probability model.......................					
_ONE|3	0.0	.....(Fixed Parameter).....				
_FEMAL|3	0.0	.....(Fixed Parameter).....				
_ET25_|3	0.0	.....(Fixed Parameter).....				
_ET18_|3	0.0	.....(Fixed Parameter).....				
_ITALI|3	0.0	.....(Fixed Parameter).....				
_FRU_D|3	0.0	.....(Fixed Parameter).....				

***, **, * ==> Significance at 1%, 5%, 10% level.

In particolare, alla Classe 1 (probabilità di appartenenza degli intervistati 19%) appartengono individui che dimostrano di porre importanza alla presenza di una certificazione di qualità o di sostenibilità ambientale, per la quale i rispondenti sarebbero disposti a pagare un premium price pari a € 1,10 al chilo. Essi inoltre gradiscono sia la zona di provenienza Friuli Venezia Giulia (disponibilità a pagare per questa caratteristica pari a € 0,98 al chilo) sia la coltivazione biologica. Per la presenza di quest'ultimo tipo di coltivazione dei kiwi, la disponibilità a pagare degli intervistati è di € 0,91 al chilo. Questi individui sono particolarmente attenti anche al prezzo. A questa classe hanno maggiore probabilità di appartenere intervistati di genere femminile. Invece, è meno probabile è trovarvi soggetti molto giovani, ossia con un'età compresa tra 18 e 24 anni, e individui che mangiano frutta fresca tutti i giorni o quasi.

La Classe 2 (45% di probabilità di appartenenza) sembra preferire soprattutto la presenza di un marchio di un'impresa locale anziché internazionale. I rispondenti evidenziano la volontà di pagare per questa caratteristica dei kiwi una cifra, al chilo, pari a € 5,30. A tale classe hanno maggiore probabilità di appartenere soggetti giovani, con età compresa tra i 18 e i 34 anni, di genere femminile e residenti in Italia. Inoltre, a questo gruppo appartengono soggetti che apprezzano il metodo di produzione biologico

(disponibilità a pagare per questo attributo per ogni chilo di kiwi pari a € 3,44) e che sono attenti al prezzo dei kiwi.
La Classe 3 (36% di probabilità di appartenenza) raccoglie consumatori che guardano soprattutto alla certificazione di qualità o di sostenibilità dei kiwi. Questa caratteristica dei kiwi suscita negli intervistati la disponibilità a pagare un'aggiunta pari a € 1,22 al chilo. Anche questo gruppo trae soddisfazione da kiwi biologici, come evidenzia la disponibilità a pagare un premium price pari a € 0,42 al chilo, e guarda con particolare attenzione al prezzo.
L'indagine ha rilevato un'elevata propensione all'acquisto e al consumo di frutta fresca in generale e di kiwi in particolare, confermando la letteratura (Mian et al, 2022b). Tra i diversi tipi di kiwi, il kiwi giallo è il più conosciuto e acquistato, seguito dal kiwi biologico e dal kiwi rosso. Un terzo del campione ha dichiarato di acquistare o di considerare l'acquisto di tutti e tre i tipi di kiwi, e questa propensione è correlata positivamente con la frequenza di acquisto dei kiwi in generale (compresi quelli verdi) e con l'atteggiamento verso il consumo di frutta. Ciò suggerisce che le azioni di marketing possono tenere conto dell'atteggiamento verso la frutta/kiwi per stimolare il mercato specifico del kiwi giallo, biologico e rosso.
Per quanto riguarda il kiwi rosso, oggetto specifico dell'indagine, una percentuale significativa di coloro che già lo conoscono lo acquista o intende acquistarlo. Altrettanto interessante è l'alta percentuale di coloro che si sono dichiarati indecisi sull'acquisto. Le azioni di marketing specifiche possono essere indirizzate a queste due categorie: da un lato, convertire l'intenzione di acquisto in un acquisto effettivo; dall'altro, cambiare l'orientamento attuale in un'intenzione o in un atto di acquisto, ad esempio migliorando la conoscenza di questo frutto ancora poco conosciuto (Hanf, e Kühl, 2005).
La ricerca condotta ha permesso quindi da un lato di profilare le preferenze dei consumatori in relazione all'acquistato del kiwi rosso. Dall'altro fornisce utili informazioni ai breeders e agli imprenditori agricoli che volessero investire in questa nuova cultivar. Fondamentale infatti è la conoscenza delle caratteristiche della cultivar per verificare il possesso degli attributi più apprezzati dai consumatori e per migliorare le caratteristiche qualitative del prodotto. Infine, potrà essere utile per i responsabili marketing della grande distribuzione per basare le loro strategie di vendita.

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Nudging towards a greener future: the effects of dynamic social norms on parents' school menu selection

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INTRODUCTION

The current global food system has significant environmental consequences (*e.g.,* climate change, land use, biodiversity loss) and provides suboptimal solutions to human dietary needs (Bhat *et al.,* 2019; Springmann and Freund, 2022; UNICEF, 2020). Citizens and scientists are advocating for a change in the food system toward more accessible and sustainable dietary patterns that improve both human health and the ecological safety of the planet (Intergovernmental Panel on Climate Change report - IPCC, 2022; Tufford *et al*., 2023). Shifting towards increasingly plant-based diets, particularly in economically developed countries, focusing on enlarged consumption of low-impact foods such as vegetables, whole grains, and fruits, and reduced eating of animal products and refined carbohydrates, aids in this transformation (IPCC, 2022; Willett *et al.,* 2019).

School meals have been proposed as a valuable platform to assist in sustainable dietary transitions, involving children and adolescents from diverse cultural and socioeconomic backgrounds, as well as their families and communities (Graca *et al*., 2022; Roque *et al.,* 2022). With over 370 million children receiving a school lunch each day worldwide (UNICEF, 2020), the school meal system plays a significant role in the global food landscape, in addition to meeting the nutritional needs of a critical phase of population development. Making school meal offerings more sustainable not only contributes to environmental protection and climate change mitigation but also has the potential to promote children's health, provide food education, and raise awareness on sustainability, while also increasing economic and agricultural productivity (Roque *et al.,* 2022).

Behavioral economics offers a promising approach to influence individual choices in favor of sustainable alternatives (Thaler *et al.,* 2010). Nudging involves designing environments and interventions that subtly guide individuals towards making positive decisions (Thaler and Sustein, 2009). By leveraging human cognitive biases and heuristics, nudging interventions can facilitate behavior change without relying on traditional approaches such as information or incentives. One effective form of nudging is the use of social norms (Sustein, 2014). Social norms are the unwritten rules that guide individual behavior based on the perceived behavior of others in society. They have a significant influence on people's attitudes and actions, as individuals often look to others for cues on how to behave in specific situations (Lehner *et al*., 2015). Particularly, dynamic social norms promise to address the challenge of promoting sustainable behavior when existing social norms are not (yet) aligned with the desired outcome (Loschelder *et al*., 2019; Mortensen *et al*., 2018). Instead of highlighting the current state of a behavior (*e.g.,* a percentage of a reference group displaying the "static norm"), dynamic norms emphasize the norm that is increasingly changing over time to evoke (pre)conformity to this change (Sparkman and Walton, 2017).

In the context of school meals, the use of dynamic social norms could be an effective manner to encourage environmentally friendly food choices. The current study focuses on parents who, as gatekeepers, play a crucial role in their children's food choices and consumption, particularly in the context of elementary schools (Damen *et al.*, 2019). Indeed, parents are responsible for procuring food for their children, including school lunches, and their decisions can have a significant impact on their children's future eating habits (Vaughn *et al.*, 2016).

The present study has a dual objective: *(i)* examine whether the inclusion of a dynamic social norm encourages parents to perform more environmentally friendly choices when selecting school menus for their child and *(ii)* explore the factors that guide parents' decision-making processes in this context, in order to identify potential barriers and leverage points in promoting sustainable initiatives in schools.

METHOD

In May 2023, a national sample of Italian parents participated in an experimental online survey administered by a professional market research agency. The survey employed a computer-assisted web interviewing (CAWI) technique and drew respondents from a private online panel. The selection criteria included: being a parent, having at least one child attending elementary school, and being responsible for the child's food procurement.

The survey applied a between-subjects design; respondents were randomly assigned to one of two experimental conditions: control or treatment. Randomization was carried out with a 1:1 ratio from the online questionnaire platform. Participants were blinded to their assignment during the study, and the recruitment agency was explicitly required to distribute respondents equally for selected key sociodemographic characteristics (sex at birth, geographic area of residence, income) to ensure homogeneity in the compositions of each experimental condition and, therefore, comparability of responses.

The questionnaire was the same for both experimental conditions except for the weekly school menu section. Parents displayed at the same time (and in randomized order of presentation) two weekly elementary school cafeteria menus - Monday through Friday - that included for each day a first course (or pizza), a second course, a side dish, bread, and seasonal fruit as shown in Figure 1.

Figure 1 – Menu display screen (original Italian version).

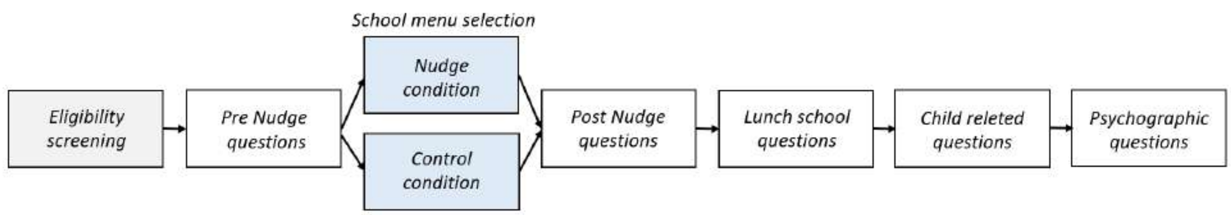
Lunedì	Martedì	Mercoledì	Giovedì	Venerdì
Risotto al pomodoro	Minestrone con farro	Riso con fagioli	Orzo con zucca	Pasta con passato di verdure
Arrosto di tacchino	Ricotta vaccina	Tortino di verdure al forno	Filetto di merluzzo al forno	Frittata
Carote all'insalata	Broccoli all'insalata	Finocchio in pinzimonio	Cavolfiore all'insalata	Insalata verde
Pane	Pane	Pane	Pane	Pane
Frutta di stagione	Frutta di stagione	Frutta di stagione	Frutta di stagione	Frutta di stagione

Lunedì	Martedì	Mercoledì	Giovedì	Venerdì
Pasta al pomodoro	Pasta al pesto	Pasta con lenticchie	Risotto con piselli	Pizza pomodoro e mozzarella
Cotoletta di pollo	Grana padano	Polpette di carne al sugo	Bastoncini di merluzzo	
Purè	Pomodori all'insalata	Insalata verde	Spinaci gratinati	Fagiolini verdi all'olio
Pane	Pane	Pane	Pane	Pane
Frutta di stagione	Frutta di stagione	Frutta di stagione	Frutta di stagione	Frutta di stagione

Referring to the menus normally offered in Italian school canteens and specifically adhering to the dietary guidelines for children from 6 to 11 years old, the composition of the two weekly menus was specifically formulated to have a different environmental impact on the basis of water footprint (WF) and carbon footprint (CF) measurements. Specifically, the SU-EATABLE LIFE database (Peterson *et al*., 2021) guided the calculation of the environmental impact of each individual recipe and, summing up, the overall environmental impact of each weekly menu was estimated.

In the control group parents viewed the two menus without any conditioning - simulating the typical scenario of selecting the school menu from apps and/or official school websites (see for example https://www.menuchiaro.it/livorno/it/#/HomeMenu or https://scuoledussmann.it/fano); in the treatment group the screen showed the sustainable menu (on the left-hand side in Figure 1) followed by the dynamic social norm: *"Thanks to parental support, more and more schools are implementing sustainable initiatives in their canteens. Be part of the change by choosing this menu that reduces the environmental impact by 41% in terms of CO2 emissions and 22% in terms of water footprint compared to the alternative menu"*. Both before and after the menu section, parents answered a series of questions related to their child's eating habits, school lunch information, parenting practices, psycho-attitudinal scales, as well as personal and child demographic information. Figure 2 shows the entire experimental flow.

Figure 2 – Experimental flow.



RESULTS

The final sample included 617 Italian parents (average age 41.5) of children aged 5 to 11 years equally distributed in the two experimental conditions. Table 1 details the socio-demographic characteristics of the parents for each experimental condition and the results of the tests conducted to confirm homogeneity between the subgroups.

Table 1 – Sociodemographic characteristics of the parents for each experimental condition.

		TOTAL SAMPLE (617)	CONTROL CONDITION (51%)	NUDGE CONDITION (49%)	Test*	*p-value*
Parents	*Father*	61.6%	61.7%	61.5%	0.00	0.950
	Mother	38.4%	38.3%	38.5%		
Age	*Mean± S.D.*	41.5 ± 6.5 [a]	41.4 ± 6.5 [a]	41.7 ± 6.6 [a]	0.34	0.562
BMI	*Severe underweight*	0.5%	0.6%	0.4%	3.49	0.478
	Underweight	2.9%	3.8%	2.0%		
	Normal weight	63.3%	64.9%	61.8%		
	Obese	26.3%	24.4%	28.2%		
	Overweight	7.0%	6.3%	7.6%		
Marital status	*Married*	74.1%	71.5%	76.7%	6.164	0.187
	Co-habiting	17.8%	20.9%	14.6%		
	Widowed	0.2%	0%	0.4%		
	Divorced/Separated	5.5%	4.8%	6.3%		
	Single	2.4%	2.8%	2.0%		
Education	*Elementary school*	0.3%	0.6%	0%	4.249	0.514
	Middle school	5.2%	5.4%	5.0%		
	Diploma	48.3%	45.6%	51.2%		
	Bachelor's degree	15.1%	15.5%	14.6%		
	Master's degree	22.0%	24.1%	19.9%		
	PhD	9.1%	8.8%	9.3%		

Working on medical field	*Yes*	5.3%	4.4%	6.3%	1.078	0.299
	No	94.7%	95.6%	93.7%		
Residence area	*Northwest*	29.2%	30.4%	27.9%	2.394	0.495
	Northeast	16.7%	14.9%	18.6%		
	Centre	23.5%	25.0%	21.9%		
	South	30.6%	29.7%	31.6%		
Income	*Very low*	9.1%	9.5%	8.6%	0.788	0.852
	Low	32.2%	32.9%	31.6%		
	Medium	44.3%	44.3%	44.2%		
	High	14.4%	13.3%	15.6%		
Diet type	*Omnivore*	90.9%	91.1%	90.7%	0.036	0.849
	Semi/vegetarian	9.1%	8.9%	9.3%		

Note: ANOVA analyses with post-hoc pairwise comparison tests for continuous variables and Pearson chi2 tests for categorical variables were applied to assess homogeneity between the two experimental groups.

The children (average age 8.4) identified by their parents in the study were male in 54% of the cases and first-born in 64% of the cases. 93% attended a public school and, overall, 84% of the schools attended actually provided canteen service.

Table 2 shows the school menu selection frequencies: in the control condition, 65% of the parents preferred the sub-optimal menu for their child's school lunch and the remaining 35% opted for the sustainable menu; in the sub-group treated, on the other hand, while the preference for the sub-optimal menu remained unchanged - since it was selected by more than half of the sample (55%) - a significantly higher percentage of parents (10% more) preferred the sustainable menu compared to the neutral condition. These results not only reveal the general tendency of parents to prefer a more conventional (but less sustainable) version of the menu for their child's weekly meal, but also confirm the potential and the effectiveness of the dynamic social norm in positively influencing towards the more ethical and sustainable choice (Loschelder *et al.*, 2019; Sparkman and Walton, 2017).

Table 2 – School menu selection rates by parents in the two experimental conditions.

Menu selection	**Control condition**	**Nudge Condition**	**Pearson's *chi*^{2} test**	***p-value***
Sub-optimal	64.6%	55.2%	5.683	0.017
Optimal	35.4%	44.8%		

Overall, 25% of the parents do not use the canteen service (either due to their preference or lack of it in the facility), however, this did not significantly influence the parents' preferential selection of one of the two menus, highlighting that the experience gained in the real context does not condition the subsequent choice.

Further detailed analyses with pairwise comparisons and logistic regressions were conducted to investigate which drivers guided the choice of parents in the treatment group in selecting the sustainable menu. With regard to the child's socio-demographic characteristics, age and gender do not influence the parent's choice towards the sustainable menu, contrary to findings in previous studies (Roque *et al.*, 2023; Pagliarino *et al.*, 2021) in which girls tend to be more open towards vegetarian options and as age increases, children tend to be more selective and exclusive in their food choices. However, the results reveal that as the child's involvement in food choices by the parent increases, the likelihood of sustainable menu selection increases. A child's omnivorous diet significantly reduces the likelihood of the parent selecting the optimal menu, while as the frequency of sporting activities increases, the likelihood of selecting the optimal menu increases.

Concerning parental characteristics, being a father and increasing income significantly increased the likelihood of selecting the optimal menu, conversely, as BMI increased, the likelihood of selecting the alternative menu increased.

The parent had to make direct assessments of the perceived palatability, sustainability, familiarity and nutritional balance of each menu. Analyzing this information shows that as the parent's familiarity with the recipes presented in the optimal menu increases, as does the palatability of the optimal menu for both the child and personal taste, the likelihood of choosing the sustainable menu (in treatment) increases significantly. Conversely, considering the recipes of the alternative menu more palatable to the child significantly reduces the probability of selecting the optimal menu. These results suggest, in line with the study by Pagliarino *et al.* (2021), that parents' priority is to ensure enough food for their children during the school day, and therefore tend to prefer familiar recipes (because they are more confident that their children will like them) or possibly use personal taste to guide their decisions in the case of new recipes. This is also supported by the child's fussiness, specifically, the higher the score on the scale measuring fussiness (Wardle *et al.*, 2001), the less likely the parent is to select the sustainable menu. Nutritional balance and sustainability do not discriminate in the selection of the optimal menu, nor do the scales on environmental concern and knowledge (Liu *et al.*, 2022). Conversely, a higher score on the social comparison orientation scale (SCO, Chae, 2015), *i.e.*, a greater propensity on the part of the parent to compare choices concerning the child with peers, significantly increases the likelihood that the parent (in treatment) will select the menu accompanied by the social norm.

To sum up, the introduction of dynamic social norms can be a powerful tool to promote more sustainable and responsible eating behaviour, particularly in school canteens that play a key role in shaping children's eating habits. The introduction of social norms can influence the choices of parents, and consequently of children, favoring the adoption of more sustainable diets. In this sense, the parental figure can become a valuable ally in the innovation process aimed at achieving social and environmental goals if properly guided. Further analysis will allow us to better investigate the peculiarities of parents and thus the levers on which we can focus to shape public policies, educational programs and awareness-raising initiatives that favor a positive change towards more sustainable food choices.

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THE EFFECT OF NUDGES ON FOOD CHOICES OF SOCIOECONOMICALLY DISADVANTAGED INDIVIDUALS: A SYSTEMATIC LITERATURE REVIEW

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Keywords: *Nudging; food choices; choice architecture; low socioeconomic position*

Introduction

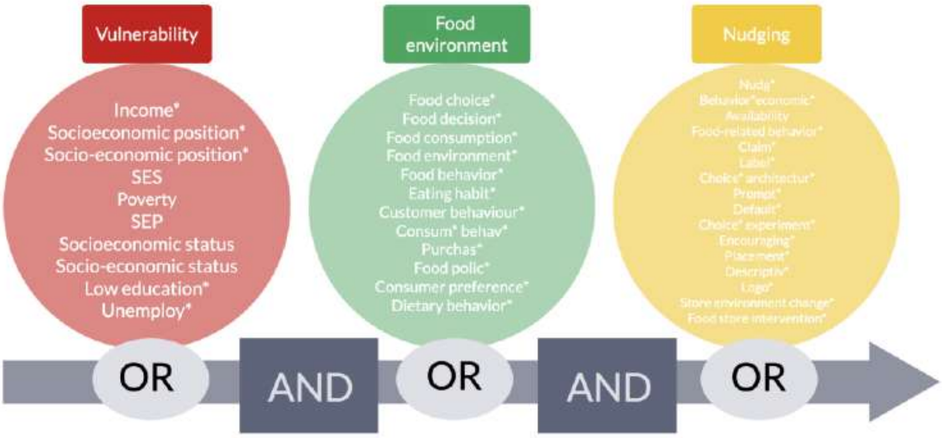
It is widely recognized that a low Socio Economic Position (SEP) is usually associated with unhealthy food choices (Giskes *et al.*, 2009), which can lead to diverse problems, such as hypertension and cardiovascular diseases (Reddy and Katan, 2004).
Low SEP individuals, indeed, may tend to select foods that can satisfy energy intake with minimal expenditure (Darmon & Drewnowski, 2008), such as high-density fast foods (Saunders *et al.*, 2015).
If compared with high SEP individuals, subjects in socioeconomically disadvantaged conditions consume less fruits and vegetables, leading to high percentages of cardiovascular disorders (Giskes *et al.*, 2009) (Reddy and Katan, 2004) and weight management difficulties (Nour *et al.*, 2018). Previous studies have also highlighted that poor dietary habits can potentially be the main contributor of Non-communicable diseases (NCD) mortality worldwide (Afshin *et al.*, 2019).
NCD constitute a priority for the healthcare system, as they account for approximately 60% of all global fatalities, of which 80% occur in low- or middle-income countries, posing significant economic and social costs. The Organization for Economic Co-operation and Development (OECD) estimates these costs to be around €115 billion or 0.8% of the annual GDP solely in the EU, relating to approximately 550,000 premature deaths (OECD and European Union, 2020). Therefore, it is urgent to improve the food choices of these disadvantaged consumers.
Growing evidences are pointing to a shift away from the conventional view of food choice as a rational and a deliberative act (Ensaff, 2021). In the health domain, nudging has the potential to exploit the spontaneous and habitual nature of health behaviors (de Ridder, 2014).
Thaler and Sunstein consider nudge as any intervention in the choice architecture, that "alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives", with the intervention remaining simple and cheap to avoid (Thaler & Sunstein, 2009).
Previous evidence has shown that information and position nudge are widely used and that might contribute to influence food purchases. In particular, a higher incidence of the interventions on low SEP subjects was observed when compared with higher SEP (Harbers *et al.*, 2020). In a recent meta-analysis by Cadario and Chandon they differentiate among three types of interventions: (1) cognitively focused interventions, which aim to influence consumers' knowledge; (2) affectively focused interventions, which aim to influence consumers' emotions without necessarily altering their knowledge; and (3) behaviorally focused interventions, which aim to influence consumers' actions without necessarily changing their knowledge or emotions. Findings revealed that cognitive nudges, have a lower impact on food choices and consumption than affective and behavioral nudges (Cadario & Chandon, 2020). Although information nudges have been defined "suboptimal", some studies, including two systematic reviews and meta-analyses, have shown that nutrition labeling and/or point of purchase labeling showed

that there was a significant average reduction of 6.6% and 7.8% in energy intake (Crockett *et al.*, 2018; Shangguan *et al.*, 2019).
The goal of the present study is to review the current evidence for the effectiveness of nudges aimed to promote healthy and discourage unhealthy food choices in low SEP individuals. The contribution of this article to the literature relies on updating available evidence of effects of nudges on vulnerable consumer food choices (Harbers *et al.*, 2020).

Methods

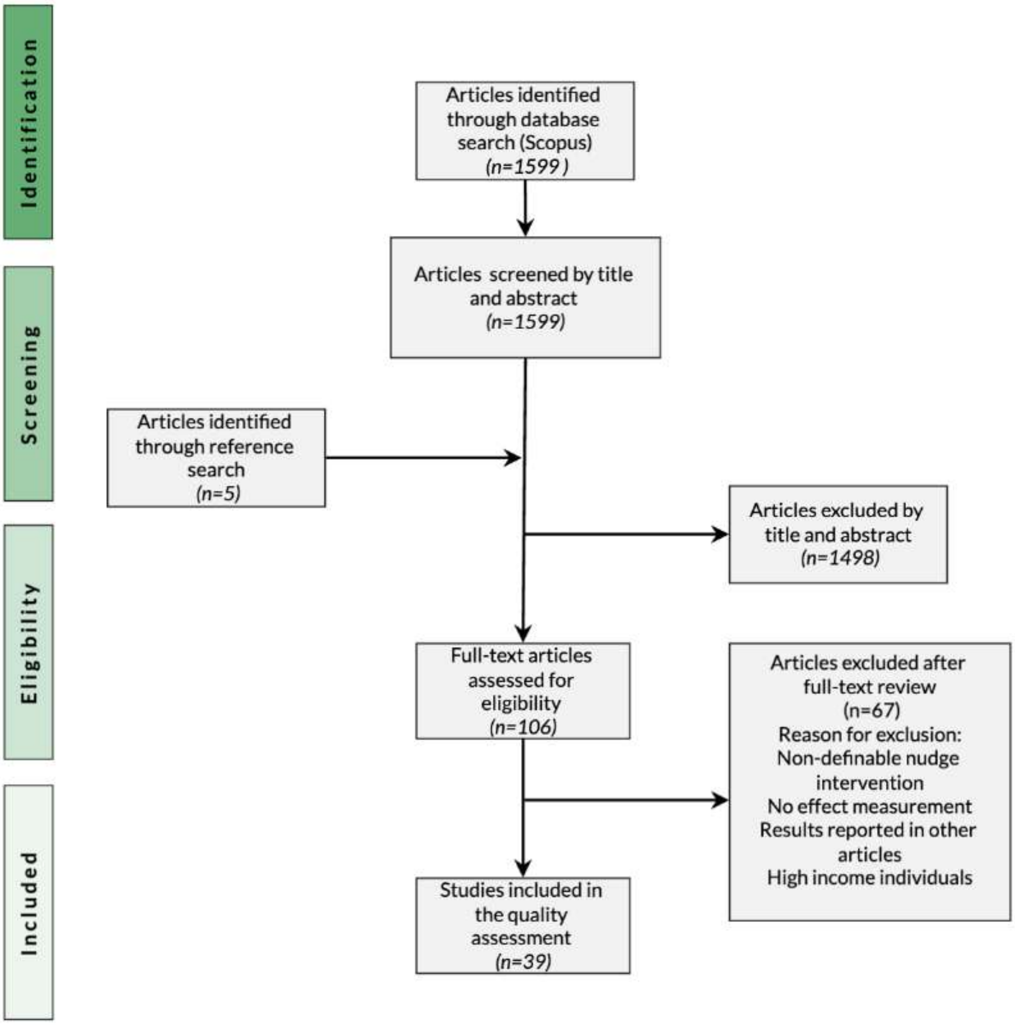
This study performs a systematic literature review following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guideline (Liberati *et al.*, 2009). We conducted a search via Scopus database using keywords described in **Figure 1**. To optimize our search results, we employed a comprehensive search strategy that incorporated both generic terms (*e.g.*, low SEP, purchase, nudging) and more specific terms (*e.g.,* low income, food choice, label). This approach aimed to maximize the scope of our search.

Figure 1: Search strategy applied (terms combined using Boolean operators).



The search range includes all articles published until August 8th, 2023. Articles not written in English, covering subjects far from the topic of interest (*e.g.,* mathematics) and written before January 2018 were excluded since the latest review with similar objectives examined studies up until that month (Harbers *et al.*, 2020). The systematic search returned 1599 articles and no duplicates were removed as, currently, only Scopus database was applied. Subsequently, the inclusion of articles identified in the "Web of Science" database is also planned. Then papers were screened by title and abstract, and 101 articles were selected for full-text review. Additionally, 5 articles have been included through a reference search (**Figure 2**). To be included, the studies needed to specifically examine the impact of nudging techniques on socio-economically disadvantaged individuals and provide data on food choices or nutrient content of food choices. Articles that compared different levels of socioeconomic situations were also included to understand whether these experienced the effects of the interventions differently. Only papers related to empirical studies have been included while deliberately excluding simulations. Articles that evaluated the effect of labels containing certifications (*e.g.,* organic) were excluded as well as studies concerning functional foods. Studies that evaluated the before-and-after effect of policy implementation were also excluded. Out of the 106 articles slated for comprehensive textual examination, 39 articles have been included and 67 have been omitted due to an array of rationales. These rationales encompass the absence of a definable nudge intervention, incongruence between the target population and the research objectives (*e.g.,* subjects exhibiting high income levels), instances where articles contained research outcomes within other articles (in such instances, the pertinent articles were subsequently appended), and the conspicuous lack of intervention effect evaluation.

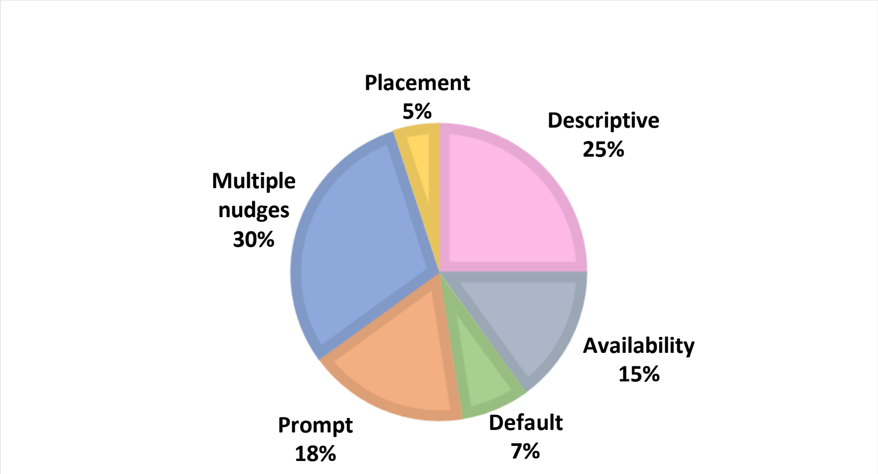
Figure 2: Flow diagram of the study selection process (PRISMA)



Preliminary results

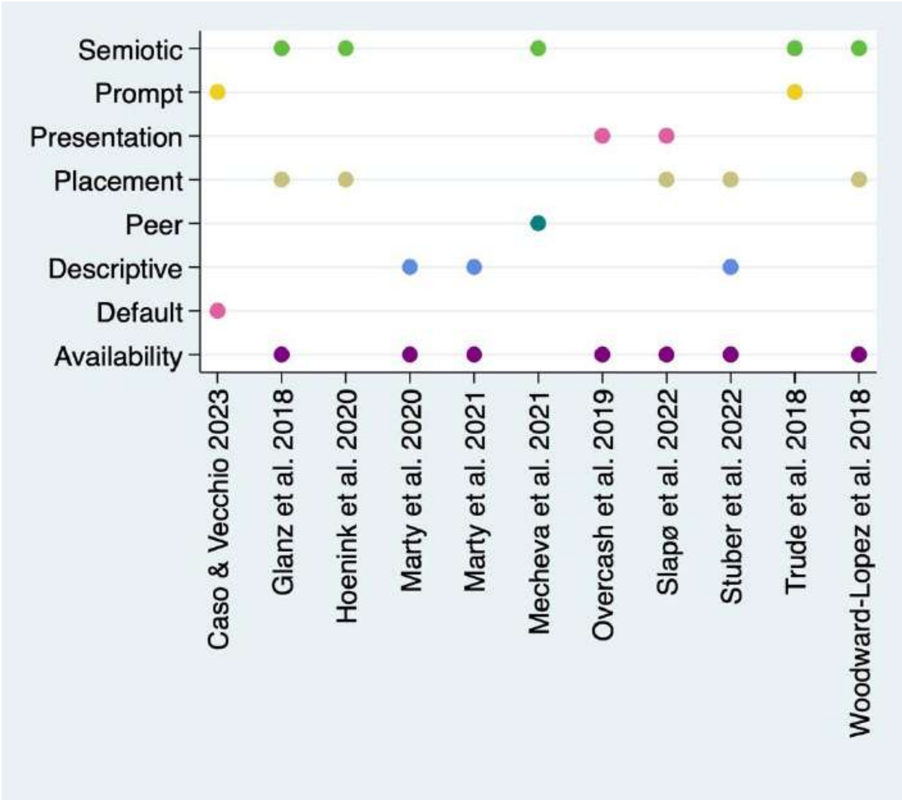
Preliminary results (**Figure 2)** reveal that among the articles selected, based on the full text review, the most frequently applied nudges are those employing descriptive interventions and multiple nudges. In fact, as shown in **Figure 3**, 55% of the interventions fall under these category (respectively 30% and 25%).

Figure 3: Percentage distribution of the different nudge categories applied in the explored studies.



Therefore, we can classify the results in two macro categories: articles that explore: - an unconscious, rapid, and automatic process and – a conscious, slow, and cognitively demanding process. Descriptive nudges (*e.g.,* labels) belong to interventions that engage the cognitive sphere, while nudges such as “placement,” “prompt,” “availability,” or “default” refer to the more instinctive aspect of individuals. Studies that have employed multiple approaches have been classified as “Multiple nudge” interventions. The category of “multiple nudges” includes both studies that apply interventions with multiple nudges simultaneously and articles that compare the effects of different nudges. The least utilized interventions on their own are those related to "placement" in fact, this type of intervention, is often associated with other types of nudges and is therefore found in the category of "multiple nudges". Other types of nudges, such as "presentation", "semiotic" or “peer” are solely used in conjunction with other interventions **(Figure 4)**.

Figure 4: Distribution of interventions in studies employing multiple nudges.



Considering the articles read in full text, we can divide them into studies that collected data directly from consumers and studies that examined information gathered from points of sale (*e.g.,* sales data) with 31 and 7 studies respectively. An article combines three studies, the first of which was conducted in a coffee shop, the second in 18 coffee shops, and the third is an online study involving 2205 representative adults (Pechey *et al.*, 2022). Studies that collect data from individuals have a mean sample size of 901 subjects and a median of 417, with a minimum of 10 (Flaherty *et al.*, 2020) and a maximum of 11.775 (Stuber *et al.*, 2022). On the other hand, studies that focus on retail outlets have an average sample size of 164 and a median of 33, with a minimum of 9 (Woodward-Lopez *et al*., 2018) and a maximum of 686 (Slapø *et al.*, 2022).

Furthermore, it may be relevant to analyze the information by grouping studies that examine samples solely from a low socioeconomic position and studies that compare samples with different socioeconomic conditions (*e.g.,* high SEP and low SEP) respectively, 20 and 16 articles. Three articles analyze a population of low and middle income.

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EXPLORING THE SUSTAINABILITY OF BIOENERGY SISTEMS THROUGH THE LAND-WATER-ENERGY NEXUS

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KEYWORDS
Nexus approach; sustainable development; environmental sustainability.

ABSTRACT

The global agrifood systems are experiencing transformative changes driven by factors like climate change, population growth, and technological advancements. This study focuses on sustainable bioenergy systems within these challenges. Bioenergy is crucial for Europe's low-carbon energy transition, but requires careful analysis, especially concerning marginal lands. The study employs a Land-Water-Energy nexus approach through a web-based platform, facilitating simulations considering land, water, and energy factors. Sustainability indicators are comprehensively evaluated, adhering to international standards. Real-world simulations validate the platform's effectiveness, showing sorghum biomass as a better option for reducing emissions and water use, while maize is more profitable. The study highlights the interplay of land, water, and energy domains, emphasizing bioenergy's role in climate mitigation. The platform aids stakeholders in developing sustainable bioenergy, contributing to low-carbon energy goals while ensuring environmental responsibility.

INTRODUCTION

The global agrifood systems operate within an ever-changing scenario characterized by continuous and profound transformations. Climate change, population expansion, depletion of natural and environmental resources, rapid technological evolution, energy instability, and recent geopolitical tensions are among the main factors driving these changes. As a result, agrifood systems face the need to pursue new objectives beyond the traditional ones, and to adopt new approaches, strategies and policies to achieve them. The pursuit of efficiency, productivity, full employment, profitability, and income stability in agrifood systems is now challenged by the imperative of minimizing input usage, reducing greenhouse gases emissions (GHG) emissions and impacts on ecosystems, adapting to changing climate conditions, while actively contributing to enhancing food security (Giller *et al.*, 2021).

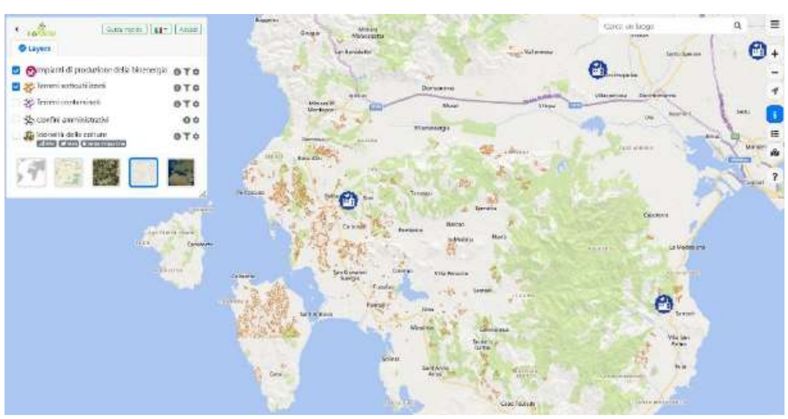
Additionally, addressing issues of poverty, malnutrition, social and gender exclusion, while promoting equity within food chains and advocating for sustainable diets, have become crucial goals that should guide businesses, organizations, and sector policies. These challenges have numerous implications for agricultural economic research, including both theoretical and practical aspects. It is essential to develop a precise theoretical-methodological framework to effectively tackle these issues and provide valuable insights. Bioenergy has been recognized as a significant contributor to the transition towards a self-sufficient low-carbon energy sector in Europe (European Commission, 2018). However, the establishment of sustainable bioenergy systems requires thorough ex-ante analysis considering specific contexts and potential trade-offs, including the competing uses of natural resources such as land, water, and energy. In this context, the utilization of marginal and underutilized lands has been identified as a promising strategy to overcome the "food versus fuel" paradigm and mitigate direct and indirect land use change associated with bioenergy crop cultivation. Nevertheless, the scattered distribution and limited extension of these marginal and underutilized plots may negatively affect the energy efficiency of bioenergy systems due to increased energy requirements both in terms of inputs and transportation, with consequent trade-offs in terms of carbon footprint of the pathway. This contribution aims to explore the economic and environmental land-water-energy nexus of bioenergy system based on local biomass production districts established in marginal lands.

MATERIALS AND METHODS

To address these complexities, this study presents an ex-ante assessment of the sustainability of a short bioenergy pathway by employing a Land-Water-Energy nexus approach (Ringler *et al.*, 2013). In order to facilitate the advancement of a sustainable bioenergy sector, this study utilizes a web-based platform (https://bioplat.eu/webgis-tool) built upon the methodology of the Global Bioenergy Partnership (GBEP) (GBEP, 2011), an international bioenergy initiative actively supported by the Food and Agriculture Organization of the United Nations (FAO). GBEP developed a set of sustainability indicators to promote the responsible and environmentally sensitive development of bioenergy initiatives.

The platform enables users to conduct iterative simulations and analyze the intricate interlinkages among the various domains of the bioenergy system nexus, which relies on the cultivation of underutilized land. By utilizing this web-based platform, we can effectively analyze and assess various geographical factors that contribute to the overall sustainability of bioenergy production. The platform considers a range of crucial components of the bioenergy system, such as land availability, water resources, and energy requirements. Through the evaluation of the sustainability indicators, a comprehensive and systematic evaluation of the complex interplay between these factors can be ensured. The development of this user-friendly platform represents a significant step forward in facilitating the ex-ante evaluation of a bioenergy system, therefore offering a basic knowledge that can guide the fine-tuning of the system towards its optimization. Its intuitive interface allows users to navigate and interact with geographic information in a seamless manner. By leveraging this tool, we can streamline decision-making processes and expedite the development of sustainable bioenergy projects. Furthermore, the platform's integration with the GBEP methodology ensures that our assessments adhere to internationally recognized sustainability requirements and best practices. In this study, the efficacy of the web-based platform was validated through the implementation of simulation models representing two distinct scenarios for biogas production pathways in a real-world case study conducted in the Sardinia region in Southern Italy (Figure 1).

Figure 1 – Snapshot of the web-GIS platform interface.



DISCUSSION AND CONCLUSIONS

The results of the scenario simulations are presented in Table 1. The findings from the simulations provide compelling evidence that the utilization of sorghum biomass for biogas production can significantly contribute to reducing greenhouse gas emissions.

Table 1 – Indicator results for maize and sorghum cultivation scenarios.

Indicators	Maize	Sorghum
Air quality	62.93 g/MJ CO2-eq	47.58 g/MJ CO2-eq
Water use and efficiency	195.6 l/MJ	69.5 l/MJ
Net annual profit	1076 €/ha/year	744 €/ha/year

Specifically, the results indicate that sorghum use as a feedstock implies substantial reduction in GHG emissions (47.58 g/MJ CO2-eq) compared to the use of maize (62.93 g/MJ CO2-eq). Compared to the reference values for fossil fuels in the transport sector (94 g/MJ CO2-eq) set by the Recasted Renewable Energy Directive (REDII), sorghum demonstrates a GHG emission savings rate of 49%, outperforming maize which achieves 33%. Sorghum exhibits superior performance in terms of water use efficiency, while maize achieves higher net annual profit (1076 €/ha) compared to sorghum (744 €/ha).

Overall, these findings provide evidence of the trade-off inherent in the land-water-energy nexus, as the divergent production inputs between sorghum and maize lead to discrepancies in the indicators results. This underscores the complex interrelationships among these factors within the local agricultural system, highlighting the need for careful consideration and optimization.

These outcomes highlight the pivotal role of bioenergy in mitigating the adverse effects of climate change and propelling Europe towards a sustainable and low-carbon energy future. Moreover, the web-based platform proves to be effective and user-friendly in assessing and optimizing the complex interrelationships among the land, water, and energy domains within the bioenergy system. It serves as a valuable decision-support tool for stakeholders involved in the development of sustainable bioenergy systems, offering a time-saving approach to operationalize the land-water-energy nexus. By facilitating informed decision-making, the platform contributes to the overall transition towards a low-carbon energy sector while ensuring sustainability and environmental responsibility.

Several implications arise from this discovery, particularly concerning the potential for cultivating specific bioenergy crops on marginal lands. In regions with greater marginal energy gains, a priority should be placed on implementing irrigation practices. As an example, the extraction of water from groundwater sources necessitates extra energy for pumping, constituting a substantial proportion of the energy input in irrigated agricultural systems when contrasted with gravity-fed irrigation techniques. However, the utilization of pressurized systems can mitigate water usage levels and subsequently curb energy consumption.

As previously mentioned, the sustainability of the bioenergy pathway hinges on intricate trade-offs involving the use of local resources, which exert an impact on the nexus. Consequently, the optimal solution envisioned depends on the priorities set by stakeholders, including farmers, industry players, and agricultural policymakers, with regards to significant concerns. In this study, our attention was directed towards the Land-Water-Energy nexus, utilizing water as an illustrative instance to highlight the potential of the web platform. However, it is evident that for a more comprehensive perspective to facilitate economically sound choices, a range of scenarios must be considered. These scenarios could encompass the optimization of additional indicators such as productivity, profitability, and gross value added.

In conclusion, this work highlights the importance of understanding and addressing the multiple challenges that the global agrifood systems shall face in the near future. It emphasizes the need for a precise theoretical-methodological framework to guide research efforts and underscores the significance of practical applications in achieving the sustainability of agrifood systems. The case study on the economic and environmental land-water-energy nexus of bioenergy production in marginal lands demonstrates the potential of web-based tools to support decision-making and optimize the sustainability of bioenergy systems. This research contributes to the broader transition towards a low-carbon energy sector, contributing to highlight the need to achieve a balance between economic growth, environmental protection, and social well-being.

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Effect of framing message to replace meat consumption with mushrooms and mushroom products

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KEYWORDS
Mushroom; framing message; meat; plant-based meat alternative; health; sustainability

1. INTRODUCTION

To achieve the Sustainable Development Goals (SDGs), it is necessary to totally re-evaluate food production and consumption systems, and in this regard, reducing meat consumption, especially in those countries where it is consistent, is now considered mandatory (IPCC, 2019; UN, 2019). High consumption of red and processed meat has been proven to negatively impact health, and it is mainly associated with an increased risk of type 2 diabetes, cancer, and cardiovascular diseases (González et al., 2020a; Maukonen et al., 2023). In addition, livestock farming is a major contributor to climate change and is considered responsible for 12% to 18% of global greenhouse gas emissions (GHG) (Gomez-Zavaglia et al., 2020; González et al., 2020b). Hence, diets low in red and processed meat and high in plant-based foods are considered beneficial to health, and they have also been found to be more environmentally sustainable (Godfray et al., 2018). In this context, many plant-based meat alternatives (PBMAs) are gaining a foothold in the market (Andreani *et al.*, 2023). Among meat alternatives, edible mushrooms and mushroom products are becoming increasingly important, due to their excellent nutritional content and high-quality protein profile. Indeed, they are low in calories but high in vitamins and fibre, particularly b-glucans, and usually contain all the essential amino acids (EAA) needed for human dietary requirements (Bach et al., 2017; Ferraro et al., 2020). From an environmental perspective, mushroom crops require little economic and environmental investment and are able to grow on various organic substrates derived from food industry waste, thus enabling their sustainable production (Chang & Wasser, 2017; Colunga et al., 2020). In addition, a study has established a model to estimate the environmental benefits of mycoproteins (fungal proteins), and projections show that replacing 20 percent of per capita ruminant meat consumption with mycoproteins globally by 2050 would reduce annual deforestation and related CO2 emissions by 50 percent (Humpenöder *et al.*, 2022).

In order to reduce meat consumption in favor of more sustainable foods, an increasing number of studies have investigated various strategies to address consumer behavior (*e.g.*, Harguess et al., 2020; Kwasny et al., 2022). Among other things, it has been found that informative messaging focusing on the health and environmental consequences associated with high meat consumption has the potential to change consumer behavior (Buttlar and Walther, 2018). The concept of “informative messaging” refers to the use of persuasive communication techniques that aim to inform individuals about a specific issue or topic in order to influence their attitudes, beliefs, and behaviors (Carfora *et al.*, 2022). The effectiveness of informative messaging lies in its ability to convey information in a clear, compelling, and credible manner. These messages often provide scientific evidence, statistics, and facts about the negative impacts of excessive meat consumption on personal health and the environment. By highlighting these consequences, individuals are made aware of the potential risks and are more likely to consider changing their behavior. To effectively promote behavior’s change, informative messages should not only provide information but also appeal to individuals' emotions, motivations, and self-identity (Thaler and Sunstein, 2009). By framing the messages in a way that resonates with individuals' values and aspirations, they are more likely to feel a personal connection and be motivated to adopt more sustainable dietary choices. Testing different messaging strategies and formats can help identify the most effective approaches to positively influence consumer behavior.

2. RESEARCH GAP AND OBJECTIVES

To date, there are a few studies that have used framing messages to influence consumer choice toward mushrooms and mushroom products. For example, Prusaczyk and colleagues (2021) found that a brief framing message extolling the propriety of mushrooms as flavour enhancers decreased the willingness to order a beef burger in favour of a blended-burger composed of 30% mushrooms and 70% beef. They also found that an educational infographic highlighting the possibility of mitigating GHG emissions with the blended option decreased the willingness to order a beef burger. In addition, a study found that good motivation to process information about sustainability and nutrition along with a positive attitude toward food innovation positively influence university students to purchase a meat-mushroom blend burger (Sogari *et al.*, 2021). Other results suggest that a higher familiarity with hybrid meat and plant-based products increases the likelihood of purchasing the meat-mushroom blended-burger in the near future, and that information about the sustainability benefits of mushrooms influences the acceptability of the blended-burger, while information on health benefits showed non-significant results (Sogari *et al.*, 2022).

Although these studies greatly enriched the literature on the effects of informative messages to encourage mushroom consumption, they measured the effect of partial meat substitution in favour of mushrooms. To the authors' knowledge, no study has measured the effect that informative messages may have on replacing one whole serving of meat with one whole serving of mushrooms or mushroom products. Furthermore, no study was tested on a statistically representative sample, making it impossible to extend the results obtained to the reference population. Based on these considerations, the present study aims to evaluate the effectiveness of two framing messages in substituting a whole portion of meat in favour of mushrooms: one pushing the beneficial effects of mushrooms on the environment and the other on health. In addition, the goal is to understand which of the two messages performs the better and to what extent they can affect consumers who eat meat at different frequency.

3. MATERIALS AND METHODS

Data were collected by a professional statistical agency through the online distribution of a questionnaire to a statistically representative sample of about 1000 Italian consumers, stratified by area of residence, age, and frequency of red meat consumption. To achieve the aim of the current study, an experimental survey, using a between-subjects design, was performed. The questionnaire was the same for the entire sample, except for the “framed messages” section (Figure 1), where each subgroup read a differentiated message (except for the control group, which received no information), and was structured into several sections.

Figure 1 - Framed messages

Health framing	*Environmental framing*
The diet has a significant impact on health. Studies have shown that red meat is a possible carcinogen and responsible for increasing the risk of type II diabetes and cardiovascular diseases. Conversely, if you reduce the consumption of red meat and replace it with protein from mushrooms, you could contribute to reducing this risk.	The diet has a significant impact on the environment. Studies have shown that cattle farming is among the contributors to deforestation and global greenhouse gas emissions. Conversely, if you reduce the consumption of red meat and replace it with protein from mushrooms, you could contribute to mitigating these negative impacts on the environment.

In the first section, some questions were asked about the consumption habits of red meat, plant-based meat alternatives, fresh and processed mushrooms, mushroom products such as burgers and patties, and organic products. Subsequently, consumers were asked about the probability that they would replace some of the red meat they consume with a portion of mushroom burger, patties or other mushroom based products. In the second section, some psychographic variables were measured by asking the respondents' level of agreement with some statements related to healthy and ecological lifestyles, the importance given to the nutritional content of food products, alternative medicine, personal development, and personal perception. Consumer familiarity with mushrooms and mushroom products, risk attitudes, social norms, food neophobia, and objective and subjective knowledge about mushroom properties were also investigated. Objective knowledge was measured with a set of true or false questions, while subjective knowledge, which is the knowledge consumers perceive to have, was measured using a 5-point Likert scale. Afterwards, the two treatment groups were shown a framed message in which some health and sustainability properties of mushrooms were elucidated, and they were asked again about the probability of replacing some of the red meat they consume with a serving of mushroom burgers, patties or other mushroom products. Thus, to measure the effect of the framing message on the probability of consuming mushroom burgers in replace of red meat burgers, the question on the intention to reduce the consumption of meat in favour of that of mushrooms is asked twice, in two different moments of the questionnaire. Finally, some questions were asked about the socio-demographic characteristics of the respondents.

The collected data were processed using the statistical software STATA 16. Homogeneity between the subgroups was first checked, and the message effectiveness was investigated. The dependent variable is treated as a continuous variable for which t-tests were developed between the sub-samples.

4. RESULTS

The final sample consists of 953 valid observations. The Hotteling test confirms successful randomization, proving homogeneity between the subgroups in socio-demographic terms. All subgroups are homogeneous by frequency of red meat consumption, by residence, and by age. Once the homogeneity of the subgroups is confirmed, the efficacy of the treatment is verified. Specifically, it emerged that both framing messages have an effect on reducing the consumption of red meat burgers in favour of mushroom burgers. Furthermore, according to our results, framing the message in health and environmental terms did not result in any difference in overall effectiveness.

5. CONCLUSIONS

The findings of the current study suggest that informative messaging can be a powerful tool for promoting sustainable dietary choices. By providing consumers with relevant information about the health and environmental benefits of mushrooms, it is possible to positively influence their attitudes and intentions towards red meat reduction.

It is important to note that this study focused on the intention to change behaviour rather than actual behaviour change. Future research could explore the long-term effects of informative messaging on actual consumption patterns and assess the sustainability impact of such dietary shifts.

Overall, the results highlight the potential of informative messaging as a strategy to promote sustainable food choices and contribute to achieving the Sustainable Development Goals. By leveraging persuasive communication techniques, policymakers, health professionals, and marketers can play a crucial role in shaping consumer behaviour towards more sustainable and healthier dietary practices.

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SUSTAINABILITY VS EFFICIENCY IN THE FISHERY SECTOR: AN ANALYSIS OF THE RAPIDO FLEET

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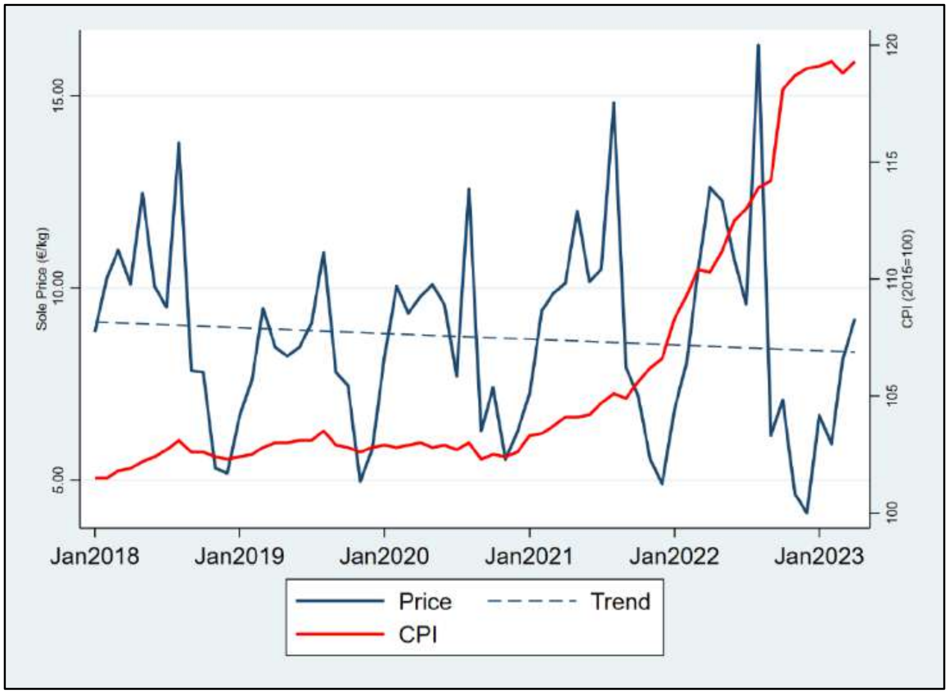
KEYWORDS

Technical efficiency, Stochastic Frontier Analysis, K-means clustering, Beam trawling, CO_2 emissions

INTRODUCTION

In order to strengthen the sustainability and resilience of European fisheries, the Commission has recently recalled the importance of reducing the impact of fishing activities on the seabed. This implies that Member States are expected to adopt measures prohibiting mobile bottom fishing in the marine protected areas (MPAs) that are Natura 2000 sites and ensure that by 2030 mobile bottom fishing is phased out in all MPAs (European Commission, 2023a). Being one of the most impacting fisheries in terms of carbon footprint (Sala *et al.*, 2022), seabed damages (Armelloni *et al.*, 2021) and unwanted catches (Pranovi *et al.*, 2001), the Italian *rapido* fishery in the Central/Northern Adriatic Sea has been indeed subject to increasing effort limitations in recent years (8663 days in 2020, 7443 in 2023). Despite this, the prices of the most relevant target species show a negative trend (sole price experienced a 31% reduction between 2008 and 2020) (STECF, 2022)), while it is essential to maintain prices at appropriate levels by channeling production in order to take advantage of market opportunities (European Commission, 2023b). As stressed by NISEA (2022), the poor performance of several segments of the Italian fleet (including *rapido*) is indeed related to the fact that first sale prices of most species are not keeping up with inflation (Figure 1).

Figure 1 - First sale price of sole at Chioggia Market and Italian consumer price index (CPI)



Source: EUMOFA, ISTAT

Our focus lies on 31 *rapido* boats (classified as beam trawls TBB[1]) from Chioggia port (Veneto), which represent approximately 86.1% of the *rapido* fleet in the region and account for 34.1% at the national level. Acknowledging the significance of grasping the attributes (seasonal, geographical, and behavioural factors) pertaining to the fishing practices of trawlers, conducting a comprehensive examination that integrates the analysis of catch profiles and technical efficiency bears significant implications for various aspects of fisheries management. These include:

i) Evaluating the relationship between local regulations (input control through limitations in fishing days/ engine power) and efficiency (risk of ineffective effort reduction programs if heterogeneity in the means of production is present, hence highlighting the importance of individual measures of productivity (Gómez and Maynou, 2020));

ii) Assessing the impact of varying levels of efficiency on the generated rent (reductions in individual producer surplus due to effort limitations leading to increased likelihood of non-compliance by fishers (Flaaten, 2011));

iii) Understanding the influence of multispecificity on effective management (vessels within the same fleet may target different species in mixed fisheries (Lewy and Vinther, 1994)); and

iv) Identifying the most sustainable strategies in terms of CO_2 (awareness that fishing practices contribute significantly to global emissions is increasing (Sala *et al.*, 2022)).

Through a novel approach linking multivariate analysis of catch profiles to Stochastic frontier analysis (SFA), we address the two following research questions: i) in the case of the TBB fishery in the Adriatic Sea, how does technical efficiency vary among trips characterized by different catch profiles and ii) how do these trips perform in terms of CO_2 emissions?

[1] *Rapido* beam trawl vessels, introduced in Veneto in the 1950s, are characterized by a cone-shaped net with a rigid metallic mouth opening that glides across the sea bottom by means of sleds, allowing fishers to catch flatfish and shellfish. Following the FAO International Standard Statistical Classification of Fishing Gear, the TBB abbreviation denotes beam trawling.

The first step involves the identification of the catch profiles (proxy for fishing strategies) in the fishery through multivariate analysis of landings composition. We then estimate the efficiency of fishing operations by means of SFA and assign a score to each trip. The previously defined clusters are therefore used to compare the performance of trips characterized by different profiles. The latter are lastly evaluated in terms of environmental footprint through the estimation of CO_2 emissions.

METHODOLOGY

First, we categorize trips into homogeneous groups using cluster analysis, a data-exploratory technique divided into partition and hierarchical methods, both of which are utilized in identifying fishing practices (métiers) in fisheries. Specifically, we employ the k-means partition method (Bastardie *et al.*, 2010). The analysis is conducted using Stata 17 and the appropriate number of clusters is determined following the criteria reported in Makles (2012).

Technical efficiency can be defined as the ability of an agent to maximize the output given a set of inputs (output orientation) or minimize the use of inputs required to produce a given output (input orientation), with the former formulation being the most used in fisheries (Pascoe and Tingley, 2007). Considering the stochastic nature of the production process at sea, we apply SFA due to its ability to account for statistical noise through the incorporation of random errors (Herrero and Pascoe, 2003). Following Battese and Coelli (1995), we apply the stochastic frontier production function

$$\boldsymbol{y_{it} = f(x_{it}; \alpha) + v_{it} - u_{it}} \tag{1}$$

where y_{it} denotes the vessel output per trip, x_{it} are the inputs to production, v_{it} denotes stochastic noise and u_{it} represents technical inefficiency. The random errors are assumed to be i.i.d. following a normal distribution $N(0, \sigma_v^2)$, while several distributional assumptions exist regarding the inefficiency component. A common approach in the fisheries literature is to model it as a function of exogenous variables (Pascoe and Coglan, 2002). The inefficiency determinants function follows the form $u_{it} = \delta_0 + z_{it}\delta + w_{it}$ where z_{it} is a vector of vessel-specific characteristics affecting efficiency, δ is a vector of parameters, and w_{it} is the i.i.d. error term. Estimates of technical efficiency per trip by each vessel are given by

$$TE_{it} = \frac{E(Y_{it}|u_{it}, X_{it})}{E(Y_{it}|u_{it}=0, x_{it})} = e^{-u_{it}} \tag{2}$$

describing the ratio of the actual output over the maximum that could be obtained given the inputs employed. The parameters of the stochastic frontier and the model for inefficiency effects are estimated simultaneously using the maximum likelihood method in Stata.

DATA DESCRIPTION AND ECONOMETRIC MODEL

The dataset contains information on 2,404 trips by 31 vessels during 2019 and it was built from AIS data provided by the Italian Coast Guard, which have been matched with the Fleet Register to retrieve information on the characteristics of vessels. Data on landings and daily prices for the most relevant species (sole SOL, cuttlefish CTC, purple dye murex BOY, caramote prawn TGS, spottail mantis shrimp MTS, queen scallop QSC and great Mediterranean scallop SJA)- covering approximately 80% of the total landed value by the fleet in the basin (STECF, 2022)- are used to compute trip revenues.

Table 1 – Summary statistics

Variable	Median	Mean	Std.Dev.

Engine power (kW)	441.00	433.17	121.00
Fishing time (hours)	17.55	19.48	10.36
Fuel (liters)	1179.84	1458.38	963.50
Landings weight (kg)	341.98	423.53	357.97
Landings value (€)	2718.22	3273.53	2721.71
CO_2 (kg)	4493.62	5591.96	6188.08
N= 2404 observations			

The estimated equation is given by

$$\ln V_{it} = \alpha_0 + \alpha_T \ln T_{it} + \alpha_{KW} \ln kW_i + \alpha_{TT}(\ln T_{it})^2 + \alpha_{KWKW} (\ln kW_i)^2 + \alpha_{TKW}(\ln T_{it} \cdot \ln kW_i) + \alpha_4 D_t + v_{it} - u_{it} \quad (3)$$

where V_{it} is catch value, T_{it} is fishing time, kW_i denotes power and D_t is a monthly dummy describing stock fluctuations. Technical efficiency effects are defined by

$$u_{it} = \delta_0 + \delta_Y \ln A_i + \delta_L L_i + w_{it} \quad (4)$$

where A is the boat age and L is the length class. Lastly, based on the engine power of vessels and their fishing time, we are able to compute fuel consumption through the equations reported by Prado (1990) and to estimate the carbon footprint of trips using the method Tier 1 (Park *et al.*, 2015).

RESULTS AND DISCUSSION

Table 2 – Catch profiles composition

Cluster	**Proportion of landings**							
	SOL	CTC	BOY	TGS	MTS	QSC	SJA	Other
1	0.36	0.35	0.02	0.02	0.03	0.03	0.07	0.13
2	0.08	0.04	0.02	0.00	0.01	0.75	0.09	0.01
3	0.66	0.07	0.05	0.01	0.06	0.01	0.05	0.10
4	0.34	0.05	0.14	0.01	0.06	0.04	0.26	0.10
5	0.02	0.10	0.03	0.02	0.07	0.00	0.01	0.75

Table 3 - Monthly variations in efficiency scores and trip emissions per catch profile

Month			**J**	**F**	**M**	**A**	**M**	**J**	**J**	**S**	**O**	**N**	**D**
Cluster 1	N		161	146	89	41	1	1	0	7	44	50	70
	Tech.eff.	*Mean*	0.72	0.71	0.72	0.69	0.43	0.11	.	0.74	0.71	0.76	0.71
		Median	0.76	0.76	0.78	0.76	0.43	0.11	.	0.69	0.75	0.79	0.76
		St.Dev.	0.14	0.15	0.16	0.18	.	.	.	0.07	0.13	0.09	0.13
	CO_2	*Mean*	8224	7824	7201	11800	1310	2058	.	6594	6749	6084	7702
		Median	8256	7488	7015	10080	1310	2058	.	6584	6416	5874	7588
		St.Dev.	7009	4372	3758	13150	.	.	.	1881	2452	2539	3617

Cluster 2	N		18	31	26	43	39	44	41	29	30	22	20
	Tech.eff.	*Mean*	0.81	0.76	0.79	0.80	0.83	0.82	0.76	0.74	0.77	0.77	0.78
		Median	0.81	0.80	0.82	0.82	0.85	0.84	0.81	0.77	0.79	0.76	0.80
		St.Dev.	0.07	0.15	0.08	0.07	0.10	0.06	0.17	0.08	0.06	0.07	0.07
	CO_2	*Mean*	2450	2555	2975	3162	4776	3283	2947	3472	2995	2639	2757
		Median	2421	2605	2549	2714	2899	2718	2548	2787	2602	2433	2648
		St.Dev.	521	586	1868	1869	7909	2112	1814	2141	946	972	729
Cluster 3	N		33	55	54	87	136	96	83	79	91	104	92
	Tech.eff.	*Mean*	0.60	0.61	0.63	0.67	0.68	0.68	0.69	0.72	0.69	0.70	0.71
		Median	0.64	0.66	0.70	0.70	0.72	0.72	0.72	0.76	0.76	0.76	0.76
		St.Dev.	0.20	0.21	0.21	0.17	0.15	0.15	0.12	0.13	0.16	0.14	0.14
	CO_2	*Mean*	4678	4995	3565	5213	6498	4806	4679	3878	5698	4306	5342
		Median	2885	3677	3304	4465	3543	3691	3910	3534	5167	3602	5117
		St.Dev.	3959	3581	1857	2863	19334	2844	3144	2078	3194	2449	2834
Cluster 4	N		12	8	47	53	67	68	53	41	33	14	14
	Tech.eff.	*Mean*	0.55	0.53	0.68	0.68	0.66	0.65	0.70	0.71	0.64	0.45	0.51
		Median	0.63	0.55	0.69	0.70	0.68	0.71	0.76	0.74	0.72	0.51	0.64
		St.Dev.	0.21	0.21	0.12	0.14	0.13	0.17	0.16	0.10	0.20	0.21	0.34
	CO_2	*Mean*	5238	4719	4755	5340	5643	5261	5305	5077	6446	4396	5295
		Median	3929	4435	3923	4332	4695	4672	4524	4895	5895	4204	4951
		St.Dev.	2442	2094	2062	2698	3202	2373	2599	1480	2480	1115	1954

Note: Observations belonging to Cluster 5 are dropped from the analysis due to the high incidence of species labelled as "other", for which no price series is available

Table 3 shows the efficiency scores and the CO_2 emissions associated with the four catch profiles during each month. First, it emerges that it is important to inspect the efficiency scores and the emissions at the monthly level because both of them tend to vary consistently across the year. For instance, Cluster 3 is characterized by good efficiency in Autumn, but it is relatively underperforming between January and February. Similarly, the number of observations denotes whether a catch profile tends to be stable during the year or not. Cluster 1- targeting together sole and cuttlefish- is indeed the most recurring strategy in the Winter months, while it almost disappears between May and September.

It is interesting to observe that in some periods of the year fishers tend to exhibit mostly one (e.g. in January) or two (in December) catch profiles (with sole prevailing) while in others the probability of belonging to one cluster is more equally distributed among the four. This is the case of April, when all the clusters are characterized by at least 40 observations and none of them has a median efficiency score lower than 0.70. For instance, vessels could either choose to prioritize sole (Cluster 3) or target as well murex and great Mediterranean scallop (Cluster 4) with no major differences in terms of efficiency. The two strategies are also comparable from an environmental point of view, although the median value of CO_2 emissions from Cluster 2 is still the lowest throughout the year. This also appears to be the most efficient strategy in the majority of months.

In order to facilitate the understanding of the results and address the research questions of the paper, the yearly summary statistics of efficiency scores and emissions are shown in Table 4. Overall, we observe that fishing trips targeting mainly queen scallop (Cluster 2) have the best performance both in terms of technical efficiency and carbon footprint. Nevertheless, Cluster 3 is the least recurring catch profile of the sample. On the other hand, landings mostly composed of sole and cuttlefish (Cluster 1) are more frequent and generate the highest levels of emissions, due to their long time at sea- especially in the Winter months. Finally, fishing trips belonging to Cluster 4 (targeting together sole, murex and great Mediterranean scallop) are the most diversified in terms of catch composition (at least three target species weighing more than 10% of the total) but they display the lowest efficiency scores. Lastly, the different fishing strategies can be also compared in terms of emission intensity by considering the ratio of CO_2 emitted to the value of landings of the seven species under analysis. Again, Cluster 2 fishing trips result to be the most sustainable, with a median value of emission intensity equal 0.62 kg of CO_2 for every € of landings. These are followed by Cluster 3 (1.67 kg/€), Cluster 1 (1.82 kg/€) and Cluster 4 (2.34 kg/€).

Table 3 - Average efficiency scores and trip emissions per catch profile

Cluster	**Technical efficiency**			**CO_2 emissions (kg)**		
	Median	Mean	St.Dev.	Median	Mean	St.Dev.
1	0.76	0.72	0.15	7306.52	7837.47	5912.18
2	0.81	0.79	0.10	2637.92	3183.40	3092.95
3	0.73	0.68	0.16	3795.75	5025.05	7944.26
4	0.70	0.65	0.17	4533.94	5318.68	2475.94

CONCLUSIONS

In summary, fisheries management based on input controls assumes that vessel within a fleet are homogeneous in terms of efficiency, meaning that limitations in fishing effort are expected to result in proportional reductions in fishing mortality. However, if heterogeneity emerges from the estimation of technical efficiency, the efficacy of management measures using input controls may be affected (Pascoe and Tingley, 2007). The results indicate that substantial heterogeneity exists within the fleet, with efficiency scores varying considerably among vessels and during the year. This suggests that a flexible and multitool management framework considering local specificities (areas, periods, fishing strategies) and market trends of relevant species (Figure 2) may positively integrate the current regulations mostly based on the reduction of fishing days.

Depending on the priority weightings placed by management institutions (economic efficiency, carbon neutrality, stock preservation), this type of analysis can support the selection of the most appropriate temporal units for future regulations involving a reduction in fishing days. To ensure that these have no impact on market supply and do not result in the closure of established commercial circuits, it is essential to consider both the distribution of fishing time limitations throughout the year in addition to the fishing time reduction itself (Sánchez Lizaso *et al.*, 2020). On the other hand, even if the introduction of quotas has been traditionally rejected in the Mediterranean Sea due to the multispecies nature of most fisheries (Mulazzani *et al.*, 2018), it is reasonable to presume that setting a total allowable catch (TAC) for sole in the Autumn/Winter season would prevent the fall in prices that occurs in November (6.35 €/kg) and December (6.89 €/kg) , especially considering that sole represents about 50% of landings in these months.

Figure 2 – Quantity and price series of sole (2019)

Source: Chioggia Market

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ASSESSING THE ECONOMIC PROFITABILITY OF VITICULTURAL PRECISION SYSTEMS: SOME CASE STUDIES IN ITALY

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Introduction

Precision agriculture utilizes technology and data to optimize farming practices, by reducing field variability, enhancing crop yields, lowering operating costs and the environmental impact (Yost *et al*., 2017). As Rose *et al*. (2022) state, precision farming contributes to socio-economic advancement, stability, and environmental health, while mitigating climate change. The adoption of precision agriculture technologies has proven to be a valuable solution. For example, the study published by Bucci *et al*. (2020), demonstrates that the adoption of precision agriculture tools contributed to the increase in yields and to the reduction of operational costs regarding several crops: 8% for corn, resulting in a 196 €/ha saving; 22% for tender wheat, with a saving of 284 €/ha; and 14% for durum wheat, correspondent to a 206 €/ha saving. However, as emphasized by several authors, the economic feasibility of adopting innovative technologies in the field of precision farming is strictly connected to farm size and technology selection (Balafoutis *et al*., 2017; Sumiahadi *et al*., 2019). On the one hand, socio-economic barriers and investment costs for small-sized farms can hinder its adoption (Mizik *et al*., 2023). On the other hand, the economic profitability of precision agriculture systems depends on factors such as technology, price or potential returns (Bentivoglio *et al*., 2021).

In the viticultural field, advanced technologies, such as tailored irrigation, fertilizer application and canopy management, based on data analysis (Mazzetto *et al*., 2010) and data-driven techniques, are to date adopted in some wineries to optimize vineyard management, enhance sustainability and firm's profitability (Matese *et al*., 2015; Ferro *et al*., 2023). In this sector, remote/proximal sensing technologies enable precise observations of spatial variability in vineyards, providing valuable insights to enhance management efficiency, optimize operations, and improve quality (Ammoniaci *et al*., 2021; Gokool *et al*., 2023). However, the adoption of innovation, in this sector as in other ones, is linked not only to the winegrowers' propensity, but above all to economic factors, like prices, production efficiency and reduction of operating costs, and the perceived utility (Vollaro *et al*., 2019). In light of this, it becomes crucial to assess the economic feasibility of precision viticulture adoption, through the evaluation of costs and returns of conventional and innovative vineyards.

While several studies have attempted to identify the potential use of precision farming tools in the agricultural and wine sector, very few empirical studies attempt to pursue a deeper understanding of the economic feasibility of adopting precision agriculture tools in viticulture, necessary to reduce the winemakers' concerns and encourage them to invest in innovative processes. Most of these studies applied the Cost-Benefit Analysis (CBA) (Borgogno-Mondino, 2017; Finco *et al*. 2022; Allegro *et al*. 2023) or the Gross Margin Analysis to evaluate the profitability of precision agriculture compared to conventional management systems (Maynard *et al*., 2015; Proffitt and Pearse, 2004). The first approach, the CBA, is essential to accurately evaluate the economic viability, considering both operating and capital costs, along with potential benefits and specific vineyard circumstances (Boardman *et al*., 2017). On the other side, the Gross Margin Analysis facilitates data-driven decision-making and comparisons between conventional and precision systems by assessing revenues and subtracting variable costs (Kasmioui and Ceulemans, 2012). Findings demonstrate that the adoption of precision technologies in vineyard management has substantial cost savings, as a result of the reduction in the cost of fertilizers and of profit gains ranging from 10 to 30 percent (Bramley *et al*., 2011; Schimmelpfennig *et al*., 2016). For example, Maynard (2015) found that the precision viticulture adoption is economically viable mainly for medium producers (71-360 ha), with potential cost savings of $290 per hectare, due to input cost savings ranging from $140 to $300 per hectare, and price discrepancies of $200 per ton, excluding very small producers (<15 ha). Consistent with this, Casson and co-authors (2022) found, by using a multidisciplinary approach including the Life Cycle Assessment (LCA), that the adoption of precision agriculture technologies in the field of viticulture increases the economic benefits and reduces the environmental impacts. More recently, Tziolas and co-authors (2023) verified the profitability of implementing two robots on four “quality-oriented” grapevine cultivars in Greece compared to conventional scenarios. Results show that the adoption of precision agriculture tools contributes to reduce significantly the labour and energy costs, on the contrary the machinery costs increase in the innovative scenario. As the same authors emphasize, machinery cost depends on the robot’s lifetime: management costs significantly reduce when the lifetime of the robots exceeds 15 years. However, there is little data available to be able to express a feasibility judgement, above all in relation to the marked variability of vineyard conditions (pedo-climatic characteristics, varieties, working conditions, duties and taxes, etc.). In this scenario, additional profitability analysis is needed in order to reduce the winemakers concerns consequent to the adoption of precision viticulture tools and to encourage them to make investments in innovation.

In light of the above, the aim of this research is to analyse the economic viability of implementing precision agriculture systems in the Italian viticultural sector by carrying out an analysis by which the production costs, before and after the adoption of precision agriculture tools for the construction of vigor maps within the vineyards, were estimated and a profitability indicator was applied. Taking into account the research nature, the case study approach was thought to be the most appropriate and suitable approach in order to explore a continuously evolving phenomenon. The current study is based on a project named “AGRIMET”, funded under the POC-Sicilia 2014-2022, whose objective is the development of an integrated system for the acquisition and processing of aerial and terrestrial data in order to finally create a decision support system. This study enriches the current literature on the economic convenience of adopting precision agriculture tools in viticulture by investigating the economic feasibility of implementing survey technologies with drones for vineyard monitoring. The results obtained could be useful to other winemakers both to deepen their knowledge of the potential for adopting precision agriculture tools and to verify the opportunities to improve production efficiency and reduce operating costs.

Methodological approach

This research adopted a case study approach in order to analyse the profitability of implementing precision farming practices in vineyards. The proposed approach is suitable because of the complexity of the analysis, which requires quantitative data from vineyards in order to perform the economic profitability analysis before and after the adoption of precision farming systems. As Yin (1984) suggests, the case study method is particularly appropriate when investigating "*a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used*" (Yin, 1984, p. 23).

The profitability analysis was performed by using the gross margin indicator calculated as the difference between saleable gross product (revenue from grapes sale) and operational costs (costs related to fertilizers, chemicals, equipment, workers, etc.,) (Nix, 1995). More in detail, the Gross Margin is obtained through a partial economic balance of a given crop and is calculated as the difference between the value of the crop Gross Saleable Production and the specific direct costs, such as fertilizers, passive rentals, herbicides, pesticides, temporary labour, water and electricity, fuels and lubricants, product insurance, etc. etc.. The data obtained from the interviews to the wineries managers were integrated with documentation provided by the same directors, as the holding file and the logbook. As regards the technical aspects, the grape yields, the technical means (fertilizers, herbicides, pesticides, ecc.), the operating hours of the agricultural machinery, temporary labour force, consumptions of water, electricity, fuel and lubricants, were quantified thanks to the support of the wineries respondents and to the documentation provided (holding file and logbook). Subsequently, unitary prices of technical means were mainly provided by the wineries respondents and, if missing, they were estimated by consulting handbooks and official agricultural price lists or by turning to expert witnesses, such as agronomists, sales managers of farm supply store. As to the agricultural wages applied to the vineyard labour requirements, the official wage rates in force in the period under analysis in the regions where the wineries investigated are situated. In order to calculate the Gross Saleable Production, unitary average value of grape production was estimated by the firms' respondents. Actual prices were not available as grape product is not sold outside because it is processed for wine production.

Data, for both precision and conventional systems, were collected in two selected Italian wineries through the administration of a data collection sheet to gather information, related to the 2018/19-2021/22 period, on the agricultural operations performed over the selected life cycle of the vineyards. More in detail, an independent survey was carried out by the researchers involved in the project and with the support of Italian start-ups operating in the field of precision viticulture in order to identify Italian wineries belonging to this market segment. 29 wineries were singled out, 23 of which have refused to give their willingness to participate in the research and 4 are currently in the survey phase. As a result, the analysis refers to two case studies, and more in detail the wineries involved in this study are "Torre Bisenzio" located in the Umbria region, at 460-580 meters a.s.l. and 118 km from the coastal strip and "Mulini di Segalari", located in Tuscany at 90-130 meters a.s.l. and just 15 km from the coastal strip. The first winery is an agricultural limited liability company directly managed by the agricultural entrepreneur with the support of permanent and seasonal workers, extends over approximately 273 hectares, 175 hectares of which are woodland, 49.50 hectares grazing land, 29 hectares are arable crops, 5.27 hectares olive groves, and 6.21 hectares are used for the vineyards. On the other hand, Mulini di Segalari is an agricultural general partnership directly managed by the agricultural entrepreneur with the support of permanent and seasonal workers. It extends over an area of 7.13 hectares, 3.06 hectares of which are covered with olive groves and 4.04 hectares are vineyards. Both wineries produce high-quality wines characterised by DOC and IGT appellations, according to Ministerial Decree 7552 of August 2, 2018, and both vineyards are organically managed with the presence of farm machinery fleets able to meet production requirements.

Results

The study aims to investigate the economic viability of implementing precision agriculture systems in the wine viticultural sector in Italy. In line with previous studies, the adoption of precision viticulture tools can help reduce the operating expenses in terms of human labour and inputs costs. The results show that the adoption of precision agriculture tools, especially drones for monitoring vineyards through the construction of vigor maps, allows, on the one hand, to reduce the number of phytosanitary treatments and, on the other hand, improve the quality of grapes. Through the adoption of vigor maps it is possible to carry out the harvest in homogeneous areas with a consequent qualitative improvement of the harvested grapes and consequently of the produced wines, which can be marketed at significantly higher prices than those ones which were obtainable before the adoption of precision agriculture tools.

The analysis carried out on the two wineries surveyed has made it possible to identify the main factors affecting profitability and to measure the economic viability to introduce precision viticulture tools. Besides, by enriching the current literature on the profitability of precision agriculture, our findings have relevant managerial implications. Indeed, the knowledge of the importance of the economic aspects in the adoption of precision agriculture in the wine field is crucial because it could represent an input for farmers to invest in innovation and sustainable solutions.

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WHAT DETERMINES SHORT FOOD SUPPLY CHAIN PURCHASES? REVEALING THE INFLUENCE OF BELIEFS ABOUT PUBLIC EFFECTS VERSUS PRIVATE MOTIVATIONS

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INTRODUCTION

In recent years, the importance of short food supply chains has become increasingly recognized as a crucial element in building sustainable and resilient food systems (Kneafsey *et al*., 2013). Unlike long and complex supply chains, short food supply chains prioritize local food and direct connections between producers and consumers (Enthoven and Van den Broeck, 2021). By minimizing the number of intermediaries and reducing the distance of food travel, this approach offers several advantages (Augère-Granier, 2016). The purchase of short food supply chain products not only addresses concerns about environmental impact and food quality but also contributes to enhancing food security, bolstering local economies, and increasing consumer trust (Kneafsey *et al*., 2013). The advantages of fresher produce, enhanced traceability, and support for local economies align with the growing consumer demand for sustainable and socially responsible food choices (Giampietri *et al*., 2018; González-Azcárate *et al*., 2021). Short food supply chains hold great potential for transforming the way we produce, distribute, and consume food, creating a more sustainable future for generations to come (Govindan, 2018). However, the disadvantages of limited product variety, potentially higher prices, and convenience barriers underscore the need for well-planned strategies to address these challenges and make short food supply chains more accessible and inclusive.

The European Union (EU) has implemented various initiatives and policies to support and promote short food supply chains as part of its broader objectives for sustainable agriculture and rural development. Among these measures are the Farm to Fork Strategy, the Common Agricultural Policy (CAP), and research and innovation funding programs (European Commission, 2019). Notably, these efforts have aimed to bolster short food supply chains, which play a crucial role in supporting local food systems, enhancing sustainability, and stimulating local economies.

Understanding consumer behavior regarding short food supply chain purchases assumes a pivotal role within this framework. By gaining valuable insights into consumer preferences and habits, policymakers can formulate targeted strategies to strengthen local food networks, promote healthier choices, and ensure food security (Kneafsey *et al*., 2013).

Emphasizing the value of short food supply chains in the EU's agricultural and rural development context is essential. These local food networks not only reduce the environmental impact associated with long-distance transportation but also foster a deeper sense of community engagement and cooperation. Furthermore, by supporting local farmers and producers, short food supply chains contribute directly to bolstering the region's economy and promoting social cohesion.

AIM OF THE STUDY

The literature has extensively focused on the study of drivers and barriers to short supply chain purchasing. Among these, studies have investigated attitudes, social norms, perceived behavioral control, convenience, and trust (Giampietri *et al*., 2018; González-Azcárate *et al*., 2021; Wang *et al*., 2022). Consumers' attitudes and behavior are influenced by private motivations, encompassing both personal benefits and personal barriers. Personal benefits refer to the individual advantages perceived by consumers when engaging in direct purchases from local farmers (González-Azcárate *et al*., 2021; Macready *et al*., 2020). These benefits may include the assurance of fresh and high-quality produce, and enhanced taste experiences (Augère-Granier, 2016). Conversely, personal barriers represent the individual challenges that consumers may encounter, such as concerns about inconvenience, limited product variety, and potential perceptions of higher costs associated with direct purchases (González-Azcárate et al., 2021). Simultaneously, a conflict between the roles of citizen and consumer explores the tensions consumers face when making food choices (Moruzzi and Sirieix, 2015). On one hand, individuals may identify as responsible citizens, driven by sustainability and ethical considerations, aiming to reduce their environmental impact and promote social inclusion. On the other hand, they also function as consumers, guided by convenience, price, and taste preferences. This conflict between roles can lead to dilemmas in sustainable food consumption and warrants deeper exploration within the food short supply chain context (Frank, 2018).

The role of consumers' beliefs about the public benefits of buying short-chain food and the consumer-consumer role dilemma are scantily addressed. This research aims to investigate the reception of European policy objectives by citizens and how their level of agreement with these policies impacts their food purchasing behavior. Specifically, we intend to estimate how individuals' evaluations of public effects that are recognized by governmental entities (environmental and socioeconomic benefits) and how private motivations (personal benefits and barriers) associated with short food supply chain purchases influence their buying choices. We focus on the case of direct purchase from farmers, which represents the shortest form of a short food supply chain. This type of purchase is supported by institutions as it aligns with the objectives of the European Commission's Farm to Fork strategy and contributes to the realization of the European Green Deal (European Commission, 2020).

METHODS

We developed new scales to measure individuals' agreement with environmental, socioeconomic, and personal benefits that can derive from purchases made through short food supply chains, as recognized by governmental entities. The creation of these scales is based on an analysis of the documents issued by the European Union, such as the European Commission (European Commission, 2019), the European Parliament (Augère-Granier, 2016), and the Joint Research Centre (Kneafsey *et al*., 2013).

After conducting a pilot study to test the developed scales, the methodology involved administering an online questionnaire to a sample of six hundred Italian consumers representative of age and residence in rural and urban municipalities. A Structural Equation Model (SEM) is implemented using Stata 18 (Anderson and Gerbing,1988; Kline, 2016). The two-step was adopted for estimating and evaluating the relationships between the latent variables of the theoretical model. This procedure involves two main steps: the measurement model and the structural model.

Six hypotheses (H) about the positive/negative (+/-) relationships between constructs were tested. In the theoretical model, beliefs about "Environmental benefits" (H1+), "Socioeconomic benefits" (H2+), "Personal benefits" (H3+), and "Personal barriers" (H4-) are antecedents positive/negative on the "Intention" to purchase food from the short supply chain. "Intention" (H5+) and "Conflict between the roles of citizen and consumer" (H6+) drive the "Purchase" of food through a short supply chain. The conflict has been included to assess whether individuals' coexistence of the two competing social roles affects their purchasing behavior. Additionally, we examined whether the relationships between constructs differ between residents of urban and rural areas. In particular, we tested the invariance for grouping the respondents of rural and urban areas to determine whether the relationships between latent variables were consistent across the two different groups in the data. Invariance testing ensures that the model's structural parameters hold for all groups being compared, allowing for meaningful group comparisons and conclusions (Lee and Whittaker, 2021).

RESULTS

All the fitting indicators met the requirements in the measurement and structural model. The results reveal that personal benefits and beliefs regarding socioeconomic benefits derived from direct purchases have a positive effect on the intention, confirming H2 and H3. However, beliefs regarding environmental benefits do not significantly influence purchase intention, disconfirming H1. Personal barriers have the greatest (negative) influence on the intention to purchase directly from farmers, supporting H4. The purchase intention, in turn, has a positive effect on actual purchasing behavior, confirming H5. While the citizen-consumer conflict has no impact on the purchase, disconfirming H6.

Grouping respondents based on their municipality of residence reveals several differences in the relationships between constructs for urban and rural residents. Overall, it is observed across all models that the effect of personal benefits outweighs public benefits in determining the intention to purchase directly from producers, and perceptions of environmental benefits do not impact the intention significantly.

CONCLUSIONS

This study contributes to the growing literature on short food supply chain purchases by unraveling the determinants that shape consumer behavior. By shedding light on the interplay between beliefs about public effects and private motivations, this research offers valuable insights for policymakers and stakeholders seeking to promote sustainable food consumption patterns.

These findings can provide important implications for policymakers in tailoring their approaches to meet consumer expectations, improve market access, and create opportunities for farmers and local food entrepreneurs. Specifically, strategies should increase consumer/citizen involvement in sustainable purchasing and consumption schemes. Supporting and promoting short food supply chains through policies that incentivize direct farmer-consumer interactions can enhance the resilience of local economies and foster a more sustainable and decentralized food production and distribution network.

Given the role of personal motivations in driving direct purchases, policymakers should prioritize consumer education and awareness campaigns. Highlighting the personal benefits of fresh, high-quality produce, and the positive impact on local communities can encourage consumers to make more informed and sustainable choices, ultimately leading to increased direct purchases from farmers. Addressing the personal barriers associated with direct purchases is essential. Policymakers can explore strategies to reduce perceived inconveniences, such as providing accessible and convenient marketplaces for farmers to directly sell their produce. Initiatives like farmer's markets, community-supported agriculture programs, and online platforms can enhance consumer access to locally sourced products.

Finally, the methodology developed in this research, which involved the creation of scales to measure consumer beliefs regarding the benefits of short supply chains recognized by governmental institutions, can be used to study other behavioral patterns concerning sustainable consumption and purchase.

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DIGITALIZATION AND ARTIFICIAL INTELLIGENCE FOR SUSTAINABLE FOOD SYSTEMS. OPERATIONALIZING A NEW CONCEPTUAL MODEL FOR EU-FUNDED CASE PROJECTS ANALYSIS

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INTRODUCTION

The role of Digitalization (DG) and Artificial Intelligence (AI) is increasingly valued by both researchers (Marvin *et al*., 2022) and policy makers (EC DG DIGIT, 2022) for the development of more inclusive and sustainable Food Systems (FS) and their territorial integration (Brunori *et al*., 2022).

Food science and technology developments based on DG/AI offer many types of opportunities to face global challenges affecting FS capacity of generating benefits (SCAR FS SGW, 2023). As a result, DG/AI started to gain relevance during the last years, nonetheless significant investigation is still needed together with more effective public and private action (Brunori *et al*., 2023). To that end, a new conceptualization effort is being carried out (EC DG RTD *et al*., 2019; Brunori, 2022) valorizing FS holistic approaches for their analysis and the definition of relevant areas of intervention.

Also, the European Union (EU) Standing Committee on Agricultural Research Strategic Working Group on Food Systems (SCAR FS SWG) posed among its priorities the enhancement of DG/AI contribution for smart, healthy, sustainable FS and rural territorial growth (SCAR FS SWG, 2019), adopting a participatory process with the involvement of EU and national stakeholders.

Accordingly, new action-research directions are expected to be identified, together with relevant policy recommendations, contributing to the enhancement of EU and national R&I Programmes and projects. Relevant inputs will be provided for the development of a new Strategic Research and Innovation Agenda (SRIA) and realization of a Partnership on Sustainable Food Systems (P-SFS). The latter are intended to guide the formulation of the scope and topics of new joint calls within Horizon Europe, through the implementation of a specific set of R&I Thematic and Activity Areas (SCAR FS SWG, 2023).

This study, funded by the European Commission (EC), aims at understanding how R&I related to DG/AI can contribute to the strengthening of FS transformation and sustainable territorial development. Specifically, we operationalize a new holistic conceptual model in order to:

- analyze recent and ongoing EU-funded R&I projects concerning DG/AI integration in FS;

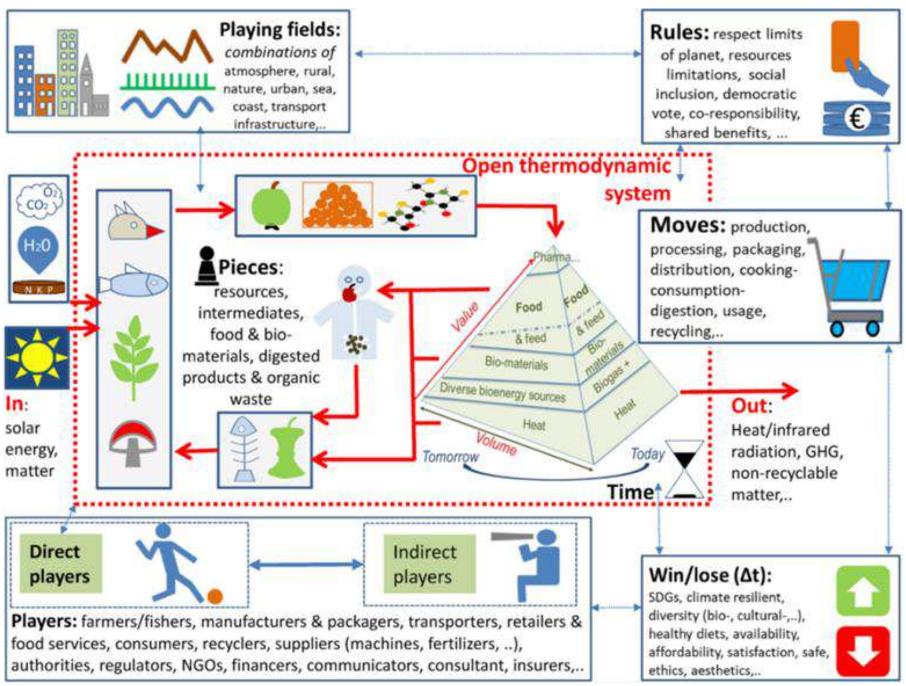
- identify the FS building blocks in which the projects intervene and the related interconnections;
- identify and evaluate good practices of EU-funded R&I projects;
- identify the effects of the DG/AI innovations proposed by the projects in different FS building blocks and at complex system level.

THE CONCEPTUAL FRAMEWORK

A FS approach is adopted for R&I analysis and support. According to EC DG RTD *et al.* (2019), a FS approach places the actors, their activities, and interactions in a central position; characterizes their interdependencies in terms of how actions may create a feedback reaction from other parts of the FS, and facilitates the identification of effective levers for change.

Our study adopts the new holistic model by de Vries *et al*. (2022) conceptualizing FS in the lens of open thermodynamic systems, constituted by seven system building blocks (reminiscent of the chess game) and related interlinks (Fig.1).

Figure 1 – A holistic conceptual model for Food Systems analysis



Source : de Vries *et al.* 2022, p. 387.

As shown in Fig.1, FS building blocks are identified as: i. *Pieces*, including e.g., resources, biomaterials, food products/services, diets, digested products, and organic waste; ii. *Moves*, concerning food handling schemes (from production to recycling) and supply-demand chains (both for products and waste); iii. *Players*, meaning all FS stakeholders, both directly (e.g., farmers, chain operators, citizens/consumers) and indirectly (e.g., financers, regulators, medical doctors) involved; iv. *Rules* intended as principles, regulations, and incentives; v. *Time*, concerning the time perspective of each FS operation; vi. Playing fields or the (physical and/or virtual) "spaces" in which FS operations take place, e.g., food contexts (geographical, spatial, cultural, etc.); and vii. *Win-lose* including sustainable/unsustainable FS outcomes.

In light of that, we retain that higher FS sustainability and territorial integration can be pursued by different R&I actions in the identified system building blocks, through the achievement of DG/AI - based Food Science and Technology developments.

METHODOLOGY

A participatory portfolio analysis (Vonortas and Ràfols, 2019) of EU-funded R&I projects was conducted, after being designed in collaboration with SCAR FS SWG experts, and receiving inputs from the EC DG RTD officers and other stakeholders mainly representing Member States. According to a common-agreed portfolio analysis protocol, an integrative review strategy (Snyder, 2019) was planned and implemented for the study realization.

Firstly, for projects searching, we queried and browsed the most reliable, updated, and comprehensive databases of EU-funded actions (i.e., CORDIS, ICT-AGRI FOOD, KEEP.EU, EIP – AGRI) by using the keywords "Food Systems", "Sustainability", "Transition", in combination with the key terms "Digitalization" and/or "Artificial Intelligence".

The selection of projects followed a purposeful approach (Snyder, 2019). Figure 2 reports the set of qualitative inclusion criteria we applied, after a collaborative identification with FS SWG experts. As obligatory inclusion criteria, all selected projects aim at valorizing the role of DG/AI for FS sustainability transition, and adopt a FS approach (either implicit or explicit).

In line with the request by FS SWG experts and the EC DG RTD, we created a sample of 10 projects (H2020, Horizon Europe, and beyond). The size of the sample requested proved to be adequate and illustrative (Epler, 2019), for an in-depth analysis, considering that most of EU-funded R&I actions on DG/AI still do not implement a systemic approach.

Figure 2 - R&I projects sampling inclusion criteria

Type of criteria		Included R&I projects characteristics
(A) Thematic criteria	A.1 Obligatory	• Adopting a FS approach (either explicit or implicit)[1] • Valorizing the role of DG/AI for FS sustainability transition
	A.2 Priority	• Targeting the post-harvest phase (i.e., processing, distribution, marketing, consuming, digesting, recycling) • Intervening on various FS building blocks (>1) • Adopting interdisciplinary research strategies • Adopting a multi-stakeholder approach • Adopting participatory methods
	A.3 Excellence	• Providing novelties (*theoretical, practical*) linked DG/AI
(B) Other criteria (Other than thematic)	B.1 Project typology	• Funded under H2020 or other EU programmes
	B.2 Temporal criteria	• Ended later than 01-01-2019 (or ongoing, officially granted)
	B.3 Geographical criteria	• Involving multiple countries and regions (multi-regional), with preference to the ones participated by Eastern countries or even non-member states

[1]We intend as projects adopting explicit FS approach the ones that openly declare to adopt it. Instead, we consider as projects adopting implicit FS approach the ones that even do not explicitly state to use it, present goals and activities designed according to the approach principles.

Source: our elaboration.

In the second step, we conducted a qualitative overview analysis of the selected projects, according to a set of 57 co-identified descriptors. As a result, we mapped R&I actions based on their characteristics, e.g., general information, met thematic priority and excellence criteria (Figure 2), adopted DG/AI - related solutions, and affected FS building blocks. Also, we highlighted projects specific linkage to the SRIA.

Lately, an in-depth thematic analysis stage was started based on de Vries *et al*. (2022) model, intended to characterize R&I projects DG/AI - based interventions affecting different FS building blocks, and the underlying interconnections.

Results were shared, enriched, and validated with relevant EU and national stakeholders during a workshop organized by SCAR FS SWG in Bruxelles, May 2023.

RESULTS

The sample includes ten projects, funded for the most under Programmes H2020 and Horizon Europe. Based on the conducted overview analysis the following insights emerge.

In geographical terms, projects partnerships are multi-regional. Quite all projects (9/10) include both Western and Eastern EU countries, and half of them also involve non-EU countries (Eastern Europe, UK).

Projects show a good level of understanding of a FS approach. Even if only 6/10 explicitly self-identify as adopting a FS approach, quite all of them (9/10) are based on a multi-stakeholder partnership and intervene, either directly or indirectly, in all seven FS building blocks. In addition, all projects target the post-harvest phase, are interdisciplinary, and adopt participatory methods.

All projects contribute to generate change in FS and territories by means of innovative DG/AI - related solutions. In particular, they provide for:

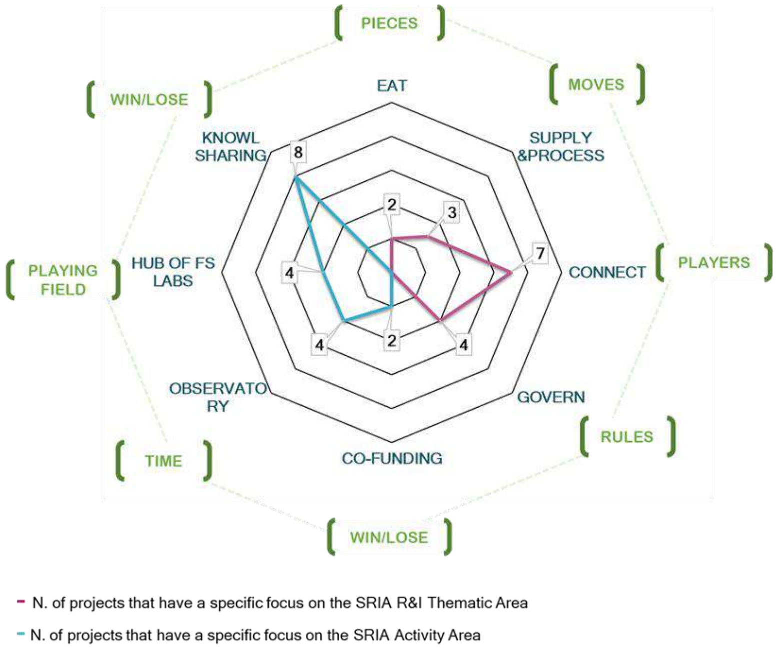
- developing and/or applying specific DG/AI innovations, with a major focus on Cloud Computing, Internet of Things, AI - driven Algorithms technologies, Digital Platforms, as well as Digital education and Digital governance settings;
- creating enabling environments and/or supporting infrastructures for DG/AI - based R&I, e.g., furthering new conceptualizations, multi-stakeholder networks, joint programming initiatives, supportive science-policy-business-society interfaces;
- deepening critical food data studies - mainly regarding topics as (personal) data access, data protection and sustainable use, and pursuing a better understanding of DG/AI role in creating a new FS Data Economy.

Despite of that, projects (3/10) pay a limited attention to identifying and facing DG/AI integration criticalities and possible trade-offs, (e.g., issues concerning data sharing, data access, consumers/citizens' rights and trust, digital standards aligning to EU policies and SDG goals).

Considering projects linkage to the SRIA, de Vries *et al*. (2022) model operationalization allows to understand the fundamental connection between projects DG/AI - based intervention in one or more FS building blocks and consequent improvements in SRIA R&I Thematic and Activity Areas (SCAR FS SWG, 2023).

Accordingly, a high level of coverage of SRIA areas is evidenced, with all projects targeting quite all areas even if with a different level of prevalence. The study outlines that, in terms of prevalence, a strong focus of adopted DG/AI innovations is on fostering change in the way people CONNECT with FS and in supporting a process of KNOWLEDGE SHARING and scaling-up (Fig.3). Differently, less attention is dedicated to generate change in the way people EAT and in facilitating the design of CO-FUNDING and joint programming initiatives.

Figure 3 - Projects linkage to SRIA R&I Thematic and Activity Areas



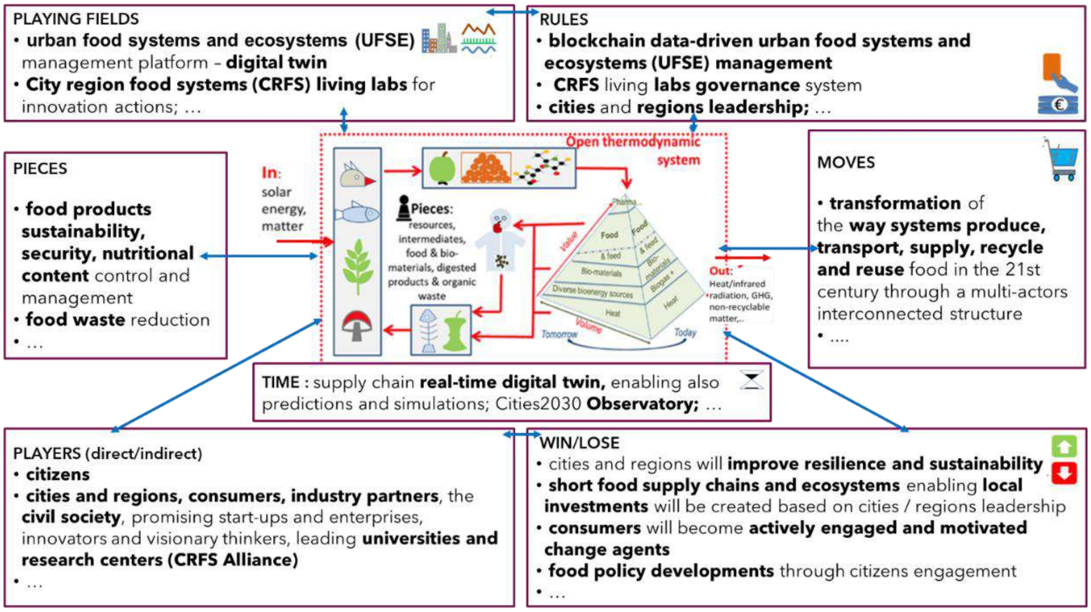
Source: our elaboration.

Lastly, the in-depth analysis was carried out on virtuous H2020 and Horizon Europe projects. These cases stand out for implementing new DG/AI - related solutions, targeting all FS building blocks and SRIA areas, and providing for sustainable territorial FS realization and integrated urban-rural development. The application of the model by de Vries *et al*. (2022) allows to show how adopted DG/AI innovations intervene in all system building blocks and activate synergic interconnections thus sustainably transforming the system.

Considering the example of CITIES2030, the model (Fig.4) describes the effects of the developed block-chain technology, the urban food systems and ecosystems (UFSE) digital twin platform and the city region food systems living labs on: multiple stakeholders' engagement (*players*), products/waste (*pieces*) management and supply chain (*moves*) renovation, transformation of the context (*playing field*) and governance settings (*rules*), enhancement of actors' predictive capacity (*time*) and balancing of FS outcomes (*win-lose*).

This results in a deeper understanding of DG/AI transformative capacity in the creation and functioning of a future-proof UFSE, based on a connected territorial structure, centered on citizens, and built on trust, with players belonging to the entire FS, and consumers playing as engaged motivated agents of change.

Figure 4 - Analyzing CITIES2030: DG/AI effects on FS building blocks and related interconnections



Source : our elaboration on de Vries *et al*., 2022.

CONCLUDING REMARKS

This work supports the understanding of how R&I projects related to DG/AI may contribute to FS sustainable transformation and territorial development.

The effective support of the holistic model by de Vries *et al*. (2022) is proved in enhancing the conceptualization of complex adaptive sustainable FS and rural-urban development processes. Food Science and Technology developments are interpreted as drivers of change in multiple FS building blocks, serving as leverage points for FS transition and territorial integration, according to the action – reaction effects generated by R&I projects concerning DG/AI integration.

The work shows how R&I projects implementation of DG/AI can generate concrete change in FS. Indeed, proposed DG/AI – related solutions appear effective in affecting all FS building blocks, by targeting and positively strengthening relevant interconnections. In addition, a major impulse to DG/AI sustainable FS applications is given by R&I actions providing a fertile breeding ground for a paradigm shift towards a new FS Data Economy.

The analysis highlights a limit in R&I projects showing an insufficient exploration of DG/AI integration criticalities and trade-offs. The latter appear still poorly identified and described, thus causing a risk of underestimation of the potential negative impacts on FS sustainability. Consequently, a need for further attention emerges.

The study highlights that DG/AI deserve a major attention by R&I programmes concerning sustainable FS. Regarding the implementation of the new SRIA, we confirm that most of R&I efforts are concentrated on the Thematic Areas “Change the way we CONNECT” – due to DG/AI role high consideration for consumers/citizens engagement, and “Change the way we GOVERN” – valuing big data transformative capability. Instead, the R&I Thematic Area “Change the way we EAT” is still underdeveloped and requires more investigation.

Some limitations of the study come from the small number of DG/AI - related R&I projects funded by the EU and adopting a FS approach, as well as from the scarce availability of results, considering that many of them are still ongoing.

For the future development of the study, a space for broadening the analysis will open, thanks to the increasing number of relevant projects and the finalisation of the identified ones. This will allow a deeper evaluation and measurement of the performance of evolving R&I programmes and actions in fostering DG/AI beneficial effects and impacts on higher FS sustainability. To that end, the expansion of the selection of R&I projects (higher number of cases) and the inclusion of projects at an advanced level of implementation (higher availability of data and results) will favor the application of quantitative and mixed methods, and the identification of tailored indicators and metrics.

As a result, we expect relevant insights will be provided for a comprehensive description and assessment of DG/AI transformative contribution for FS, as well as significant inputs will be given to the design of supportive R&I programmes and actions, to be implemented in a synergic coordination of public and private efforts.

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Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
Marina di Orosei (NU), 21-22 settembre 2023.
Articolo No. SIDEA2023_123

La valutazione economica dei soprassuoli di castagno attraverso un modello geo-spaziale: prima applicazione in Valle di Susa

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PAROLE CHIAVE
Utilizzazione forestale, costi di utilizzazione, prezzo di macchiatico, strumento di supporto decisionale, GIS

INTRODUZIONE E OBIETTIVI DELLO STUDIO

Il castagno rappresenta la prima specie forestale in Piemonte, occupando circa il 17% della superficie boschiva regionale (Gasparini et al. 2022). La sua ampia diffusione non corrisponde tuttavia a produzioni significative, riscontrandosi spesso una situazione di diffuso abbandono o sottoutilizzo, con la presenza di piccole nicchie dove il mercato riesce a svilupparsi grazie a sporadiche iniziative locali.

In molti contesti la mancata gestione non è da imputare ad uno scarso interesse, ma piuttosto ad una mancanza di informazioni sistematiche sulla disponibilità e sulle caratteristiche della risorsa (Berton et al. 2018). In particolare, non si conoscono le potenzialità di utilizzo dei boschi di castagno e molti territori che si presterebbero alle utilizzazioni non sono dotati di infrastrutture: aree che necessiterebbero di investimenti e finanziamenti da parte delle politiche di sviluppo (Bruzzese et al. 2023; 2020) sono lasciate così all'abbandono nonostante la presenza di una preziosa risorsa.

In questo contesto, è stato sviluppato un modello di stima del valore di macchiatico dei soprassuoli che tiene conto delle caratteristiche geo-spaziali e degli aspetti dendrometrici, con l'obiettivo di valutare l'economicità della gestione selvicolturale. Tale modello è stato validato sulla base di uno scenario di gestione che caratterizza i boschi di castagno della Valle di Susa, in provincia di Torino, ipotizzando di operare nelle condizioni di ordinarietà per quanto riguarda le caratteristiche del mercato, delle tecniche di utilizzazione e delle imprese presenti nell'area geografica oggetto di studio.

INQUADRAMENTO TEORICO

Il modello, implementato a partire da un precedente studio su scala più ridotta (Accastello et al. 2017), rientra nella categoria dei cosiddetti strumenti di supporto decisionale (*Decision Support Systems* - DSS) e si basa sull'impiego di sistemi informativi geografici (GIS) come molti dei DSS più recenti (Sacchelli et al. 2022; Sferlazza et al. 2021; Bernetti et al. 2013, Sacchelli et al. 2013). Partendo dagli input principali che contraddistinguono un'utilizzazione forestale, ovvero (i) caratteristiche geomorfologiche; (ii) dati economici relativi ai costi elementari delle utilizzazioni e al valore degli assortimenti ritraibili; (iii) dati dendrometrici dei popolamenti e (iv) caratteristiche dei cantieri forestali, il modello consente di stabilire l'attitudine di un'area ad essere sottoposta ad utilizzazione, determinando i costi unitari e giungendo alla stima del più probabile valore di macchiatico dei soprassuoli (Blanc et al. 2017).

In riferimento al caso di studio, sulla base delle condizioni di operatività ordinarie dei cantieri forestali in Val Susa, si sono individuate due metodologie per le fasi di concentramento e altrettante per quelle di esbosco. Queste, combinate tra loro, danno origine a quattro cantieri di utilizzazione:

- Cantiere A: concentramento manuale ed esbosco tramite trattore e rimorchio;

- Cantiere B: concentramento manuale ed esbosco a strascico;
- Cantiere C: concentramento a strascico ed esbosco con trattore e rimorchio;
- Cantiere D: concentramento a strascico ed esbosco a strascico.

Tali cantieri-tipo sono stati identificati per poter suddividere il territorio in aree omogenee e tener conto della sua variabilità geo-morfologica che richiede pertanto differenti operazioni di utilizzazione.

Attraverso l'uso di dati secondari (Hippoliti 1994) è stato poi possibile stabilire i parametri geo-spaziali dai quali dipende l'operatività e di conseguenza le rese delle operazioni di utilizzazione: (I) pendenza, (II) distanza di concentramento, (III) direzione di concentramento, (IV) distanza di esbosco.

A ciascun parametro è stato poi assegnato un indice basato sulla letteratura (Economie Forestière Suisse 2011; Hippoliti 1994), variabile tra 0 e 9, definito in relazione alla modalità di svolgimento delle operazioni, che permette di valutare, attraverso un modello additivo, i differenti livelli di realizzabilità delle operazioni di intervento, livelli che possono essere cartografati in un indice sintetico chiamato vocazionalità del territorio all'utilizzazione.

RISULTATI E DISCUSSIONE

La determinazione dell'indice di vocazionalità costituisce uno dei principali risultati del DSS, consentendo di identificare i soprassuoli dove possono essere effettuati convenientemente gli interventi di utilizzazione, i quantitativi di legname disponibile e i costi di utilizzazione.

Applicando il modello all'area di studio (pari a circa 2'000 ha), il 78% dei boschi di castagno è risultato tecnicamente utilizzabile tramite uno dei quattro cantieri ipotizzati. In Figura 1 è raffigurata la carta della disponibilità di legname ritraibile in un'area collocata all'imbocco della valle di Susa, presa ad esempio.

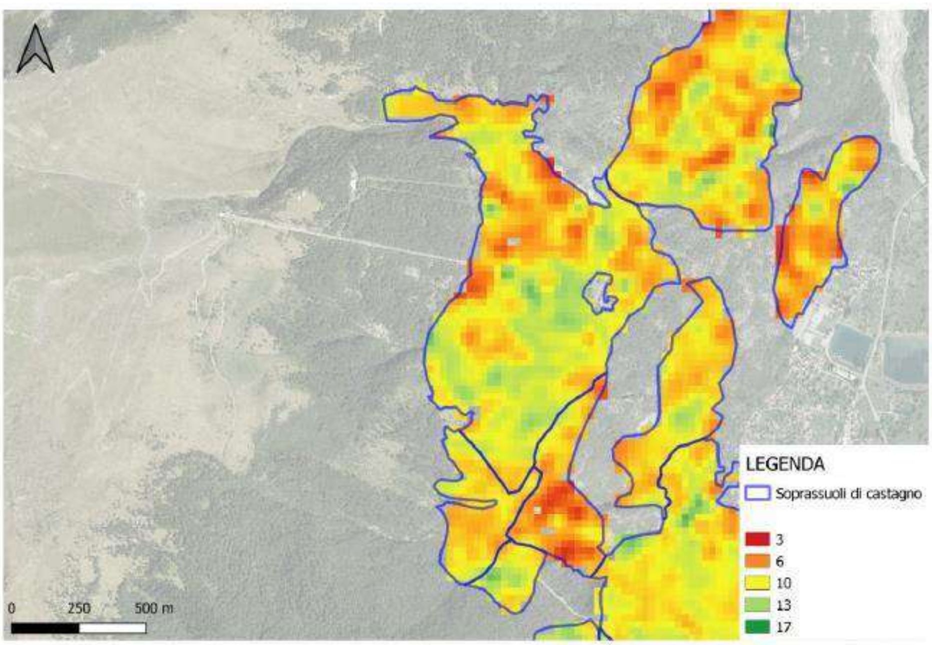

Figura 1 - Volume di legname ritraibile dal cantiere A (m^3/pixel). Ciascun pixel si riferisce ad una superficie di 25 m^2.

Si tratta di un risultato utile per approfondire le cause dell'abbandono di questi boschi. Infatti, si sono ottenuti risultati molto variabili, con costi di utilizzazione che spaziano da minimi di 30 a oltre 60 €/m 3 che rendono l'economicità delle utilizzazioni fortemente dipendente dai prezzi di mercato degli assortimenti. A tal proposito, in questa simulazione si è ipotizzato di vendere tutta la massa legnosa ricavata in un'unica forma, destinata all'assortimento da cippato per estrazione del tannino.

Tale scelta, adottata per semplificare il modello, rappresenta anche la condizione commerciale più diffusa per la regione Piemonte, dato che questo prodotto è l'unico che ha un mercato attivo a livello regionale, grazie alla presenza dello stabilimento LEDOGA Silvateam S.r.l., che monopolizza di fatto la domanda di legname di castagno. Il prezzo dell'assortimento da cippatura, ritirato localmente, varia da 45 a 70 €/m 3 (fine 2022) e considerando il valore minimo, le superfici a macchiatico positivo si attestano su circa 1'000 ha, ovvero il 50% dei soprassuoli considerati. In Figura 2 è raffigurata la carta dei prezzi di macchiatico ottenibili dall'area collocata all'imbocco della Val di Susa.

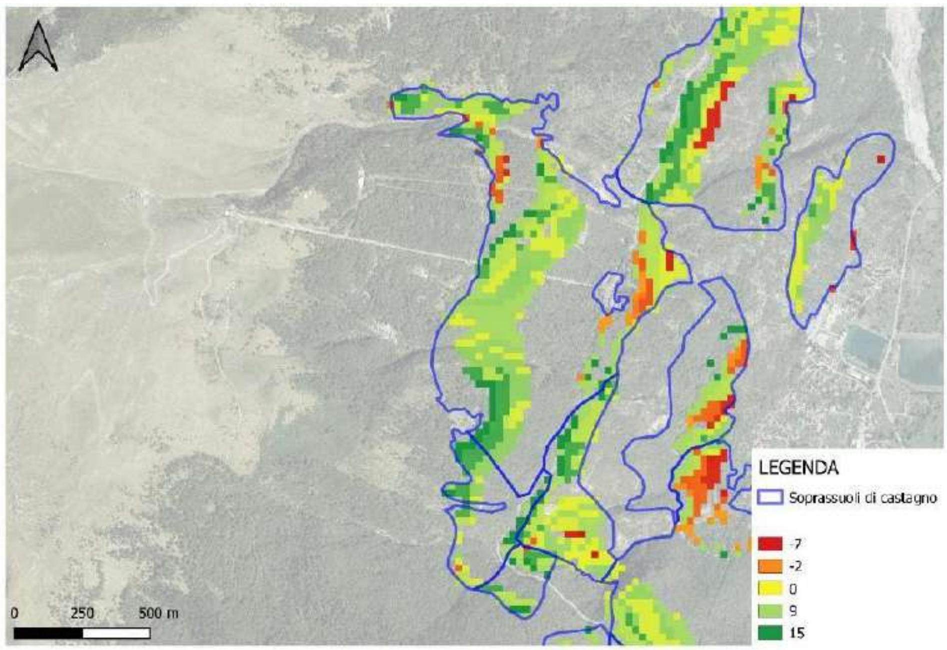

Figura 2 - Prezzi di macchiatico del cantiere A (€/m^3).

Data la forte dipendenza dei risultati dagli input impiegati, si è svolta poi un'indagine sulla sensitività dei prezzi di macchiatico ottenuti alle variazioni dei costi della manodopera. A tal proposito si sono ipotizzati tre livelli di costo, da 12 €/h a 18 €/h, considerando che per le piccole imprese che svolgono le operazioni di utilizzazioni, la manodopera è quasi sempre un fattore interno, da remunerare a costo opportunità. Il campo di variazione del costo totale evidenzia la forte sensitività del modello al costo della manodopera, in particolare per le aree con bassa produttività (Figura 3).

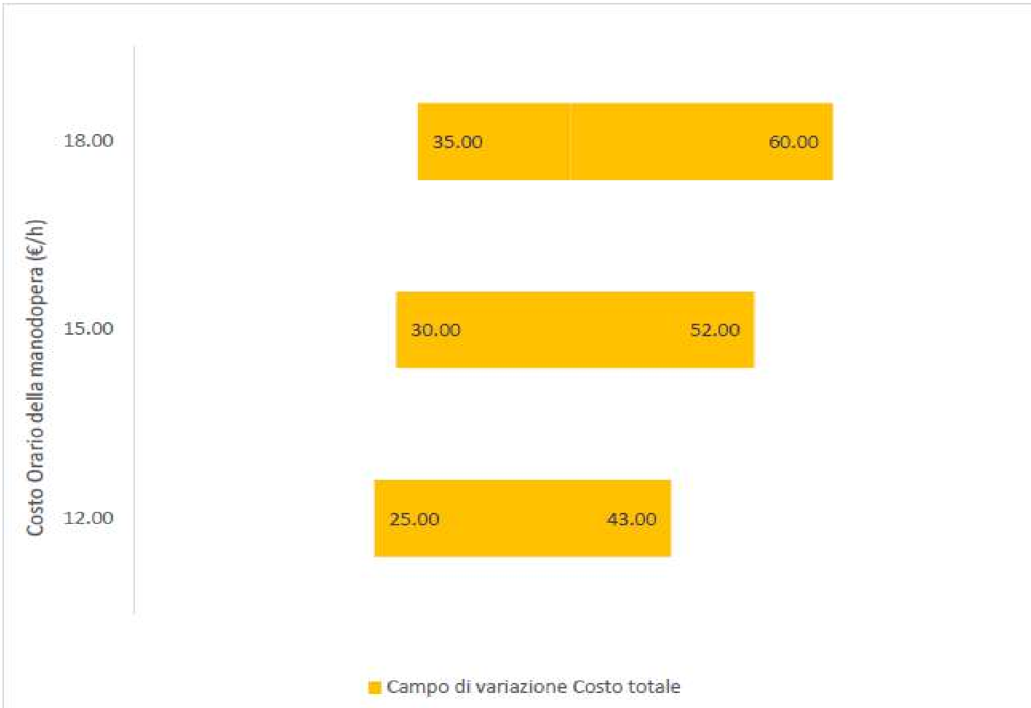

Figura 3 - Analisi di sensitività del costo unitario al variare di quello della manodopera (Cantiere A).

CONCLUSIONI E IMPLICAZIONI

Il modello sviluppato, pur in una versione preliminare e ancora contraddistinto da numerose semplificazioni, è in grado di fornire le informazioni tecnico-estimative essenziali per stimare la disponibilità della risorsa legnosa, valutando la sostenibilità economica dei cantieri di utilizzazione impiegabili nei diversi contesti territoriali indagati.

L'impiego di dati open-source garantisce l'utilizzo del DSS realizzato da parte degli utenti interessati fra cui possiamo includere i tecnici gestori dei boschi o i funzionari/consulenti dei decisori politici.

La qualità dei risultati ottenuti dipende tuttavia molto dall'aggiornamento degli input impiegati. A tal riguardo va segnalato che numerose informazioni e assunzioni del modello si basano su informazioni scarsamente aggiornate, come quelle relative alle rese tecniche di utilizzazione forestali ferme ai primi anni 2000 e quelle relative ai costi unitari e ai prezzi degli assortimenti, che hanno subito forti variazioni ultimamente in seguito agli eventi bellici in Ucraina.

Questi sono aspetti che potrebbero modificare largamente i risultati ottenuti e che inducono alla prudenza nella loro interpretazione. D'altra parte, lo stesso modello consente di implementare agevolmente le variazioni degli input e si presta come strumento di analisi per simulazioni di scenario di tipo "*what if*" che consentono di comprendere gli effetti delle variazioni macroeconomiche in atto.

Tra gli sviluppi futuri del modello sono comprese le possibili applicazioni ad altre specie, a tecniche di utilizzazione forestali innovative, con l'implementazione di vie di esbosco aeree e di meccanizzazione avanzata e l'applicazione a scale territoriali maggiori, per indagare le disponibilità della risorsa legnosa su scala regionale.

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Future scenarios for insect protein production in Europe by year 2035

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Keywords
Scenario analysis, Insect for food; insect for feed, sustainable food production

Objectives and methods
The objective of this study is to examine the future market opportunities for insect-derived products for food and feed in Europe using scenario analysis.
Over the past decade, the industry of insect for food and feed (IFF) has experienced global growth, primarily due to its environmental benefits. Insects require fewer resources, such as water, land, and feed, compared to traditional livestock, while still producing the same amount of nutritional proteins (Mancini et al., 2022).
In Europe, insects are primarily breed as a protein ingredient for fish feed and pet food, as these applications were permitted under European law until 2021. The current growth in the insect-feed market has generated increased interest in the use of insects as food in Europe (IPIFF, 2020). The European insect industry is projected to invest over 2.5 billion euros by the mid-2020s, with potential production reaching five million tonnes under the appropriate legislative framework (IPIFF, 2019).
According to the FAO, insects are consumed as part of the diet by at least two billion people worldwide. Several recent studies have focused on Western countries' consumer acceptance of edible insects as food (Altmann et al., 2022; Mancini et al., 2022; Onwezen et al., 2021; Skotnicka et al., 2021; Sogari et al., 2019).
Due to limited data on the edible insect market and a lack of consensus among reports, an exploratory and qualitative approach using scenario analysis was employed. Scenarios serve as a cognitive tool to utilize the qualitative information provided by expert assessments, allowing for envisioning rather than making simple data extrapolation (Bunn, D.W. Salo, 1993; Georgoff and Murdick, 1986; Van der Heijden, 1996). Scenarios help to bound uncertainty when data is scarce and are based on a causal model of how different driving forces or drivers are linked to influence future developments in a specified system. All types of scenario analysis must identify the driving forces, or drivers, and their trends, as well as define the framework to investigate the system's evolution over the given time horizon.
The involvement of stakeholders played a crucial role in the scenario analysis process. Stakeholder input was gathered through interviews and combined with desk research on the future development of the food sector and specifically the IFF industry. Fourteen experts were involved among relevant stakeholders of the IFF industry (producers, processors, and umbrella organisations), chosen among members of the research project SUSINCHAIN stakeholder platform. Partners of the SUSINCHAIN project were also invited. Additionally, two 'remarkable experts' – external to the industry and the Project consortium – were asked to participate to bring new and unexpected viewpoints into the scenario analysis.

Variables selection and the process of scenario building
As a first phase, we considered the outcomes of in-depth, semi-structured personal interviews with selected representatives from 19 European companies operating in the IFF industry as part of the SUSINCHAIN project. The focus was on identifying trends and uncertainties that could influence the IFF sector. The information from these interviews was combined with desk research on the food sector's future development and specifically the IFF industry. This analysis involved scientific and grey literature, datasets, reports, and other scenario analysis to study the historical development of the variables relevant to the IFF industry.

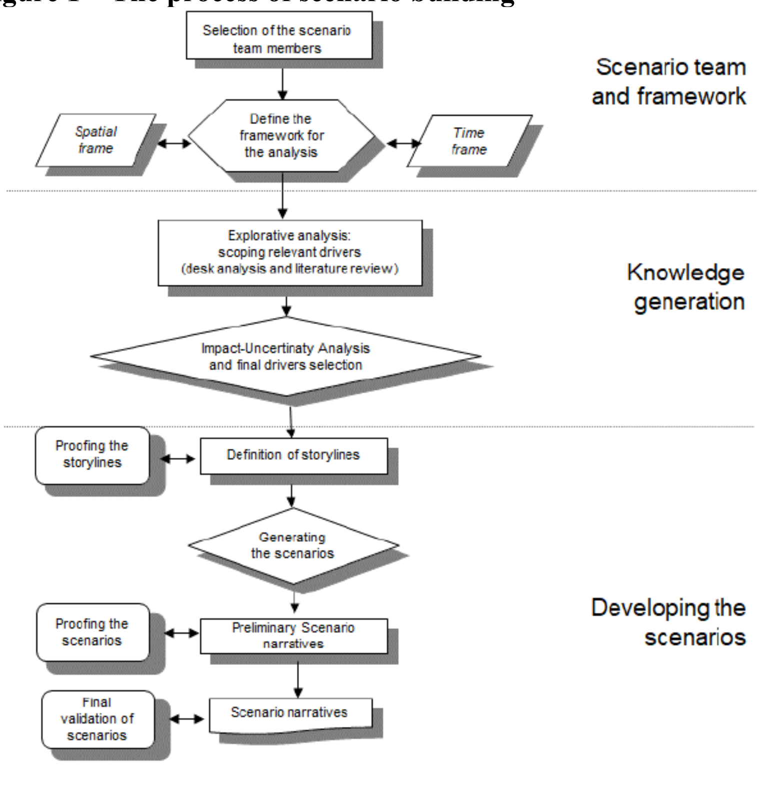
The analysis mainly concentrated on two categories of drivers: first, the exogenous global drivers that could impact the development of the IFF business, which included potential trends and uncertainties related to the EU agri-food sector. Second, sector-specific drivers for the IFF industry, such as consumer attitudes towards insects for food and feed, and policy and regulatory issues.
The next step involved selecting the final list of ten drivers using an online survey administered to experts chosen from the SUSINCHAIN project. The experts were asked to assess the preliminary drivers based on a 7-point Likert scale, considering each driver's expected impact and uncertainty for the future development of the IFF sector. The collected data were then used for an Impact-Uncertainty Analysis (IUA), an adaptation of the Importance-Performance analysis (IPA) introduced by Martilla and James (1977). The drivers were classified into two main groups: the exogenous global drivers that could impact the IFF business development, including relevant trends and uncertainties related to the EU agri-food sector, and the sector-specific drivers for IFF, such as consumer attitudes towards insects for food and feed, and policy and regulatory issues. The final driver selection according to IUA results was made taking into account the drivers that were ranked above average for both uncertainty and impact for the future development of the IFF business. The final list of selected drivers is shown in Table 1.

Table 1: List of the selected drivers for the development of the scenarios

Exogenous drivers	Sector specific drivers
Societal environmental and ethical concerns	Scaling up of EU insect industry
Food preferences	Competitiveness of insect proteins vs substitutes
Market globalisation	Insect food / feed safety
Political climate towards sustainable food systems in EU	Access to finance for the EU insect industry
Climate change control	EU policy and regulatory framework

Each of the ten selected driver was associated with several states, defined to cover all possible mutually exclusive outcomes between the two extremes. For each driver state, a concise definition and a brief description were provided.
A synthesis of the scenario process is described in Figure 1.

Figure 1 – The process of scenario building



In total, eight scenarios were developed, including two highly favorable, one favorable, three partially favorable, and two strongly unfavorable scenarios for the development of the IFF sector. Brief descriptions of these scenarios are provided in the section below.

Results

Highly favorable scenarios for the IFF sector

Scenario 1: Super Green Europe

The European identity exhibits strength and aligns with the western inclination towards a sustainable and equitable society, and the successful implementation of the Farm to Fork (F2F) policy is indicative of this. Consumer preferences towards insects are favourable, and the IFF sector demonstrates high competitiveness and innovation, attracting fresh investments and businesses. A favourable economic environment enables companies (mainly SMEs) in the IFF sector to flourish and access credit and public financial support, either individually or in integrated industrial ecosystems.

Scenario 2: Green Fortress EU

In a world where cultural differences are becoming more contentious, EU countries discover the circumstances that reignite their political motivation to remain united. A shared and robust dedication to green values becomes deeply ingrained in people's consciousness, nurturing a European identity as guardians of the planet. In this evolving landscape, although not as established as the conventional food sector, the IFF sector emerges as an appealing investment opportunity. The IFF sector is experiencing rapid growth, driven by open innovation and the implementation of common standards that enhance transparency in the supply chain.

Favorable scenario for the IFF sector

Scenario 3: True Cost Accounting

The successful implementation of global true-cost accounting (TCA) has resulted in the establishment of sustainable and healthy diets. This achievement is not solely attributed to a shift in mindsets but rather to the regulatory framework and government mandates that enforce a change in behavior. The supply chain of the insect-for-food (IFF) industry depends on either large companies or small and medium enterprises (SMEs) that are integrated into ecosystems and adhere to stringent standards of production and sustainability, encompassing environmental, economic, and social aspects.

Partly favorable scenarios for the IFF sector

Scenario 4: Grey Fortress EU

Ethical and environmental concerns within society vary across the EU due to regional and country-specific attitudes, as well as disparities in income distribution among EU citizens. Consequently, the EU food market is influenced by diverse consumer preferences, resulting in the coexistence of expensive, high-quality food and affordable, convenient food options in households. The stringent and expensive safety standards, coupled with the requirement for sufficient economies of scale, make it financially feasible for only a limited number of large insect companies to operate. As a consequence, the IFF market is predominantly dominated by a small group of major companies.

Scenario 5: Get big or get out

The food system in the EU continues to heavily rely on a global food supply chain and international trade, creating significant regional and national interdependencies. The unregulated growth of the market, driven by capitalist motives and lacking environmental and ethical considerations, leads to an abundance of inexpensive, nutritionally poor, and unhealthy food. Insufficient production standards further contribute to this issue. The absence of strict regulations allows a small number of large insect-for-food (IFF) companies to emerge in the market, often resorting to greenwashing and making false claims. This situation also opens up the possibility of speculation in the financial and commodity markets within the IFF sector. As a consequence, existing small and medium-sized enterprises (SMEs) either exit the market or are acquired by larger companies.

Scenario 6: Each Country for Itself

Nationalistic agendas within the EU have caused a loss of cohesion and leadership, resulting in varying agricultural policies across member countries. This has led to a patchwork regulatory framework for the insect-for-food (IFF) sector, with national rules prevailing over common EU regulations. Countries with sustainable food systems enforce strict safety standards for IFF products, while others have less rigorous regulations. Only a few countries with market size, resources, and environmental concerns have developed a domestic IFF sector. Thriving in larger, wealthier nations prioritizing food security, the IFF sector faces challenges in countries focusing on price-oriented imports. Limited support policies, financial resources, and unfavorable market conditions may lead to the collapse of the IFF sector in some countries.

Unfavorable scenarios for the IFF sector

Scenario 7: Off-shore production

Insect production in Europe becomes very difficult because of the lack of uniform EU regulations and a puzzle of national laws leading to regulatory overload. IFF supply is completely delocalised out of Europe, which relies heavily on overseas operations and imports. Cultural and safety-related concerns reduce the interest in insects in the diet, and the insects-as-food sector does not grow beyond its niche. The IFF sector stays embryonic because it grows elsewhere but in Europe.

Scenario 8: Race to the Bottom

The production of insects in Europe faces significant challenges due to the absence of standardized EU regulations and a complex framework of national laws, resulting in regulatory overload. As a consequence, the supply of insect-for-food (IFF) products is completely relocated outside of Europe, heavily relying on operations and imports from overseas. Cultural and safety-related apprehensions contribute to a reduced interest in incorporating insects into diets, preventing the insects-as-food sector from expanding beyond its niche. Consequently, the IFF sector remains in its early stages of development, with growth occurring primarily outside of Europe rather than within the continent.

Discussion

The results of the scenario analysis shows that two key factors that might affect the future development of the IFF sector are a strong policy capacity and a positive societal attitude towards sustainability, as in scenarios "Green Fortress Europe" and "Super Green Europe". Conversely, an unfavourable scenario ("Off-shore production") occurs when both policy capacity and societal attitude towards sustainability are low. Intermediate policy capacity can lead to a range of outcomes, from unfavourable scenarios like the "Race to the Bottom" to favourable ones like "True Cost Accounting" and "Each Country for Itself.", according to hypotheses on the societal attitude for sustainability. A positive societal attitude can compensate for moderate policy capacity and support the IFF sector's development. However, the sector's success relies on robust policy support.

Compared to other important countries like the US and Canada, the EU has recently approved using insects as animal feed. In 2021, the EU authorized the use of insect PAPs in poultry and pig feed. The future of sustainable alternative feedstuffs in European animal agriculture remains uncertain due to regulatory complexities.

The IFF sector could potentially produce up to 5 million tonnes per year with the right legislative framework, but without legislative changes, growth will be limited to around 2 million tonnes by 2030. To achieve the EU's long-term sustainability goals, policymakers need to make significant changes to the current regulatory framework, especially regarding the food system. Insect-based protein consumption is more environmentally beneficial than traditional sources, so updating legislative texts to support the use of insects in food and feed is recommended.

A crucial area of policy intervention is ensuring a clear regulatory framework to support the IFF sector's scaling-up process. All scenarios, even seemingly favourable ones, anticipate turbulent times that could disrupt the sector's development. Policymakers should focus on clear regulations for mergers and acquisitions, the possibility of start-ups and SMEs being acquired by larger companies, and ensuring EU policy supports the IFF sector against international competition.

Clear and uniform regulations for novel food and increased support for educational campaigns are also essential to communicate the importance of insect-based protein consumption for sustainability and address food neophobia.

Insects as novel food or ingredients have been introduced since 1997 under Regulation (EC) No. 258/97. From 1 January 2018, edible insects fall under the 'new' EU novel foods legislation – Regulation (EU) 2015/2283. Whole edible insects and their derived ingredients can be legally placed on the EU market, but they require pre-market authorizations involving the European Commission and EFSA.
Article 35.2 of Regulation (EU) 2015/2283 provides transitional measures allowing products already commercialized in an EU Member State before 1 January 2018 to remain on the market under specific conditions. However, some EU Member States reject this advantage, leading to non-compliance with the regulation and creating differentiated treatments across the EU.
More than 20 novel food applications for insect food products have been submitted to the EU, and the authorization process is ongoing.
Consumer education is crucial in all scenarios. Educational campaigns at the institutional and marketing levels can boost demand. Establishing EU safety standards and a common label would be desirable but might not be feasible in all scenarios.
Consumer acceptance of insects as food is influenced by factors like food neophobia, disgust, familiarity, and differences between processed and unprocessed insects. Addressing concerns about flavor, aroma, structure, and health safety is essential for promoting consumer acceptance.
The circular economy presents a resilient strategy for the IFF sector, especially in treating waste, with insects like the Black Soldier Fly being a viable solution.
Fostering cooperation and industrial ecosystems with open innovation and collective IPR protection can help SMEs grow together and become more resilient to shocks in most scenarios. Policymakers play a crucial role in facilitating the formation of industrial ecosystems in the IFF industry, attracting finance and appropriate funding.

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DRIVING BETTER CHOICES: UNDERSTANDING THE DECISION-MAKING THROUGH THE LENSES OF HEALTH, SUSTAINABILITY, NATURALNESS, AND PRICE IN ATYPICAL SITUATIONS.

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Keywords
Consumer behaviour; Choice experiment; Dietary habits; Latent class analysis.

INTRODUCTION

The global food system is at the centre of a widespread debate due to its unsustainable and unhealthy consumption patterns (Herrero et al., 2023; Van Loo et al., 2021). In terms of sustainability, the literature emphasizes the harmful impacts arising from the daily production of certain foods (González et al., 2020). Chemicals from intensive livestock farming and agriculture, heavily reliant on pesticides and fertilizers, have caused significant pollution of arable land worldwide (Hassaan et al., 2020). Moreover, the processing and transportation stages within the food system generate substantial greenhouse gas emissions, resulting in considerable environmental damage (Borsellino et al., 2020). These aspects also have health implications, as concerns arise about chemicals in food (De-la-Torre, 2020). Furthermore, the modern-day consumption system poses health risks due to the nutritional composition of meals (Cena et al., 2020). Obesity and cardiovascular issues resulting from imbalanced diets are major causes of death worldwide (Koene et al., 2016). Moreover, certain non-communicable diseases, including some types of cancer, can be attributed to dietary factors (Chen et al., 2020; Mayne et al., 2016).

As a result, researchers and policymakers face a significant challenge in understanding the factors that can trigger changes in dietary habits. Despite proposed solutions, the expected changes have been slow to materialize, often hindered by institutional and consumer barriers (Goshua et al., 2021; Vermeulen et al., 2020). Consumer habit change is a critical aspect of this process, as consumers often adhere to their familiar consumption patterns and resist change (Wood et al., 2016; Sabaté et al., 2014). Even choices made under different circumstances from the usual ones do not always lead to more virtuous, sustainable, and healthy product selections. In fact, instances exist in the literature where, despite creating favourable situational conditions, changes have occurred in an undesired direction.

Hence, it is crucial to investigate consumer behavior in contexts that deviate from the norm to understand how to encourage consumers to make more virtuous choices. Identifying triggers for behavior change is essential to promote the sales of virtuous products that differ from the norm. In recent years, there has been an increasing emphasis on the widely recognized connection between health and nutrition. The goal is to prevent non-communicable diseases such as cancer and cardiovascular problems by focusing on product healthiness (Scapin et al., 2021; Van Loo et al., 2021; Viana et al., 2021).

Simultaneously, consumers are increasingly adopting sustainable behaviors driven by environmental concerns, with more individuals prioritizing the well-being of future generations and the environment. Interest in eco-friendly products has surged as awareness of their environmental impact grows. While awareness of this issue has indeed increased, only a portion of consumers has made partial changes to their habits (Aprile et al., 2022; Sigurdsson et al., 2022; Kronthal-Sacco et al., 2019).

Furthermore, dietary choices are increasingly influenced by a preference for naturalness. Consumers gravitate towards foods produced without additives and grown using traditional methods. The absence of additives is perceived by consumers as a bonus, ensuring genuine and "clean" products. The review conducted by Roman et al. (2017) concluded that the most common characteristics shared by products defined as "natural" are the origin of raw materials, the technology used, and the properties of the final product. These product aspects play a decisive role in consumer choices (Dominick et al., 2018; Syrengelas et al., 2018; Liu et al., 2017).

Despite the growing interest among consumers in healthier, more sustainable, and natural products, current food prices continue to significantly influence consumer choices, especially during periods of inflation. Economic factors directly impact consumer behavior, and the affordability of food products greatly influences decision-making. As prices rise, consumers may need to make trade-offs and compromise on their preferences for healthier and more sustainable options. The accessibility and affordability of nutritious, eco-friendly, and natural products are crucial considerations in developing a food system that supports positive dietary changes (Granato et al., 2022; Yao et al., 2020).

While healthiness, sustainability, and naturalness are recognized as drivers of modern dietary preferences, their interplay has been insufficiently explored in the literature. It remains unclear whether these aspects harmoniously coexist or if conflicts exist between them. Gaining a deep understanding of how consumers consider these factors when making "unusual" choices can facilitate an increase in virtuous choices.

Given the diversity of consumer choices, it is intriguing to investigate whether different consumer groups exhibit varying trade-offs. Factors such as age, gender, income, and cultural background can influence individual preferences and priorities regarding health, sustainability, naturalness, and price. Conducting comprehensive research that takes into account these variations can provide valuable insights into the complex dynamics of consumer decision-making.

METHODOLOGY

To delve into the interaction between healthiness, sustainability, naturalness, and price as influences on consumer choices in an unconventional context, we embarked on an investigation involving a representative sample of 600 individuals from both Italy and Denmark. This choice of comparison was motivated by the significant divergence in dietary patterns between these two countries (Contini et al., 2015). Our objective was twofold: firstly, to ascertain whether the attributes capable of stimulating transformative changes in consumption habits are indeed influenced by geographical origin, an idea also previously explored by Ghvanidze et al. (2017); secondly, to uncover whether alternative determinants, distinct from geographical location, exert a more significant influence.

The core of our investigation was based on a discrete choice experiment. Within this experiment, participants were tasked with a series of decisions, each involving the selection between two distinct variants of yogurt. Notably, we deliberately omitted the 'not purchase' option from the choice set, thereby simulating a scenario in which consumers are compelled to make a purchase when their usual product is unavailable. This configuration allowed us to shed light on the intricate trade-offs consumers make when faced with different options from their usual ones.

After collecting the data, we employed the latent class analysis technique. This methodology enabled us to identify discrete clusters within the sampled population, each characterized by shared preferences. Building on this division, we profiled these consumer groups, utilizing psychographic, behavioral, and sociodemographic attributes of the participants.

RESULTS AND DISCUSSIONS

We applied latent class analysis to process our data. The sample, consisting of 300 Italians and 300 Danes, was divided into four distinct classes based on key statistical indicators (BIC and R2). The initial class encompasses slightly less than half of the total sample and solely focuses on yogurt price. The second and third classes share striking similarities, both reflecting a positive affinity for attributes related to naturalness, sustainability, and health. The differentiation lies in the second class, which demonstrates a sensitivity to price, whereas the third class remains indifferent to this aspect. In contrast, the fourth class unveils a clear trade-off, with the health attribute taking centre stage. Notably, all other attributes register negative utility for consumers within this category, underscoring their readiness to prioritize fat-free yogurt over other considerations.

Our profiling efforts have revealed noteworthy differentiations across these classes in terms of a range of psychographic, sociodemographic, and behavioral characteristics. On a socio-behavioral level, the classes differentiate based on factors such as country of origin, frequency of yogurt consumption, dietary preferences, and engagement in physical activity. In the realm of psychographic variables, factors such as price awareness, universalism, interest in wholesome dietary choices, adoption of sustainable consumption practices, yogurt consumption habits, attitudes, and available monetary resources emerged as significant differentiators. Furthermore, our questionnaire encompassed inquiries soliciting consumer opinions on the extent of responsibility attributed to producers, consumers, retailers, farmers, and regulatory bodies within the food supply chain concerning sustainability, healthfulness, naturalness, and pricing. Many of these responsibility-related variables also serve to delineate the four classes. Lastly, the clusters display differentiation based on the attributes of yogurt typically purchased, encompassing facets like fat content, jar weight, inclusion of fruit, and organic certification.

The prevailing consumption patterns pose substantial challenges, encompassing both sustainability and health considerations. Our research findings offer insights into the critical imperative of understanding the catalysts driving shifts in dietary habits and the nuanced exploration of consumer behaviors across diverse contexts. These insights serve as a foundation for the formulation of effective policies and the development of products tailored to meet evolving consumer preferences.

Given the intricate interplay among healthiness, sustainability, naturalness, and pricing, the need for ongoing research remains apparent, including our own endeavors, to disentangle the intricate relationships and trade-offs existing between these pivotal factors. This dynamic landscape underscores the necessity for continuous inquiry to unravel the complex tapestry of consumer preferences, as well as the intricate decision-making processes that underlie these choices.

Armed with a heightened understanding of consumer preferences and the intricate decision-making processes at play, policymakers and producers are well-equipped to craft targeted strategies aimed at fostering healthier, more sustainable, and natural food choices, while judiciously considering the economic landscape faced by consumers. By integrating these research-driven insights into their decision-making, stakeholders can collaboratively shape an environment that encourages positive shifts in dietary behaviors and aligns with the evolving aspirations of consumers.

In this context, our research serves as a stepping stone towards a more profound comprehension of the factors influencing consumer choices, providing a roadmap for the development of forward-thinking policies and market-responsive products. As the food landscape continues to evolve, the integration of these findings into actionable strategies can lead to a more harmonious and sustainable relationship between consumer preferences, industry practices, and broader societal goals.

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What Europeans Want: Insights on Citizens and Research Debate on Nutri-Score

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Key-words
Topic Modelling; Twitter analysis; Systematic Literature Review; Nutri-Score; GIs

Introduction

Every year, non-communicable diseases (NCDs), such as obesity, cancer, or cardiovascular diseases, are responsible of 74% of deaths globally. Modifiable behaviours, such as tobacco use, physical inactivity, unhealthy diet, and the harmful use of alcohol, all increase the risk of NCDs (World Health Organization 2021). Thus, to reduce and prevent NCDs, Front-Of-Pack labels (FOPLs) have been widely used both at the global and European levels to improve the nutritional habits of the population. These labels might help consumers to identify the overall nutritional quality of food, thus guiding them towards healthier food, and encourage food industries to reformulate and improve their products (Kanter et al. 2018).

At the European level, the Farm to Fork strategy stresses the need to make the use of FOP nutritional labelling mandatory on pre-packed foods, using harmonized standards across the EU. The Nutri-Score (NS), a five-step colour-graded nutrition label, is the most promising FOP candidate to be used.

The NS has already been adopted in several EU countries on a voluntary basis. However, the possibility envisaged by the European Commission to extend its use to the whole EU stimulated some debate, highlighting contrasting positions between different Member States (Fialon et al. 2022).

In light of these discussions, therefore, it is important to investigate what are the main issues raised by the European society about the possible implementation of the NS at the EU level. At the same time, it is important to understand whether, and to what extent, these issues are considered and/or resolved by the current scientific literature on NS. A proper and solid policy intervention on the NS issue should in fact rely on robust scientific evidence, which consider and addresses the points and criticisms raised by consumers and the other actors involved in the policy debate. In this way, it will be possible to solve legitimate doubts of the public opinion, and to issue a legislation reaching a larger agreement between different stances.

The objective of this work is therefore twofold. On the one hand, we aim at identifying the major themes discussed within the public debate on NS in different EU countries. On the other hand, we aim at assessing to what extent the scientific literature on NS addressed these themes, to understand whether some important issue (for the political and public opinion) remains to be adequately investigated.

Data and methods

To address the objectives detailed above, the analysis considered both scientific material and tweets posted by Twitter users, the latter being used to investigate the public debate on NS. To do this, it was necessary to use consistent and homogeneous methods to retrieve the initial material (tweets and scientific articles) and to extract the content of the documents.

Scientific documents were retrieved from Scopus and Web of Science, using a basic search string (Nutriscore OR Nutri-Score) and limiting the search to articles written in English. Following the PRISMA guidelines to screen the literature, we obtained 150 original documents. Similarly, we downloaded tweets including the words “Nutriscore” or “Nutri-Score” from January 2017 to January 2023 (only few tweets dealt with NS before 2017). The tweets analysis was limited to France, Germany, Italy, and Spain, namely the countries with a sufficiently high number of tweets.

To analyse the content of tweets and scientific literature we choose to resort to Structural Topic Modelling (STM), a quantitative text analysis technique that allows to retrieve a set of topics from a collection of textual documents (Roberts et al. 2013). Specifically, STM was performed separately on tweets from the four considered countries and on the abstracts of the scientific articles. In addition to assure the use of a consistent method of analysis for both types of material (Twitter and scientific), STM, like other text analysis techniques, has the advantage of allowing researchers to deal with a large amount of textual data, which in our case is especially useful for the analysis of tweets.

Specifically, relying on a generative model of text, STM provides some latent structures (the topics) that give information about the content of a collection of documents. The topics are returned as frequency distributions of words and each document is considered a mixture of different topics. The STM also allows to model the prevalence of the topics in the collection of documents according to some covariates, a feature that we used to explore how the relevance of the different topics varied over time in the Twitter discourse.

STM allowed us to retrieve five sets of topics, one for each corpus of documents (four for country-specific tweets, one for scientific abstracts). While the optimal number of topics for each model was selected according to a criterion based on exclusivity and semantic coherence (a standard practice in the field of topic modelling), the topics’ names were assigned based on the inspection of some exemplary documents. Specifically, we looked at the content of documents containing a very high share (above 70%) of a specific topic, and we assigned the name to that topic accordingly.

The four topics from the country-specific tweets were compared to identify similarities and differences, also referring to their time trends. Afterwards, these were aggregated in macro-categories of broad themes, and topics emerging from the scientific literature were compared to these categories to address the second objective of our work.

Results and discussion

In Figure 1 we report the final summary of the topics identified within the public debate and in the scientific literature. The country-specific debates show both similarities and peculiarities. Overall, Twitter users generally discussed about “NS adoption” in all countries, mostly in the first part of the analysed period. These discussions were mostly about updates in countries and firms adopting the NS as a system to provide nutritional information on food. Another recurrent theme is "Politics", which contains political flavoured discussions. These debates have, as expected, a strong national component, addressing specific issues perceived as important at the country level. In Italy, the country where NS is facing the fiercest opposition, this FOPL recursively enters the political debate, most often stimulating critiques against EU institutions or NS supporters. In Spain, most of the criticisms on the topic were directed against the government, whose behaviour and position on the NS issue was not always clear and stable. Critiques to the government also characterised the German discussion, even if in this case Twitter users seemed to press for an adoption of the NS rather than for its ban.

As can be observed from Figure 1, nor "NS adoption" nor "Politics" have any counterpart among the scientific topics. This, however, is not unexpected, since these themes can be considered as rather descriptive of temporary conditions and events, which can hardly be the object of scientific research.

While in France political controversies seem to be almost absent, French users tended to highlight the "Positive aspects" of NS. These, which are mostly related to increased information and improvement of transparency in the food system, are also acknowledged, to some extent, in Germany and Spain, while they are usually disregarded by Italian users.

In contrast to the previous themes, this group of topics is flanked by a quite high number of topics from the scientific literature. In this respect, scientific studies spent considerable effort in investigating the effects of NS labelling at different levels. Most of the research agree that NS is actually one of the easiest to understand FOPL (Pettigrew et al. 2023). This appears to have a positive effect on the healthiness of the actual choices made by customers (Finkelstein et al. 2019) and, ultimately, on several medical aspects and diseases (Donat-Vargas et al. 2021).

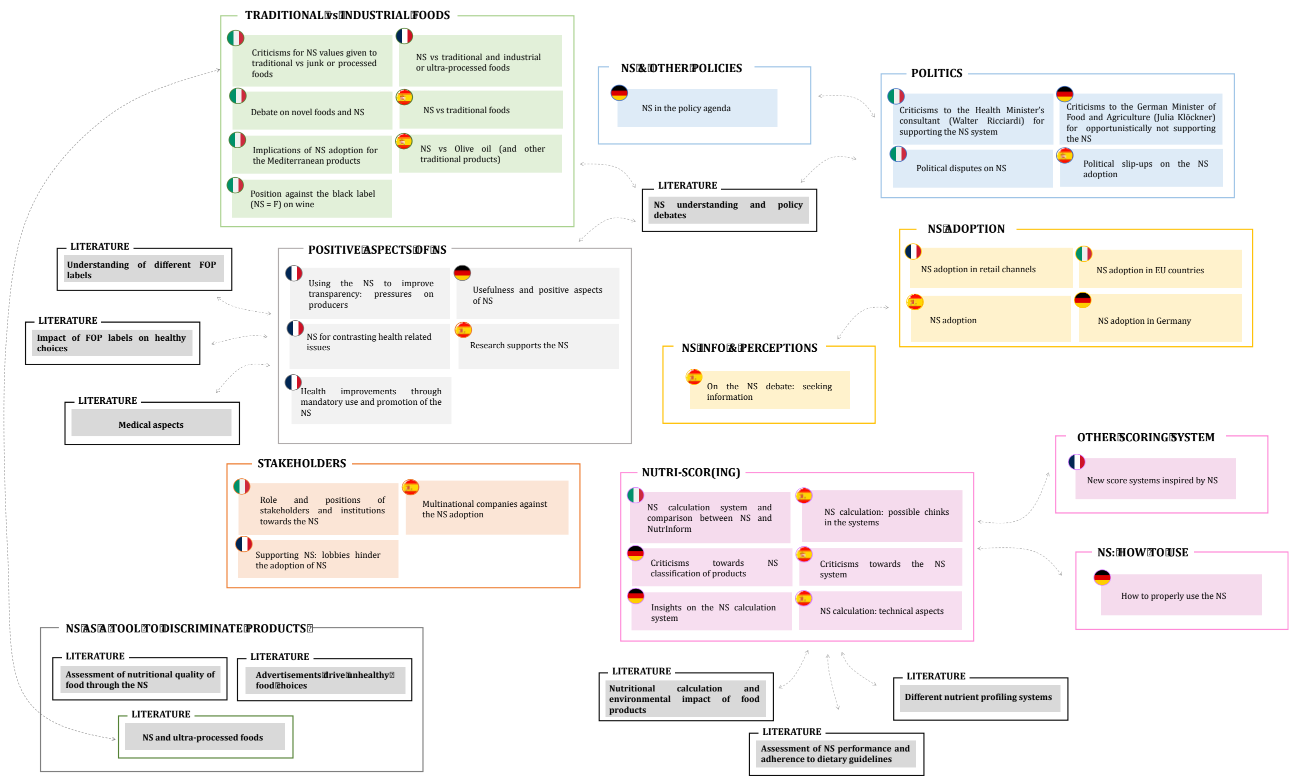
Despite the benefits highlighted by the literature, some issues continue to be in place according to the public debate. Especially users from Germany and Spain mention some potential flaws in the NS algorithm (or in its interpretation by consumers) that seem not to be aimed at invalidating the NS system as a whole, but that might call for some technical (or communication) improvements. It is the case, for example, of issues related to the size of the consumed portion or to the role of a single ingredient in a whole meal. These topics, which we grouped in the "Nutri(scoring)" theme, are somewhat related to criticisms that Italian users make to the NS algorithm to support "Nutrinform", the FOPL supported by the Italian governments in official EU debates.

These technical critiques, which in some cases denote a good knowledge of the topic, might merit some attention from the scientific world. Actually, there is some literature focusing on the NS algorithm and its evaluation, either comparing it with other nutritional scoring systems or evaluating its performance with respect to specific dietary guidelines. A couple of papers also propose some improvements to the NS algorithm, to include potential positive nutritionally important ingredients. However, specific aspects such as those mentioned above seem to be sill out of the scope of current scientific papers.

Despite purely technical aspects have certainly some space in the public discussion, a more evident and stronger criticism to NS comes in relation to "Traditional vs industrial foods". In Mediterranean countries (also in France this kind of discussion is gaining importance during the last years) it is strongly noticed the contrast between NS and typical or traditional products. It is especially the case of cheese and cured meat products (many of which are labelled as geographical indications, e.g., Parmigiano Reggiano PDO, Prosciutto di Parma PDO, Roquefort PDO), which would receive, if the NS is mandatorily applied, a negative nutritional score. Often, users compare this scoring with the (positive) one that would be assigned to some products commonly perceived as unhealthy (e.g., ultra-processed foods), to highlight the NS inconsistency. In Italy, this debate can be considered particularly passionate, embracing several aspects connected to a broader conflict between national traditions and foreign and innovative food (e.g., insects, lab meat).

Despite the importance of this theme within the societal debate on NS (it accounts for 42.5% of the content of Italian tweets, 28.8% of French tweets, and 15.4% of Spanish tweets), scientific literature seems to have, so far, quite ignored the issue. There are actually some papers jointly investigating NS and ultra-processed products, but they simply confirm that NS works well for identifying the nutritional quality of a product, not its degree of processing (Sanchez-Siles et al. 2022). An aspect that is completely missing, for example, is the investigation of the actual impacts of NS on the perception and consumption of traditional products . In this respect, such a strand of literature might investigate whether the claiming of citizens and stakeholders fearing for the negative impact of this label on the local economy are actually well-founded. This is particularly important, considering that the Farm to Fork strategy seems to be at odds with the EU GI policy. Within the Geographical Indication policy, the PDO and PGI products are protected for their quality attributes, which are strictly linked to their geographical origin and traditional know-how. However, the EU adoption of the Nutri-Score could damage these products.

Figure 1 - Comparison between the topics emerged from the scientific literature (grey) and tweets on the NS label



Conclusion

A good amount of scientific research proves that NS promotes healthier food choices and that it performs better in communicating nutritional information than other FOPLs. However, within the public debate, some critical issues are evident that might hinder its effectiveness if not adequately addressed. These issues, such as the presence of some inconsistencies in the algorithm or the negative effects of NS on specific products, are only barely addressed by the scientific literature so far.

In this respect, scientific research has an important role to play. On the one hand, a more in-depth study of relevant issues raised by the society might lead to discover that some of the concerns are actually unfounded. These results, if properly communicated, can serve to alleviate the doubts of consumers and stakeholders. On the other hand, if some issues were actually confirmed as relevant, scientific research will contribute to improve the NS tool. Such improvements were already made in the past after some concerns for the classification of olive oil and nuts were brought to the attention by the public debate.

This double function of the research has a clear potential of supporting policy decisions, a role that is particularly important in a moment when the EU Commission is setting the stage for the adoption of a common and mandatory nutritional label. Having a robust scientific basis to be used to alleviate the reasonable societal concerns and to confront oppositions by interested parties would be important to take a more solid final legislative decision, whichever it will be.

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Nudge Theory, food, and the climate crisis: how behavioral economics can support sustainable choices

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Nudge theory, consumer behavior, meat, labelling, carbon footprint, food preferences

INTRODUCTION

Over the past years, there has been a global imperative to reduce CO_2 emissions due to the increasingly extreme and dangerous consequences of climate change, which pose a threat to human existence itself (IPCC, 2023). One of the major contributors to global CO_2 emissions is food production, particularly the impacts associated with meat production. Estimates suggest that food production is responsible for approximately one-third of global greenhouse gas emissions, with 71% attributed to agriculture and land use choices (Crippa et al., 2021). A comparative study conducted in 2020 examined four diet types: omnivorous, pescetarian, vegetarian, and vegan. The findings highlighted that the omnivorous diet, which includes high consumption of animal products, has the highest environmental impacts in terms of greenhouse gas emissions, energy demand, and land occupation. On the other hand, the vegan diet, which involves higher consumption of organically produced foods using environmentally friendly practices, has the lowest environmental impact (Rabès et al., 2020). Numerous studies, such as Chai et al. (2019) and Rosi et al. (2017), support these findings.

Livestock production is a particularly impactful factor within an omnivorous diet. According to a 2006 report by the Food and Agriculture Organization of the United Nations (FAO), livestock production accounts for 18% of total greenhouse gas emissions (Steinfeld et al., 2006). However, calculations by Goodland & Anhang (2009) estimate that livestock and its associated by-products contribute to at least 51% of global greenhouse gas emissions. Livestock production also significantly contributes to global methane emissions, accounting for approximately 35-40% of them. Methane is a potent greenhouse gas with a warming potential of more than twenty times higher than that of CO_2, posing a serious environmental threat. Additionally, livestock production is responsible for approximately 64% of total ammonia emissions, which contribute to acid rain and water eutrophication processes (Dopelt et al., 2019).

Moreover, meat production has severe impacts on the planet due to factors such as land and water use. Approximately 80% of global agricultural land is dedicated to the livestock industry, which only provides 20% of the world's calorie supply (Ritchie, 2017). This exacerbates issues related to world hunger while also leading to land degradation and loss of biodiversity. The water demand associated with meat production also causes significant environmental stress, with beef production requiring nearly fifty times more water than vegetable production (Mekonnen & Hoekstra, 2010).

Recently, behavioral economics theories, including the Nudge Theory (Sunstein & Reisch, 2017; Thaler & Sunstein, 2008), have gained prominence as tools to guide consumer choices. Nudges are attempts to influence people's judgment, choices, or behaviors in a predictable way, leveraging individual cognitive biases and the decision-making process within a social context. By utilizing these biases, nudges can redirect consumers toward eco-friendly perspectives (Hansen, 2016). Applying this theory to various domains, including sustainability policies, can be highly effective on a large scale.

Often, individuals make choices unconsciously, relying on habitual behavior without considering the environmental impact of their actions. This is where nudges can play a pivotal role, steering consumers' automatic (fast and unconscious) decisions toward more eco-friendly options. The cumulative effect of these actions, when multiplied by the population of entire nations, is often underestimated. One potential nudge, in this case, is the Carbon Footprint Label, which measures the total emissions of CO_2 and other greenhouse gases associated with the life cycle of a product (Wiedmann & Minx, 2008).

In the context of Italy's food sector, the use of the Nudge Theory to influence citizens' choices toward more sustainable lifestyles seems to be limited. However, it holds tremendous potential for widespread effectiveness.

Therefore, this research aims to investigate whether the use of a nudge can effectively influence people's choices toward products with reduced environmental impact.

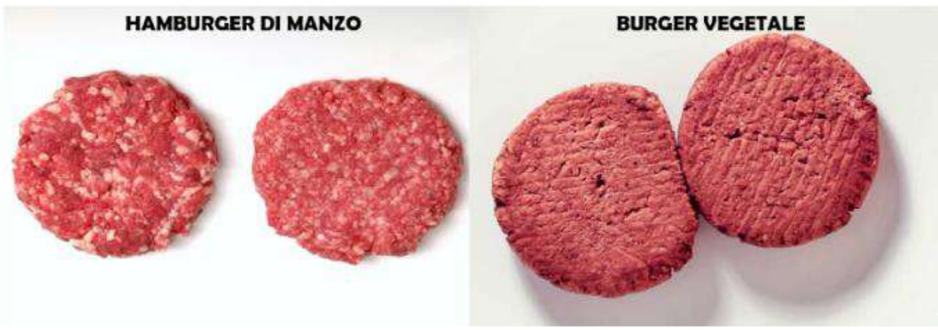
MATERIAL AND METHODS

To assess the effectiveness of the Nudge Theory, a within-subjects experiment was designed, comparing a beef hamburger, known for its high environmental impact, with a plant-based alternative with significantly lower environmental consequences. An online questionnaire was administered to a sample of individuals in Italy, asking them to choose between the beef burger and the plant-based substitute in two scenarios. The first scenario (Figure 1) involved no nudge, allowing participants to make choices based on their daily habits without any information about the products' CO_2 emissions. After the first scenario respondents were presented a brief explanation of the carbon footprint label with the relative logos (Figure 2). In the second scenario (Figure 3), the Carbon Footprint Label was introduced accompanying the plant-based substitute as a nudge. The price of both foods was assumed to be the same (€ 3.99) to avoid influencing the choice. The choice of the price for the proposed products was made observing current prices at supermarkets in northern Italy for 300gr of beef burger and the equivalent portion of a plant-based burger.

Google Forms was utilized as the data collection tool to administer the online questionnaire during a two-week period from May 16th to May 27th, 2022, resulting in 254 responses.

Figure 1 – The first-choice scenario presented to respondents without nudge.

Immagini di essere al supermercato e di dover acquistare uno dei seguenti prodotti di origine italiana. A parità di prezzo (€3,99) quale acquisterebbe? *



- Hamburger di manzo
- Burger vegetale

Figure 2 – The information provided to respondents between the first-choice scenario without nudge and the second-choice scenario when the nudge was introduced.

L'etichetta "Carbon Footprint" indica quanto la produzione di un determinato cibo contribuisce in termini di emissioni di CO2 (anidride carbonica) al riscaldamento climatico. Tale etichettatura viene effettuata usando i seguenti loghi:

RIDOTTO CONTRIBUTO AL CAMBIAMENTO CLIMATICO

MEDIO CONTRIBUTO AL CAMBIAMENTO CLIMATICO

ELEVATO CONTRIBUTO AL CAMBIAMENTO CLIMATICO

Figure 3 – The second-choice scenario presented to respondents with the nudge.

RESULTS

Based on the sociodemographic information collected in the questionnaire (Table 1), the sample exhibited near-even gender distribution, with 47.6% men, and 50.8% women and 1.6% not specified. The most represented age category was individuals between 18 and 25 years old (46.1%), followed by age groups between 46 and 55 years (15.7%), 26 and 35 years (13.8%), and 56 and 65 years (12.2%). Individuals over 65 years old and those between 36 and 45 years old constituted smaller proportions of the sample. More than half of the respondents had obtained a high school diploma, with a significant number holding a university degree. The sample included a smaller portion of individuals who completed only middle school or possessed a master's or doctoral degree.

Regarding dietary habits, 90.6% (N = 230) of the respondents reported consuming meat. Among them, almost half consumed red meat at least once a week, a significant fraction consumed it more than twice a week, while less than 10% consumed it less than once a month. However, over 50% of meat consumers indicated a reduction in meat consumption over the past five years. Additionally, most respondents in this category had tried plant-based burgers and 65% expressed willingness to purchase them again. Both vegetarians and omnivores cited ethical and environmental reasons as primary motivations for consuming plant-based products, while only a small percentage favored the taste over meat. The main reason inhibiting plant-based products consumption was the perceived lack of similarity in sensory characteristics compared to meat. Nonetheless, even among non-consumers, there was a tendency to recognize the lower environmental impact of plant-based alternatives.

Considering the full sample (vegetarians and omnivores, N = 254), the results of the first experimental phase indicated a clear preference for the beef hamburger, chosen by 68.1% of the sample. However, in the second phase, when the necessary information regarding the Carbon Footprint Label was provided, and the plant-based substitute was presented with this label as a nudge, the preferences were almost reversed, with a significant majority favoring the plant-based (vegan) option (57.1%) (Figure 4).

Table 1 – Sample socio-demographic characteristics

Variable	Levels	n	%	∑%
Gender	Other	4	1.6	1.6
	Woman	129	50.8	52.4
	Man	121	47.6	100.0
	all	254	100.0	
Age	<18	4	1.6	1.6
	18-25	117	46.1	47.7
	26-35	35	13.8	61.5
	36-45	18	7.1	68.6
	46-55	40	15.8	84.4
	56-65	31	12.2	96.6
	>65	9	3.5	100.0
	all	254	100.0	
Education	Elementary or lower secondary school diploma	13	5.1	5.1
	High school diploma	156	61.4	66.5
	Bachelor's degree	81	31.9	98.4
	Master/PhD	4	1.6	100.0
	all	254	100.0	
Employment status	Housewife	4	1.6	1.6
	Executive	5	2.0	3.5
	Unemployed	6	2.4	5.9
	Employee	98	38.6	44.5
	Freelance	15	5.9	50.4
	Worker	14	5.5	55.9
	Retired	11	4.3	60.2
	Student	101	39.8	100.0
	all	254	100.0	
Living status	On the average	217	85.4	85.4
	Over the average	31	12.2	97.6
	Under the average	6	2.4	100.0
	all	254	100.0	
Environmental Assoc. Membership	No	226	89.0	89.0
	Yes	28	11.0	100.0
	all	254	100.0	
Region	Campania	1	0.4	0.4
	Friuli Venezia Giulia	6	2.4	2.8
	Lombardia	5	2.0	4.7
	Marche	19	7.5	12.2
	Piemonte	1	0.4	12.6
	Other (Spain)	1	0.4	13.0
	Trentino - Alto Adige	5	2.0	15.0
	Veneto	216	85.0	100.0
	all	254	100.0	
Meat consumer	No	24	9.4	9.4
	Yes	230	90.5	100.0
	all	254	100.0	

Notably, 37.6% of initial beef hamburger choosers subsequently opted for the plant-based burger after the introduction of the label highlighting its reduced CO_2 impact (Figure 5). This group accounted for

25.6% of the sample. The full sample results therefore highlight that the introduction of the nudge would reduce the amount of people buying meat by around 25% in the sample considered in our experiment.

Figure 4 – Choice frequencies between the first-choice round without nudge (No_Nudge) and the second round when the nudge was introduced (Nudge), considering the full sample (N = 254).

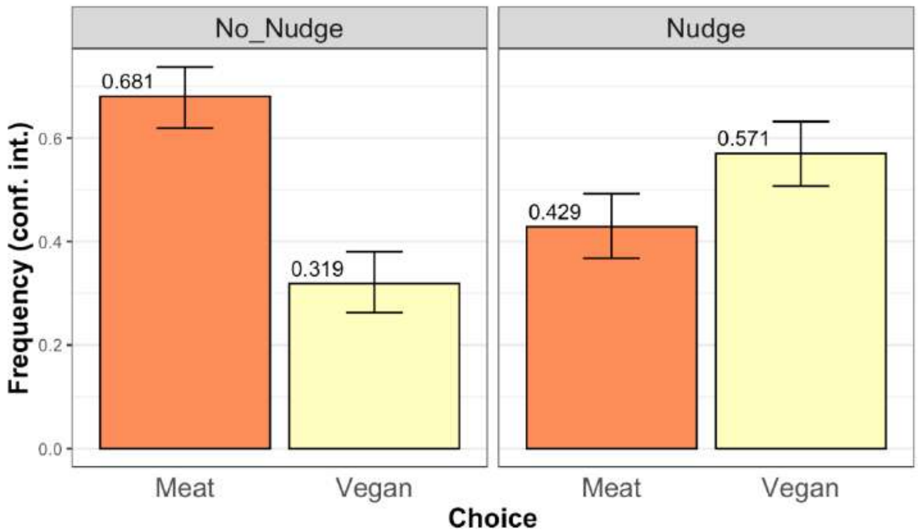
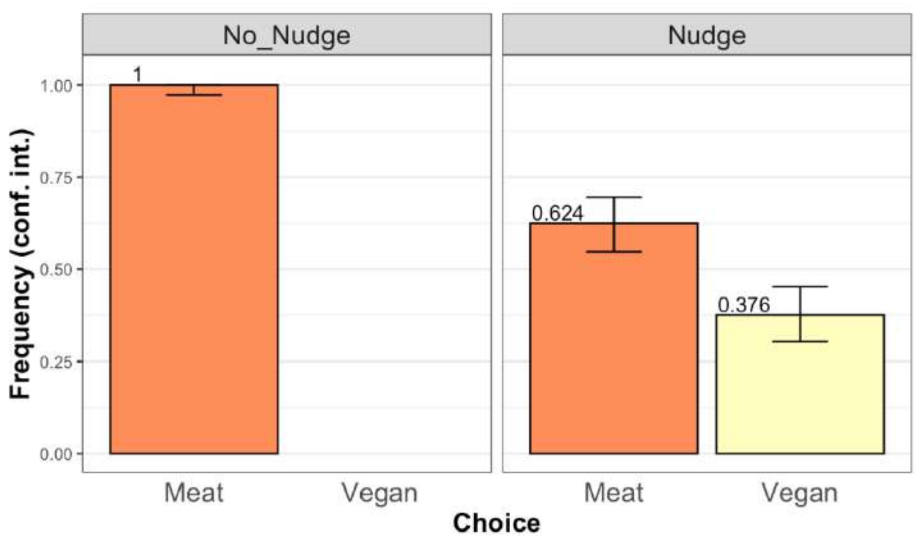
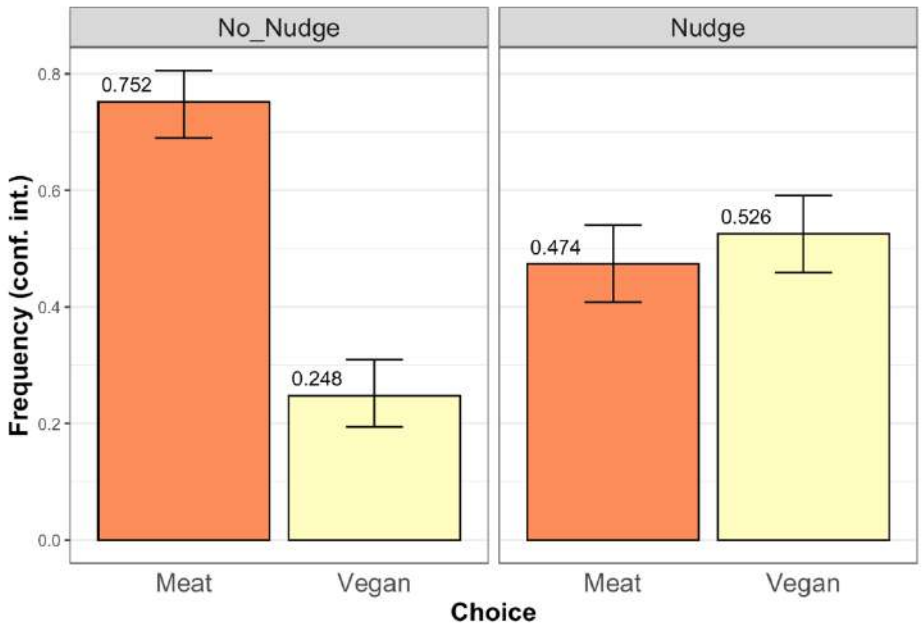


Figure 5 - Comparison between the results of the first and second phase of the experiment regarding those who had chosen meat as first choice (N = 173).



If we take into consideration only meat eaters (N = 230), in the first scenario the beef hamburger was chosen by 75.2% of respondents (N = 173), while the plant-based alternative by 24.8% (N = 57) people (Figure 6). After the introduction of the nudge, 37.6% (N = 65) of those who had chosen the beef hamburger in the first scenario opted for the plant-based hamburger in the second scenario. This represents 28.3% of meat eaters: it is therefore possible to affirm that the nudge changed the purchase intention of 28.3% of meat eaters.

Figure 6 – Choice frequencies between the first-choice round without nudge (No_Nudge) and the second round when the nudge was introduced (Nudge), considering only meat eaters (N = 230).



Subsequently, in order to verify the effectiveness of the treatment, a non-parametric test (the McNemar test) was carried out given the experimental setting within-subjects. Such a test can determine whether there are variations in a dichotomous dependent variable between two distinct groups. A decidedly significant p-value was obtained (p-value < 0.001), once again highlighting a significant shift in consumer choices due to the introduction of the nudge. The same results were obtained considering the full sample (N = 254) and only meat eaters (N = 230).

Among the respondents who changed their initial choice, certain factors can be considered. A logistic regression (Table 2) was applied to check on which groups of respondents, based on their socio-economic and attitudinal characteristics, the nudge had a greater effect. The logistic regression considered the respondents (N=172[1]) that on the first scenario (without nudge) opted for the meat burger choice. The dependent variable in the logistic regression was a dummy assuming value 1 if the respondent changed his/her choice from meat burger to vegan burger.

As can be inferred from the results reported in Table 2, the effect of the nudge depends on the respondent's gender, specifically having a greater effect on women compared to men. However, no

[1] From the 173 subjects, 1 observation was dropped by the Stata software (Gender = Other) given that it did not result statistically significant.

significant differences in the effect are observed regarding age groups, as indicated by the model ($p > 0.05$). Therefore, it can be concluded that the effect of the nudge does not depend on the age of the individual subjected to the stimulus.

If we instead examine the effect of the nudge considering the respondents' opinions, it is possible to observe that those who do not consider meat production a significant contributor to climate change (Meat_Climate variable in Table 2) are less likely to change their choice compared to those who hold an opposite opinion. Therefore, the nudge has a lesser effect on these individuals.

The importance attributed by respondents to the environment on a scale from 1 to 5 (1 = not important at all; 5 = very important) is also statistically significant. As the importance attributed to the environment by respondents increases, the effectiveness of the nudge also increases.

Considering the odds ratios reported in Table 2, the odds ratio for the female population to change their choice following the introduction of the nudge are greater by a factor of 2.6 (160% more) compared to those of men. For each additional point attributed to the importance of the environment, the odds ratios are greater by a factor of 2.18 (118% more). However, for those who do not consider meat production as a cause of climate change, the odds ratios are lower by a factor of 0.086 (91.4% less) compared to those who are convinced of this aspect.

In summary, therefore, the studied nudge appears to be more effective on female subjects who attribute significance to meat production in terms of its contribution to climate change and consider the environment to be important.

Table 2 - Logistic regression to characterize the respondents who changed their choice (N = 172) following the introduction of the "nudge".

	Odds Ratio	Std. Err.	z	p-value	[95% Conf.	Interval]
Gender (reference: Man)						
Other§	-	-	-	-	-	-
Woman	2.595	0.944	2.62	0.009	1.272	5.292
Age (reference: < 18)						
18-25	1.103	1.573	0.07	0.945	0.067	18.067
26-35	0.992	1.476	-0.01	0.996	0.054	18.328
36-45	0.741	1.177	-0.19	0.85	0.033	16.662
46-55	0.981	1.440	-0.01	0.989	0.055	17.426
56-65	0.553	0.838	-0.39	0.696	0.028	10.769
>65	0.723	1.344	-0.17	0.862	0.019	27.631
Meat_Climate§§ (reference: Totally agree)						
I don’t know	0.378	0.228	-1.62	0.106	0.116	1.230
Partially agree	0.500	0.221	-1.57	0.117	0.210	1.189
Partially disagree	0.115	0.085	-2.94	0.003	0.027	0.486
Totally disagree	0.086	0.101	-2.09	0.037	0.008	0.863
Importance_environment§§§	2.181	0.647	2.63	0.009	1.220	3.900
constant	0.030	0.056	-1.9	0.057	0.001	1.107

N = 172; LL = -96.12566; McFadden Pseudo $R^2 = 0.153$

§ omitted, 1 observation

§§ “Meat_Climate” refers to the following question: “La produzione di carne rappresenta uno dei contributi più significativi al cambiamento climatico. Cosa pensa riguardo a questa affermazione?”.

§§§ “Importance_environment” refers to the importance attributed by respondents to the environment on a scale from 1 to 5 (1 = not important at all; 5 = very important).

CONCLUSIONS

The results indicate that the use of a nudge, specifically the introduction of the Carbon Footprint Label on the packaging of the plant-based burger, significantly influenced respondents' choices. The percentage of individuals selecting the plant-based option increased by approximately 79% compared to the previous scenario where the label was not present. This suggests that providing information about the reduced environmental impact of the plant-based option successfully influenced consumer behavior, leading to a substantial shift in preference.

It is worth noting that the sample size of 254 respondents is relatively small and cannot be considered representative of the entire Italian population. Additionally, the concentration of respondents in the Veneto region makes it challenging to generalize their perceptions to residents of other regions in Italy. To obtain more reliable and representative results, the questionnaire should be re-administered to a larger and more diverse sample that reflects the age distribution in Italy.

Nonetheless, the findings indicate that the respondents exhibited particular attention to nature and a heightened awareness and concern for the environment. This suggests a positive inclination toward sustainability and a willingness to make choices aligned with ecological values. The study highlights the potential role of promoting environmental awareness and education in fostering environmentally conscious behaviors and encouraging individuals to make more sustainable choices in their daily lives.

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The adoption of fungus-resistance grapevines: an analysis of producers approach in the Italian region of Veneto

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KEYWORDS
sustainability, viticulture, innovation, PIWI, Veneto, wine

BACKGROUND AND OBJECTIVES

The attention to sustainability aspects of viticulture has grown in last years, involving not only consumers but also producers, institutions and policy makers. One evidence, at European level, is given by the reform of Common agricultural policy (CAP) which has introduced some changes geared toward making the viticulture of the future more environmentally friendly.

For example, starting from January 2023, it will be possible to identify with designation of origin (DO) also wine *"obtained from vine varieties belonging a cross between the Vitis Vinifera species and other species of the genus Vitis*" (Reg. 2021/2117). Considering that fungus-resistant vines (FRV) obtained through hybridization programs exists, this policy change will be very significant for DO wine producers. These varieties, also known as PIWI[1], in fact have resistance genes from American or Asian species, which confer lower susceptibility to the most common fungal pathogens, making them a sustainable innovation for the wine sector.

The current climate change scenario in fact is even more negatively affecting the viticulture and the sustainability of the entire national and international wine supply chain (Ashenfelter and Storchmann, 2016; Santos *et al.*, 2020). For these reasons, it is necessary to adopt innovative strategies to deal with the effects of climate change, in a sustainable way. In this regard, the new CAP introduces and encourages the possibility to conduct a more sustainable viticulture, through the use of FRVs which allow the reduction of the use of chemicals for treatments, that as known, when overused may have negative environmental and social impacts (Fouillet *et al.*, 2022; Tsakirakis *et al.*, 2014).

Although there is not much information regarding the spread of these varieties in Europe, some authors have pointed out that while a significant number of farms adopt these varieties, the area under vines involved is very limited (Finger *et al.,* 2022).

Despite the effective tolerance of these varieties to powdery mildew and downy mildew, (Pedneault and Provost, 2016) and although there seems to be consumer interest for wines produced by fungus-resistance varieties (Vecchio *et al.*, 2022), the winegrowers still appear rather reluctant to their cultivation. The adoption of this innovation is in fact obviously not without obstacles (Montaigne *et al.*, 2016), especially

[1] German for "*pilzwiderstandfähig,"* meaning "fungus-resistant vines"

because involves a radical change in winegrowing farm production, as it requires replacing old varieties with fungus resistant ones.

Given the importance of this varieties as innovation to conduct a more sustainable viticulture, this study aims to investigate the ways and approaches by which the use of these varieties is spreading among early adopters, investigating the population of PIWI wineries from Veneto, which is the region with the highest percentage of area planted with resistant varieties in Italy. This region, located in the North-East of Italy, is also relevant because is the second Italian region with the highest area under vines, that for 2022 was equal to 97.495 ha (ISTAT, 2022) and is famous in world for the production of sparkling wines such as *Conegliano Valdobbiadene Prosecco DOCG* and *Prosecco DOC*, and also high-quality red wines such as *Amarone della Valpolicella.*

DATA

The research has been conducted analyzing data provided by AVEPA, the venetian payments agency, about declarations of area planted with fungus-resistant varieties. In addition, data about PIWI wines producers and wines has been collected from the official websites of the PIWI Veneto association (https://www.piwiveneto.it/aziende-vinicole-piwi/), wineries websites, through phone interviews with wineries from October to December 2022, and face-to-face interviews with key informant.

Semi-structured interviews were also conducted during August 2023, involving a representative sample of 22 FRV wine producers in the Veneto region (about 1/3 of the total number of FRVs wineries in Veneto). Interviews were conducted online, via Zoom, with the aim of investigating producers' opinion and experience about viticultural, oenological and marketing aspects of FRVs. The semi-structured questionnaire was defined and validated by a group of researchers with expertise in viticulture, enology, and marketing. In order to reduce potential bias interviews were always conducted by the same interviewer and following the same procedures. Respondents were asked about their experience in growing, winemaking and selling FRVs, also providing information about disadvantages and advantages of growing FRVs. Questions about the future perspective of these varieties and the public and private actions that are needed to encourage more sustainable viticulture were also conducted.

RESULTS

The analysis of data has shown that Veneto is the main producer of Italy of PIWI grapes, with an area under vines with fungus-resistance varieties around 526 ha (less than 0,6% of the total area under vines). Although the surface is very limited, it has grown a lot in the recent years, recording an increase of more than 500% compared to 2018. According to producers' perception, growing sensitivity to environmental protection, and the possibility of reducing costs associated with treatments are the main drivers encouraging the expansion of areas.

The vineyards are located mostly in the provinces of Treviso and Verona, which are also the provinces with the largest area under vines of Veneto. Due to the small dimension of the wineries, the extension of vineyards is very limited in term of size, which almost always is less than one hectare, and it is very common to find rows of fungus-resistant varieties in the midst of Vitis Vinifera vineyards.

The varieties registered as PIWI in the Italian national register of vine varieties are 37, but among these, only 24 are authorized for the cultivation in Veneto and especially 13 of which are white varieties and 11 are red varieties.

Data analyzed shows that around 61% of the total are under vines with PIWI is cultivated with white grapes. Among these the most cultivated, in descending order, are Souvignier Gris B., Bronner B., Solaris

B., Johanniter B. and Sauvignon Rytos B.. The remaining 39% is represented by red grapes, especially Merlot Khorus N., Cabernet Volos N. and Cabernet Cortis N..

The use of resistant varieties has an impact on vineyard management and production costs. However, it is not possible to homogeneously define whether this type of vine variety can have only positive and/or negative repercussions for the winegrower. It is indeed very important to consider species-specific aspects of the vine, such as vigour, earliness or production capacity (yield/hectare). Interviews with key informant in fact has highlighted the choice of these varieties must be considered with regard to the context in which they will be planted and with regard to the intended use. On the wine-growing side, producers did not identify significant differences in the FRVs vineyard management compared to the traditional varieties: some varieties, such as Solaris and Muscaris, are more vigorous and require a greater investment of time and money in green pruning, in the same way as some traditional varieties with greater vigour, such as Glera. Conversely differences in the ripening period have been highlighted: compared to conventional varieties, FRVs ripens with 7-10 days in advance, with technological ripening very often anticipating phenolic ripening.

However, what makes these varieties so interesting for producers is definitely the reduction in the number of treatments: respondents said that they had at least halved the number of treatments on FRVs compared with traditional varieties and in some cases they were even able to do no treatment at all. Taking into account the variability given by pedoclimatic characteristics and vintage, producers said they make an average of 3-4 treatments per year on FRV, compared to the average of 14-15 of the traditional varieties. This makes it possible to significantly reduce not only the costs associated with disease management, but also the carbon footprint, with significant benefits for workers and communities' health.

Tolerance to powdery mildew and downy mildew is therefore effective, although these varieties appear to be slightly less resistant to downy mildew in the opinion of producers. In addition, respondents pointed out the occurrence of black rot in FRVs especially in wetter areas, not present, however, on traditional varieties. Diseases, nevertheless, are kept under control without criticality with few treatments that are typically given.

Regarding the production of wines, data show that there are just over 60 wineries that claim to produce wines made from FRVs. When looking at the total number of wine types produced per winery, there are about 14 wineries producing less than 10% of wine types with resistant varieties. Around 19 wineries produce a number of types of PIWI wines between 10% and 29% of the total number of wines, while only 4 wineries produce between 30% and 49%. In the end, 4 wineries produce a number of PIWI wines between 50% and 99% of the total types of wine produced and 23 wineries produce only wine from FRVs.

In addition, about 36% of wineries declares to conduct environmentally friendly production of wines, guaranteed by certifications such as organic, biodynamic, or integrated production (SQNPI). According to many producers in fact, vineyard management with FRVs is definitely compatible with more sustainable vineyard management system, such as organic production, even in an area such as the Veneto with high humidity.

Among the wines produced by the wineries, about 67% are made from a single FRV, 26% are the result of blending two or more FRVs, and only 7% are made from FRVs and *Vitis Vinifera* grapes.

Regarding winery aspects, some differences in winemaking management have been highlighted, but they differ substantially from variety to variety. In terms of tartaric/protein stability, there are no major differences with conventional grape varieties, although problems in color stability are sometimes encountered in red berry varieties. In addition, occasionally a sudden drop in acidity is underlined in particular terroirs and climates. The foxy aroma is often mentioned among the characteristics of these wines, especially in red varieties. What the producers highlighted is that knowledge related to the winemaking of FRVs, which by their nature have very different organoleptic characteristics from traditional varieties, is still poor and needs to be improved. For this reason, currently, winemaking is more difficult and requires greater controls.

One of the main barriers to the spread of FRVs is the lack of consumers awareness of these varieties. Indeed, there is not yet a well-defined market because consumers who know and drink FRVs wines are still few. Producers interviewed in fact stated that nonexpert consumers are sometimes frightened by these varieties because they mistakenly associate them with GMOs. Moreover, these wines do not yet have well-defined organoleptic characteristics that distinguish them. In fact, given to the limited production, the stylistic differences in wines between companies are greater, so consumers are unlikely to look on the shelves for wines from Solaris grapes, for example. However, there is a niche of consumers potentially interested in FR wines: they are generally young wine enthusiast, who want to learn and get to know more about this world, to experiment tasting new products and with a particular sensibility to the environmental protection.

Considering the data about price positioning and distribution, in most cases these wines fall within the medium-high price category and they are sold in two main channels which are HO.RE.CA. and specialized large-scale distribution.

CONCLUSION

The analysis of data shows an interest from Veneto winegrowers about FRVs. Although, in fact, the area planted with these varieties is still limited, the number of farms using FRVs is already quite significant.

This, of course, can be related to the uncertainty associated with the adoption of innovation and also to the Italian policy framework that currently does not allow the use of these varieties in DO wines (L. 238/2016), which thus results in a cautious attitude by producers.

Considering the importance and the great potential of FRVs as innovations that enable more sustainable viticulture, the area under FR vines and the number of farms involved may increase when new varieties, including once with more resistance, and more information about cultivation, defense and winemaking techniques will be available.

In these terms, the inclusion of these varieties in DO wine regulations could be also an advantage for their diffusion. Moreover, most of producers are in favour of this initiative, emphasising the environmental and economic benefit deriving from the introduction of FRVs in DO wines. This could start with the inclusion of 10% of FRVs that would certainly lead to an increase in the area planted with FRVs. Considering that Veneto is the first region for wine production this would lead to a major reduction in treatments, contributing to the Green Deal goals of reducing CO_2 emissions and the use of chemicals plant protection products.

Certainly, normative regulations such as the municipal regulations of the Veneto region approved in 2019 that obligates in the case of new planting or replanting near highly sensitive sites the use of resistant varieties, as the only alternative to organic (DGR nr. 1082, 30 July 2019 of Veneto Region, annex B), could be helpful in fostering the propensity of farmers to plant FRVs, but probably this is not enough. The Veneto region has long allowed the financing of the reconversion and restructuring of vineyards with resistant varieties thanks to CMO measure 46, but without assigning premiums to those who use them. Conversely, additional scores are awarded to farms that adopt organic production methods in the vineyard. In this regard, economic incentives to farmers from the European Union or regions, as is already happen for organic production will make a greater contribution to the expansion of the area planted with vines.

In order to stimulate these changes, communication and awareness-raising actions towards both consumers and producers are necessary to encourage the spread of these varieties. In this regard, a synergetic work between private and public entities (Institutions, consortia, universities, specialised associations, producers etc.) aimed at promoting targeted and shared communication campaigns is required.

To achieve this goal, more research is needed to quantify and demonstrate the real benefits of these varieties, both in terms of economics and reduced impact. Research will also need to move in the direction of improving cultivation and winemaking techniques by gathering and sharing information that can help producers in managing these varieties, both in the vineyard and in the cellar. On the consumer side, communication should be geared toward promoting in the consumer's mind that the use of these varieties reduces risks to the environment and society, following a communication strategy similar to that of organic production.

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Climate change and the quality of wine: a preliminary study on Collio whites

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KEYWORDS
Wine; quality; climate change; Collio.

1. INTRODUCTION

Italy is the biggest wine producer worldwide, followed by France and Spain (OIV, 2022). With a total value of about 3.8 billion euros in 2021, wine is also the most important agricultural vegetable production in Italy (CREA, 2022). Italian wines benefit from significant protection within the European Union (EU) quality schemes: out of the 3,069 registered product names classified as Geographical Indications (GIs), 526 pertain to Italian wines (Rosati and Del Bravo, 2022). The variety of terroirs across the Italian peninsula defines the quality and identity of its wines.

The concept of terroir refers to the broad set of environmental conditions (soil, climate, topography, site-specific microbiome) whose interaction with human activities defines the sensory characteristics of agricultural products, most notably wine (van Leeuwen and Seguin, 2006). Consequently, similarly to any other agricultural product, the quality of wine closely depends on both controllable, or relatively stable over time, and uncontrollable factors. While oenological practices and processing technologies largely influence the quality and features of the final product and have the potential to limit defects, excellent grapes and musts are essential to produce high-quality wines (Reynolds, 2010; Reynolds, 2021). As a consequence of this peculiar combination of controllable or relatively stable variables (e.g. wine-making processes, soil composition, geomorphological features) and external factors outside the control of wine growers and winemakers, together with the time gap between grape production and release on the market, predicting quality of the final product is particularly challenging (Corsi and Ashenfelter, 2019). Furthermore, uncertainty has increased in recent years due to climate change, growing weather variability and extreme weather events (van Leeuwen and Darriet, 2016).

Several scholars have addressed the issue of limited predictability of final outcomes, and proposed different econometric models to illustrate and assess the effect of meteorological variables on wine quality (Byron and Ashenfelter, 1995; Jones et al., 2005; Ashenfelter, 2010; Ashenfelter and Storchmann, 2016; Corsi and Ashenfelter, 2019), in an effort to concurrently support winemakers' formulation of pricing strategies and facilitate buyers' purchase and investment decisions. Nevertheless, "wine equations" have traditionally been based on red varieties, while it is well known that different effects are to be expected for white varieties, so much different that, in some extreme cases, they might even suggest the ones with the others. Therefore, it is interesting to focus on the difference between climatic effects on the quality of white and red varieties. As is usually the case, doing so in an otherwise homogeneous context can be of great help in isolating the effect of interest.

The focus of our study is the analysis of meteorological variables as antecedents of white wine quality in the Collio region, Northeastern Italy. Located in close proximity to the mythical 45° Parallel North, which runs through the most important wine-producing regions in the Northern hemisphere (Patic et al., 2009), Collio is famous for the outstanding quality of its whites, within a country most famous for its reds. The research presented in this manuscript is the first to address the estimation of a Bordeaux equation *à la* Ashenfelter in a panel context, drawing on a large sample of varieties from the same region, including, crucially, both whites and reds. The results, in terms of the predicted consequences of global warming on the quality of Collio wines, are relevant to producers and policymakers of the region, whose economy relies on the production of its celebrated whites.

2. MATERIALS AND METHODS

The Collio region produces wine from a wealth of different grapes as opposed to the relative uniformity one will find in other famous wine regions such as Burgundy, where most wines come from Chardonnay grapes (whites) and Pinot Noir (reds), and the greatest emphasis is on the terroir; the same goes for some Italian DOCGs (*Denominazione di Origine Controllata e Garantita*, which, together with *Denominazione di Origine Controllata*, DOC, is equivalent to the EU Protected Denomination of Origin, PDO) like Brunello di Montalcino or Barolo. In the Collio, wines are identified mostly by the grape variety and the producer. As reported in Table 1, we consider a panel dataset of white and red wines, of 14 grape varieties (including three blends), produced in the Collio region between 1985 and 2021 by 61 producers. As a proxy measure for quality, ratings were extracted from the Wine Spectator dataset (2023) and expressed on a 100-point scale as a result of blind expert tasting of finished wines. Our individual unit of observation (the "wine") is the intersection of "label" (e.g., "FriulanoCollio") and "producer" (e.g. "Livio Felluga"), so that "Friulano Collio (by) Livio Felluga" is one cross-sectional unit of observation: henceforth, a wine. Wines are observed multiply over time, every year a vintage, for a total of 1059 observations. The individual observation is then a wine vintage, e.g. "Friulano Collio (by) Livio Felluga, 2000.

Table 1: Dimension of the dataset

Entity	Number	Index
Labels	145	
Vintages	37	t
Producers	61	j
Varieties	14	k
Wines	344	i
White wine vintages	956	
Red wine vintages	103	
(Total) wine vintages	1059	it

The dataset was then integrated with daily meteorological data for the same time frame. The Capriva del Friuli weather station, approximately located in the centre of the Collio PDO area, was assumed to be representative of the climatic trends of the study area. For the years before 1991, when it was not yet active, the nearby Gorizia station was selected, which, before being decommissioned in 2000, was positioned in a comparable orographic context as registered at the weather station in Capriva del Friuli (OSMER, 2023).

The climate is assumed to affect wine quality, as measured by rating, in a linear fashion:

$$Rate_{it} = \beta_0 + \beta_1 SPTEMP_{it} + \beta_2 SUTEMP_{it} + \beta_3 WIRAIN_{it} + \beta_4 SURAIN_{it} + u_{it} \quad (1)$$

We specify Ashenfelter's "Bordeaux Equation" as an individual components panel model. Wine quality is explained by (cross-sectionally invariant, "common") climatic factors: Spring temperature (SPTEMP), Summer temperature (SUTEMP), Winter rain (WIRAIN) and Summer rain (SURAIN). Our a priori belief, based on the results in Ashenfelter et al. (1995), is a positive effect of SUTEMP and WIRAIN on wine quality, whereas for SURAIN the effect is negative. We consider a model with individual heterogeneity at the wine level, i.e. a separate intercept for each producer/variety unit. For each individual unit i=1,...,n and every time period t=1,…,T , the disturbance term u in Eq. 1 is then specified as:

$$u_{it} = \mu_i + \varepsilon_{it} \tag{2}$$

where μ can be correlated with the regressors: i.e., the individual heterogeneity is assumed potentially endogenous. As a consequence, we employ the so-called "fixed effects" (FE) estimator. We also experiment with alternative assumptions, either uncorrelated heterogeneity (leading to the random effects (RE= estimator) or a middle ground with RE plus producer dummies: the Hausman test confirms FE as our preferred choice.

3. RESULTS

In principle, white and red wines can be expected to react differently to climatic conditions due to both varietal-specific needs and desirable characteristics of the final product. This consideration likely explains why the results of the general model, including both white and red wines, are not in line with the literature (Ashenfelter et al., 1995; Byron and Ashenfelter, 1995; Ashenfelter, 2010; Corsi and Ashenfelter, 2019), and only the effect of Summer rain is consistent with previous results (see Table 2).

Table 2: Regression results: separate models for red and white varieties. RE: random effects; RE.PFE: random individual effects plus producer dummies; FE: fixed individual effects.

	RE.Red	RE.PFE.Red	FE.Red	RE.White	RE.PFE.White	FE.White
Spring temperature	-0.5734 (0.5898)	-1.3402 (0.6851)	-1.9797** (0.7105)	1.3776*** (0.1348)	1.1138*** (0.1376)	0.9591*** (0.1498)
Summer temperature	0.5972* (0.2966)	0.9640** (0.2967)	1.1534*** (0.3014)	-0.4427*** (0.0937)	-0.3744*** (0.0962)	-0.3691*** (0.1032)
Winter rain	-0.0002 (0.0014)	-0.0002 (0.0013)	-0.0012 (0.0014)	0.0006 (0.0004)	0.0003 (0.0004)	0.0001 (0.0004)
Summer rain	0.0009 (0.0034)	0.0044 (0.0034)	0.0055 (0.0034)	-0.0038*** (0.0011)	-0.0035** (0.0012)	-0.0035** (0.0012)
s_idios	2.4476	2.4476		2.7121	2.7121	
s_id	2.6616	2.2775		1.5773	1.2118	
R^2	0.9545	0.9724	0.2647	0.9557	0.9522	0.0787
Adj. R^2	0.9526	0.9604	-0.4999	0.9555	0.9488	-0.3392
Num. obs.	103	103	103	956	956	956

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

By segregating models by grape variety, the behaviour of white wines reveals interesting results (see Table 3). Warmer springs and cooler summers appear to enhance the quality of Pinot Blanc, Sauvignon Blanc, Friulano and Pinot Gris. On the one hand, higher spring temperatures favour vegetative development, which predisposes the plant to lower yields (Kizildeniz et al., 2015), resulting in smaller wine production but higher dry extract. On the other hand, cooler summer temperatures slow down sugar production processes in the grape berry, thus preserving to a greater extent the acid components (Gutiérrez-Gamboa et al., 2021). Furthermore, warmer temperatures from budbreak to flowering (late March to May) are associated with higher levels of 3-isobutyl-2-methoxypyrazine at harvest (Mendez-Costabel et al., 2013): this molecule is reminiscent of green bell-pepper-like aromas, that is the Sauvignon Blanc impact compound (Coetzee et al, 2015; Li et al., 2022).

Conversely, higher summer temperatures have no statistically significant effect on the quality of Chardonnay and Ribolla Gialla. If compared to the other white varieties, the anisohydric behaviour of Chardonnay and Ribolla Gialla makes them more resilient in drought conditions: actually, organoleptic characteristics seem to be enhanced by moderate water stress (Castellarin et al., 2011; Pou et al., 2012). In fact, these two cultivars reach their full expression when grown on hillsides, under low humidity conditions and in moderate water restriction.

Table 3: Regression results of separate models by grape variety, FE.

	Collio Bianco	Chardonnay	Friulano	Pinot Blanc	Pinot Gris	Ribolla Gialla	Sauvignon Blanc
Spring temperature	0.4907 (0.3943)	1.0993 (0.5436)	0.4062 (0.3866)	1.0402* (0.4578)	1.1001*** (0.2827)	-0.6178 (0.9468)	1.4654*** (0.3075)
Summer temperature	-0.3632 (0.3151)	0.2391 (0.4840)	-0.7047** (0.2159)	-0.1880 (0.3412)	-0.4196* (0.1952)	1.2417* (0.4779)	-0.2794 (0.2261)
Winter rain	-0.0012 (0.0009)	0.0005 (0.0019)	0.0006 (0.0011)	0.0002 (0.0015)	0.0004 (0.0008)	0.0061* (0.0023)	-0.0003 (0.0009)
Summer rain	-0.0058 (0.0035)	0.0012 (0.0049)	-0.0042 (0.0027)	-0.0002 (0.0036)	-0.0041 (0.0025)	0.0107 (0.0074)	-0.0022 (0.0025)
R^2	0.0998	0.1535	0.0975	0.0761	0.0927	0.5928	0.1598
Adj. R^2	-0.3441	-0.7244	-0.5191	-0.2934	-0.2097	-0.4478	-0.1751
Num. obs.	110	56	171	92	281	33	194

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

4. DISCUSSION AND CONCLUSION

As discussed above, existing literature substantiates the outcomes yielded by our model, thus efficiently bridging knowledge on the effects of meteorological conditions in the vineyard and the quality of white wines. This research fills the gap in the study of meteorological variables as antecedents of white wine quality. Our model may support winemakers in defining optimal pricing strategies by anticipating quality expectations. Similarly, investors and consumers who seek for quality wines could benefit from reduced uncertainty over quality of immature wines, or recently released wines whose quality hasn't already been assessed.

To a broader extent, in a period of growing meteorological instability and unpredictability, the results of our study could support wine growers' efforts in mitigating the negative consequences of climate change and designing and implementing adaptation strategies. In the short run, precise knowledge of the interaction between meteorological conditions and the annual cycle of vines, and their effect on wine quality, is necessary to fine tune targeted interventions to minimize quality impairing or maximize outcomes. Complementarily, in the long run, the extension of our approach may support the inclusion of considerations on climate variability in the definition of informed cultivar selection and choice.

Despite the significant findings of this study, it is important to consider its limitations as well. The panel is unbalanced and contains many units with a short time series: more specifically, 152 wines with only one yearly observation were discarded in the panel analysis. Furthermore, other factors closely influencing the quality of the final product (such as soil zoning and the "oenologist effect") were not included in the analysis.

While our findings regarding the different effects of climatic factors on white wine varieties are reasonable and consistent with the predictions of viticulture, further comparative research would be in order before they can be carried over to other regions. A natural progression of this research is to analyse the interactions among the main determinants of grapes and wine quality to gain a deeper understanding of their complex relationships and combined influence on the final product.

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Cultivating Trust: Navigating Perceptions of RNAi Technologies in Agriculture After COVID-19 Vaccine Era

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KEYWORDS

gene silencing, biotechnological innovations, risk perception, attitude formation, communication strategies

INTRODUCTION

RNA is a molecule that plays a key role in regulating gene expression and defending against diseases. In agriculture, RNA can be used to create new agrochemicals based on RNA interference (RNAi), a technology that allows silencing the genes of pathogens or parasites that attack plants, thus reducing the need to use chemical pesticides. The benefits of this technology are manifold: greater safety for the environment and the consumer, greater yield and quality of crops, greater adaptability to climate change and drought (Halder *et al.*, 2022; Mezzetti *et al.*, 2020).

RNAi is a natural mechanism found in most eukaryotic organisms in nature and can be exploited to improve plant health. RNAi-based technology is already being exploited, and the realized examples confirm its great potential in a range of areas of crop production and protection (Das and Sherif, 2020). RNAi can be applied in two ways: by modifying plants to express target dsRNAs (host-induced gene silencing, HIGS) or by spraying dsRNAs on plants (spray-induced gene silencing, SIGS) (Das and Sherif, 2020; Cagliari *et al.*, 2019). Both methods have advantages and disadvantages in terms of efficacy, stability, specificity, and regulation (Cagliari *et al.*, 2019).

However, the use of RNAi in agriculture also faces some challenges and uncertainties, especially regarding its public perception and acceptance. Consumers frequently exhibit caution towards new technologies in food production and processing (Verneau *et al*., 2014), while its market success definitely depends on consumer acceptance (Califano *et al*., 2023). Risk perception is a crucial factor in the social acceptance of new technologies, especially when they involve uncertainty and complexity (Cembalo *et al.*, 2019). Previous studies have shown that experts and the public often have very different views of risk, depending on their knowledge, values, attitudes, and emotions (Pappalardo *et al.*, 2021; Sjoberg, 1998).

For example, experts tend to judge nuclear waste risk as low, while the public perceives it as high (Sjoberg, 1998). Similarly, experts tend to have more positive attitudes towards GMOs than the public (Pappalardo *et al.*, 2021). These differences can create a gap between scientific assessment and public opinion, leading to social conflicts and policy dilemmas. Therefore, it is important to understand how different groups perceive and evaluate the risks and benefits of RNAi technologies in agriculture, and what factors influence their judgments.

One possible factor is the association with COVID-19 vaccines, which are based on mRNA technology. Indeed, mRNA vaccines are similar to RNAi in that they use RNA molecules to induce an immune response against a specific pathogen. However, they are also different in many aspects, such as their mode of action and delivery method. The public may not be aware of these differences and may transfer their opinions about mRNA vaccines to RNAi technologies. This hypothesis represents one of the main objectives of our study. Vaccines, and especially those related to the COVID-19 pandemic, can easily evoke negative emotions in the population (Chou and Budenz, 2020), while trust in science represent a protective factor for vaccination behavior and general attitude towards vaccines (Capasso *et al.*, 2022).

This study aims to contribute to this understanding by comparing the level of opposition to RNAi technologies in agriculture of experts and laypeople, and by examining how it is influenced by an induced association with COVID-19 vaccines. Hence, the study aims to test the following research hypotheses:

- **H1** The level of opposition to RNAi technologies in agriculture is lower among experts in the field than among the general public.
- **H2** The association with COVID-19 vaccines increases the opposition to the use of RNAi in agriculture.

Furthermore, to test the underlying theoretical model, it is also hypothesized that:

- **H3** Trust in science is positively associated with attitude towards COVID-19 vaccines (**a**), and as trust in science (**b**) and attitude towards COVID-19 vaccines (**c**) increase, opposition to the use of RNAi in agriculture decreases.

The results could provide useful indications for developing more effective communication strategies on the use of RNAi in agriculture.

METHODS

The data are being collected in Italy using an online questionnaire, using a convenience sample reached through the dissemination of the questionnaire on social networks.

After reading and accepting the informed consent, participants fill out a series of pre-manipulation measures, in particular:

Attitude towards COVID-19 vaccines (adapted form Capasso *et al.*, 2021; 2022), measured with 3 items on a 5-point semantic differential scale, where low values indicate the negative pole ("Harmful/Useless/Dangerous") and high values indicate the positive pole ("Beneficial/Useful/Safe").

Trust in science (adapted from Farias *et al.*, 2013), measured with 10 items on a Likert scale ranging from 1 ("Strongly disagree") to 5 ("Strongly agree"). An example item is "*Science is the most efficient means of attaining truth*".

Next, they indicate whether they work or have worked in a field related to genetics or molecular biology, and if so which one (to filter experts from non-experts), and finally provide basic sociodemographic information (such as age and gender).

Subsequently, to test the effect of the association of RNAi technology in agriculture with COVID-19 vaccines, participants are randomly directed to a control condition (*n* = 122), where RNAi technology in agriculture is presented without explicit references to the COVID-19 vaccine, or a treatment based on framing (*n* = 85), where the technology is presented with an explicit parallelism with the RNA vaccine for COVID-19 (Table 1).

Table 1 – Presentation of RNA technology in agriculture for both experimental conditions

Control	Treatment
RNA is a molecule that transfers genetic information from DNA to produce proteins in cells. RNA in agriculture can be used to protect plants from diseases, parasites and environmental stress, through a natural mechanism that silences the genes of pathogens or parasites that attack them. RNA in agriculture protects the plant by introducing itself into cells, **by spraying RNA molecules specially formulated.** This technology replaces the use of chemical pesticides and is considered absolutely safe for humans and sustainable for the environment.	RNA is a molecule that transfers genetic information from DNA to produce proteins in cells. RNA in agriculture can be used to protect plants from diseases, parasites and environmental stress, through a natural mechanism that silences the genes of pathogens or parasites that attack them. RNA in agriculture protects the plant by introducing itself into cells, **in a similar way to how the RNA vaccine protected us from COVID-19.** This technology replaces the use of chemical pesticides and is considered absolutely safe for humans and sustainable for the environment.

Note – In bold are the parts of the text that vary between control and treatment conditions.

Finally, following the description of the technology, participants fill out post-manipulation measures, namely they indicate their attitude towards the use of RNAi technology in agriculture, by answering two questions about their opposition (1 = no opposition; 5 = extreme opposition) and concern (1 = no concern; 5 = extreme concern) (adapted from Fernbach *et al.*, 2019).

RESULTS

The process of data collection for our study is currently ongoing. The preliminary sample consists of 207 participants (103 women and 104 men), aged between 19 and 73 years (M = 35.2, SD = 13.3). Participants who declared themselves experts in genetics or molecular biology are 8.2% of the sample.

The two experimental groups were homogeneous with regard to pre-manipulation variables (e.g., attitude towards COVID-19 vaccines and trust in science). Moreover, responses to the questions related to opposition and concern towards the use of RNAi technologies in agriculture showed a strong correlation ($r = 0.75$, $p < .001$), and the average between them was used as the main dependent variable of the study that we called *Opposition*. Overall, 56% of respondents reported some level of opposition towards the use of RNAi technologies, and 64% reported some level of concern.

As for the main analyses, two independent samples *t*-tests were performed to assess differences in opposition: (i) between experts and non-experts, and (ii) between treatment group (COVID-19 vaccine framing) and control group.

The results of the first comparison show that experts (M = 1.50, SD = 0.87), compared to non-experts (M = 2.08, SD = 1.00), have a significantly lower level of opposition, $t(205) = 2.32$, $p = .01$ (one-tailed) and $p = .02$ (two-tailed), supporting **H1**.

The results of the second comparison show that those who received an explicit association with COVID-19 vaccines (M = 2.19, SD = 0.99), compared to the control group (M = 1.92, SD = 0.99), have a significantly higher level of opposition, $t(205) = 1.90$, $p = .03$ (one-tailed) and $p = .06$ (two-tailed), supporting **H2**.

Finally, to support these preliminary results, a Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to assess the effect on the level of opposition of the psychological characteristics hypothesized as underlying the observed differences (i.e., attitude towards COVID-19 vaccines and trust in science).

PLS-SEM is a multivariate analysis technique that allows testing complex relationships between observed and latent variables (Hair et al., 2017). Unlike covariance-based SEM, which requires large sample sizes and multivariate normality assumptions, PLS-SEM is more suitable for exploratory research, small to medium sample sizes, and non-normal data (Hair et al., 2017). For these reasons, PLS-SEM was chosen as the appropriate method to test **H3**.

Table 2 shows the results of the PLS-SEM measurement model, indicating adequate factor loadings for the three constructs analyzed, ranging from 0.723 to 0.935. Cronbach's α (as well as Rho A) also shows good reliability for opposition, attitude towards COVID-19 vaccines, and trust in science (0.854, 0.865 and 0.936, respectively).

Table 2 – PLS-SEM measurement model, with factor loadings, Cronbach's α and Rho A

	OPP	**ATT**	**TRUST**
OPP.1	0.935		
OPP.2	0.933		
ATT.1		0.924	
ATT.2		0.901	
ATT.3		0.832	
TRUST.1			0.793
TRUST.2			0.804
TRUST.3			0.774
TRUST.4			0.846
TRUST.5			0.723
TRUST.6			0.835
TRUST.7			0.743
TRUST.8			0.803
TRUST.9			0.858
TRUST.10			0.781
Cronbach's α	0.854	0.865	0.936
Rho A	0.855	0.897	0.943

Note – OPP = Opposition; ATT = Attitude towards COVID-19 vaccines; TRUST = Trust in science.

In addition, the results for discriminant validity (Table 3) show low conceptual overlap between constructs, with Average variance extracted (AVE) for each factor largely exceeding the square of correlations between other factors.

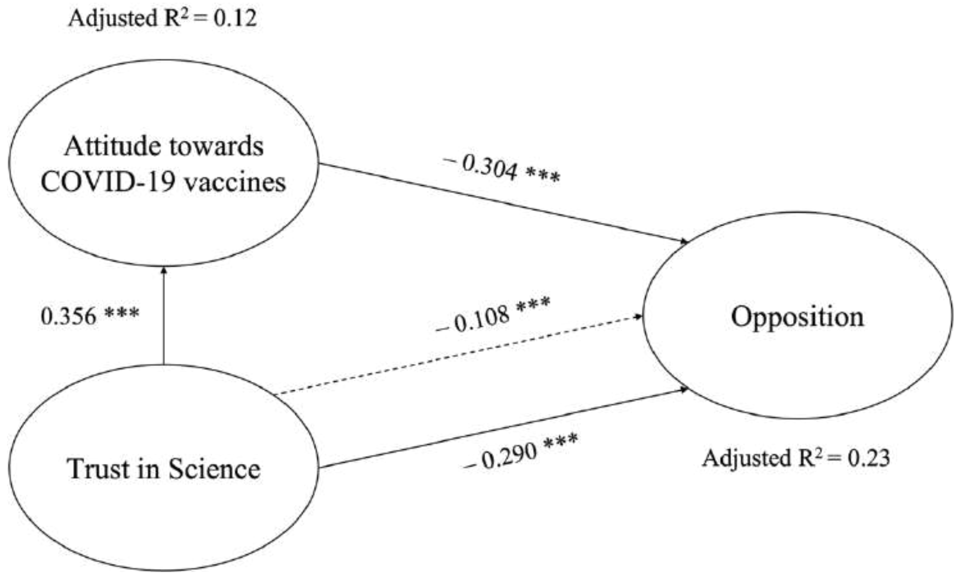
Table 3 – Squared interfactor correlation vs AVE

	OPP	ATT	TRUST
OPP	–		
ATT	0.166	–	
TRUST	0.159	0.127	–
AVE	0.873	0.786	0.635

Notes – OPP = Opposition; ATT = Attitude towards COVID-19 vaccines; TRUST = Trust in science.

Finally, Figure 1 reports the results of the structural model with standardized direct and indirect path coefficients, indicating all significant relationships and with the expected sign, confirming **H3a**, **H3b**, and **H3c**. Moreover, mediation analysis showed a significant mediator role of attitude towards COVID-19 vaccines in the relationship between trust in science and opposition (*Indirect effect* = –0.108; 95% CI [–0.180, –0.037]), with a total effect of trust in science on opposition of –0.398.

Figure 1 – PLS-SEM structural model



Note – Solid lines are direct effects, whereas dotted lines represent indirect effects; *** $p < .001$

DISCUSSION AND CONCLUSIONS

The study aimed to investigate the level of opposition to RNAi technologies in agriculture among experts and the general public, and how this opposition is influenced by an association with COVID-19 vaccines. The results, although preliminary, shed light on important implications and provide insights into the factors that influence public perception and acceptance of RNAi technologies.

Firstly, the study confirmed the hypothesis that experts in the field of genetics or molecular biology have a significantly lower level of opposition to RNAi technologies in agriculture compared to non-experts. This finding suggests that knowledge and expertise in the subject matter play a role in shaping attitudes and perceptions (Pappalardo *et al.*, 2021; Sjoberg, 1998). Experts may have a better understanding of the scientific basis and potential benefits of RNAi technologies, which could lead to more positive attitudes and reduced opposition. This highlights the importance of engaging experts in public communication and decision-making processes to bridge the gap between scientific assessment and public opinion.

Secondly, the study found that the association with COVID-19 vaccines increased the level of opposition to the use of RNAi in agriculture. This result supports the hypothesis that public opinions and emotions related to COVID-19 vaccines can transfer to RNAi technologies, despite the differences between the two. Negative emotions associated with COVID-19 vaccines, such as fear or skepticism (Chou and Budenz, 2020), may influence perceptions of RNAi technologies, leading to increased opposition. Scientists, experts, policy makers and communicators might be tempted to exploit the link between the two technologies, one of which is vaccines, a familiar topic for most people. However, this finding highlights the importance of clear and accurate communication that differentiates between various biotechnological approaches and prevents generalizations or misconceptions based on unrelated technologies.

Furthermore, the study examined the role of trust in science and attitude towards COVID-19 vaccines in shaping opposition to RNAi technologies in agriculture. The results demonstrated that trust in science was positively associated with attitude towards COVID-19 vaccines, supporting previous research on this topic (e.g., Capasso *et al.*, 2022). Moreover, both trust in science and positive attitudes towards COVID-19 vaccines were associated with reduced opposition to RNAi technologies. These findings suggest that trust in science acts as a protective factor, influencing attitudes and acceptance of biotechnological innovations. Building trust and addressing public concerns through transparent communication and evidence-based information is crucial for fostering acceptance of RNAi technologies in agriculture.

The study has some limitations that should be considered. Firstly, the sample size is relatively small and based on a convenience sample recruited through social networks, which may introduce biases and limit the generalizability of the findings. Future research should aim for larger and more diverse samples to strengthen the validity and representativeness of the results. Additionally, the study focused on participants from Italy, which may limit the cross-cultural generalizability of the findings. Further research should explore the perceptions and attitudes of individuals from different cultural backgrounds to capture the diversity of perspectives on RNAi technologies in agriculture.

In conclusion, this preliminary study provides valuable insights into the level of opposition to RNAi technologies in agriculture and the factors that influence public perception. The findings highlight the role of expertise, associations with similar technologies, and trust in science in shaping attitudes and acceptance. The study suggests that effective communication strategies should consider the knowledge gaps, emotions, and public concerns surrounding RNA technologies, particularly in relation to COVID-19 vaccines. Continued research and communication efforts are needed to bridge the gap between experts and the public, foster trust in science, and promote informed decision-making regarding the application of RNAi in agriculture.

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Exploring the path to sustainability in olive oil production: A stakeholder perspective on the Tuscany supply chain

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KEYWORDS
Olive oil supply chain; Olive growing practices; Food system; Sustainability; Common Agricultural Policy.

BACKGROUND

The pursuit of sustainability has garnered considerable attention across various sectors, including agrifood systems. However, sustainability is a multi-dimensional and intricate concept that demands analysis and interpretation from diverse perspectives (Kwatra *et al.*, 2020; Lombardo *et al.*, 2022). To evaluate the sustainability of agrifood systems, it is essential to adopt a holistic approach that encompasses environmentally non-degrading attributes, technical efficiency, economic viability, and social acceptability. These considerations align with the FAO's definition of sustainable agricultural development (FAO, 1988), emphasizing the need for a comprehensive evaluation.

Italian olive oil production stands out as a valuable national asset. Italy is the second-largest world producer of olive oil in terms of volume, covering 16% of the total production from the European Union, which maintains its position as the leading producer, consumer, and exporter of this product on a global scale (International Olive Council, 2022). Olive oil represents a crucial component of the Mediterranean diet, known for its health benefits and cultural significance. Notably, Extra Virgin Olive Oil (EVOO) constitutes an indispensable element of Italy's gastronomic identity.

Tuscany, located on the western coast of central Italy, covers 7.4% of the national olive oil production, ranking as the fourth Italian region in terms of production volumes (ISMEA, 2023). Olive tree holds a distinct presence within the Tuscany landscape area. The region's exceptional olive oil quality can be attributed to its unique microclimatic conditions, orographic characteristics, germplasm heritage, and cultural significance. Olive farming in Tuscany is characterized by small farm sizes averaging around 2.5 ha (ISMEA, 2023) and high fragmentation. Within this context, two contrasting production systems coexist. First, small-holder farms with limited mechanization, often found on steep lands, known as "heroic farming," focus on traditional practices. Olive is often not the principal crop in these farms. The activity is usually unprofitable due to the high production costs and poor mechanization. Nonetheless, this traditional cultivation method contributes significant social value. Olive crops stand as a form of territory and environment conservation, prevent rural abandonment, and preserve local traditions and biodiversity (Lombardo *et al.*, 2022). On the other hand, more advanced production systems, e.g. intensive approaches, are able to guarantee the economic efficiency of the crop by delivering higher yields (Stillitano *et al.*, 2017). However, these systems require increased inputs, such as phytochemicals and water, as well as a higher degree of mechanization. Consequently, intensive olive farming systems have been associated with detrimental impacts on the environment, biodiversity, landscape, and social value of olive farming (Ben Abdallah *et al.*, 2021).

In the past two decades, the cultivated area for olive trees in Tuscany has experienced a significant decline of 23%, accompanied by a remarkable 49% reduction in the number of agricultural farms engaged in olive cultivation compared to the year 2000 (ISTAT, 2023). This decline reflects the pressing issue of rural land abandonment, which carries severe implications for the region. The abandonment of traditional olive groves entails adverse environmental outcomes, including the reduction of biodiversity, heightened erosion risk, increased vulnerability to fires, and elevated hydrogeological hazards (Duarte *et al.*, 2008). Moreover, it brings about substantial transformations in the iconic rural landscape of Tuscany, leading to the degradation of the region's cultural and aesthetic value.

Within this context, evaluating the sustainability of olive oil production in Tuscany poses inherent challenges due to its complex nature and the multitude of factors that must be considered to gain a comprehensive understanding. An all-encompassing analysis is required to identify effective actions and policies aimed at promoting a holistic approach to a more sustainable olive-oil system and addressing existing challenges such as the abandonment of olive groves. Therefore, the objective of this study is to assess the sustainability challenges and prospects of the olive oil supply chain in Tuscany. We seek to answer to the following research questions:

RQ1. What are the key environmental, economic, and social issues within the olive oil agri-food system?

RQ2. What are the various functions provided by the olive-oil supply chain and how do they contribute to sustainability?

RQ3. What are the possible solutions and strategies for preserving olive oil cultivation in the region and improving the sustainability of olive oil production?

METHODS

Although chemical and physical aspects related to sustainability can typically be quantified, the evaluation of intangible factors, such as social, cultural, environmental, and landscape values, is strongly influenced by specific local circumstances and subjectivity (Lombardo *et al.*, 2022). Due to this reason, we employed in-depth interviews to investigate the perspectives and contributions of different stakeholders involved in the olive oil supply chain.

We conducted 14 in-depth interviews from March to June 2023. The complete list of the interviews is provided in Table 1. In order to collect a comprehensive and exhaustive set of information, we selected stakeholders involved with the different production phases including farmers, farmer associations, agri-food producer associations, processors, retailers and researchers. This approach allowed us to gather insights from various actors regarding their roles, viewpoints, actions, and relationships within the olive-oil system, facilitating a comprehensive understanding of the supply chain dynamics.

Table 1. List of the interviews

ID	Stakeholder	Description
S1	Food technology researchers	Academic experts of olive oil processing and chemical characterization
S2	Agronomy researcher	Academic expert of olive varieties and cropping systems
S3	Farmer	Farm size: 250 ha. Olive cultivated area: 50 ha Traditional production system
S4	Farmer	Farm size: 40 ha. Olive cultivated area: 6.5 ha Traditional and intensive production system
S5	Farmer	Farm size: 8 ha. Olive cultivated area: 6 ha Traditional production system
S6	Farmer	Farm size: 8 ha. Olive cultivated area: 5 ha Traditional production system
S7	Farmer	Farm size: 45 ha. Olive cultivated area: 24 ha Traditional production system
S8	Farmer	Farm size: 23 ha. Olive cultivated area: 18 ha Traditional and intensive production system
S9	Agrifood producer association	Director of a national association of olive oil farms
S10	Processor	Founder and CEO of a modern olive mill (capacity 5000 kg/hour of olives)
S11	Nutrition researcher	Nutritionist doctor and academic expert of diet and nutrition properties of wheat and oil
S12	Farmer association	Director of a farmers' association
S13	Farmer and processor	Farm size: 15 ha. Arable land: 6 ha Olive cultivated area: 9 ha The olive mill is present in the farm
S14	Retailer	Executive of large-scale retail distribution

The interviews were recorded and transcribed verbatim. Subsequently, a content analysis was conducted using the constant comparative method (Glaser and Strauss, 1967) through the following steps. First, the transcripts were coded using the Nvivo software. The coder developed preliminary coding categories that reflected the consistencies and main themes identified within each interview. A second coder conducted an audit of the text, specifically focusing on those areas highlighted by the first coder as exemplary responses that provided insights about the emergent themes (Saldaña, 2021). In the last step, the emerged categories and themes were compared both within the same interview and across interviews (Boeije, 2002).

PRELIMINARY RESULTS AND CONCLUSIONS

Preliminary findings have revealed several key sustainability functions of the olive oil production in Tuscany. These include the preservation of rural territories, prevention of land abandonment, biodiversity protection, and cultural heritage. These distinctive elements provide recognition and market value for the Tuscan EVOO olive oil, further incentivizing sustainable production. However, the stakeholders' perspectives have also shed light on the barriers that impede the attainment of sustainability within the olive oil supply chain in Tuscany. Small farm dimensions and limited collaboration among stakeholders hinder the adoption of more sustainable processes. Embracing modern technologies and mechanizing production practices offer possibilities for optimizing resource utilization and reducing waste and costs, leading to more efficient and environmentally sustainable approaches. However, implementing higher levels of mechanization in agronomic practices proves challenging in steep terrains or small traditional farming systems with low densities. The scarce mechanization is one of the major barriers to pursue economic sustainability within this supply chain.

On the other hand, the significance of traditional olive cultivation systems assumes a pivotal role in the preservation and revitalization of marginal lands that would otherwise face abandonment. Traditional cropping methods also actively contribute to the conservation of agricultural landscapes, adorning scenic areas with picturesque olive groves. Therefore, the maintenance of olive crops not only fosters territory stewardship but also serves as a means of safeguarding cultural heritage and territorial identity.

The diversification of farm activities is a remarkable strategy to enhance economic sustainability in the olive oil farming. Farmers are increasingly exploring avenues beyond olive oil production, such as agritourism, guided tours, tastings, and cooking classes, to create new income sources and strengthening the economic viability of their activity. The promotion of olive oil tourism is strictly connected to this aspect and is considered a promising strategy not only to generate direct income for farmers but also to contribute to local economies by attracting visitors, stimulating local businesses, and showcasing the cultural and gastronomic heritage associated with olive oil.

The stakeholders acknowledge the imperative of adopting a holistic approach towards sustainability. Nonetheless, they emphasise that the economic pillar plays a fundamental role in not only supporting environmental, social, and quality initiatives but also enabling the comprehensive integration of diverse sustainability aspects within the supply chain. Financial constraints often impede the implementation of sustainable production methods, underscoring the significance of providing financial support to facilitate the transition towards more sustainable practices. The recently introduced Common Agricultural Policy (CAP) for the period 2023-2027 aligns with this objective. Notably, the implementation of Eco-scheme 3 focused on the “protection of olive trees of particular landscape value” aims to valorize the environmental and landscape significance of traditional olive-growing systems. This policy instrument represents an important step towards promoting sustainability and preserving the cultural and ecological significance of traditional olive farming in Tuscany. The imperative for advocating support to olive oil farmers arises from the intrinsic economic challenges characterizing olive oil cultivation, often yielding constrained profitability. Nonetheless, this agricultural pursuit engenders a diverse spectrum of favorable externalities that transcend conventional market assessment. These externalities, encompassing ecological enhancements, cultural preservation, and regional distinctiveness, remain insufficiently recompensed within existing market frameworks. Thus, targeted policy interventions become indispensable to rectify this market inefficiency, thereby acknowledging and incentivizing the multifaceted contributions of olive oil cultivation to societal well-being and the transition towards a sustainable food system.

This study allows to analyse the multifaceted and diverse aspects of sustainability within the context of olive oil production in Tuscany. Through an in-depth examination of the facilitating and hindering factors for sustainable practices, valuable insights could be obtained from the key stakeholders involved in the agrifood supply chain. Consequently, our research makes a significant contribution to the development of policy strategies aimed at improving sustainability within the agrifood sector and preserving and enhancing the value of this remarkable Italian asset.

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PROFILING CONSUMERS' FOOD BEHAVIOURS AND SECURITY: EVIDENCE FROM TWELVE AFRICAN CITIES

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Consumers, behavioural economics, cluster analysis, food-value chain, food security.

INTRODUCTION AND RESEARCH OBJECTIVES

Background knowledge of African consumers' food behaviours and security is of paramount importance for the development of nutrition-responsive food supply systems, the production of local, novel foods, the design of marketing strategies, and the development and implementation of tailored food policies. To fulfil this objective, the heterogeneity of the contextual and individual conditions implies the identification of homogenous consumer groups (e.g., according to economic conditions, age, education levels, food security dimensions, etc.; Visschers et al., 2013). By segmenting the consumers' food preferences, habits, and nutritional needs, policy makers as well as producers can better evaluate the relevant challenges and opportunities and provide customized measures and solutions to improve the consumers' diet quality and overall health.

The aim of this study is enhancing the overall understanding of African urban consumers' preferences and behaviours, by identifying groups of urban consumers with similar food security, diets and behavioural profiles, while linking such profiles to the urban consumers' stated propensity to adopt nutritional dietary innovations as well as to socio-demographic variables.

METHODOLOGY

Primary data from 5,924 urban consumers located in 12 cities from five African countries (Kenya, Morocco, Tanzania, Tunisia, and Uganda) was collected in 2022 through surveys. In 5 cities surveys were combined with incentivized economic in-lab experiments. In each city, 500 targeted urban consumers were recruited through randomly stratified sampling based on gender and age. When one gender (usually males) was poorly represented, it was oversampled to shed light on dynamics and conditions that would otherwise be overlooked. Only consumers with a residence in an urban area and responsible for food shopping within the household were sampled. To ensure that the sample was representative of the urban population, local enumerators sampled consumers in different city neighbourhoods and in the proximity of various food distribution systems (e.g., supermarkets, grocery stores, wet and food markets, areas with many street vendors, etc.).

The survey gathered information on: food purchasing habits and decisions, consumer preferences towards new local and more nutritious food, Individual dietary quality indicators (DQQ; GDQP, 2022), Household diet diversity (HDDS), Socio-economic and demographic household information, consumer setbacks and worries, social capital, trust, and risk attitudes.

To identify dietary and behavioural profiles of urban consumers linked to socio-economic and demographic factors, we implemented two cross-country cluster analyses:

1. A **cluster analysis focusing on the urban consumers' diet quality**. In this cluster analysis we profiled urban consumers according to a series of variables and indicators characterizing the consumer's diet. The objective of this profiling was (i) to assess whether we could discern groups of consumers with <u>similar dietary patterns</u>, (ii) to link these groups with urban consumers' propensity to adopt dietary innovations and socio-economic and demographic factors. The variables used for this cluster analysis are provided in Table 1.
2. A **cluster analysis focusing on the urban consumers' revealed preferences**. In this analysis we profiled urban consumers according to a series of information on behavioural precursors (e.g., trust, risk, and temporal revealed preferences) collected through the organization of incentivized in-lab behavioural experiments. The objective of this profiling was (i) assessing whether we could discern groups of consumers with <u>similar behavioural patterns</u>, (ii) linking these groups with urban consumers' propensity to adopt dietary innovations and socio-economic and demographic factors. The variables used for this cluster analysis are provided in Table 2.

The two analyses were run separately since the behavioural experiments were conducted only in five cities out of 12, and thus have a different sample size (5,226 urban consumers for the cluster analysis 1, while 843 consumers for the cluster analysis 2).

Table 1. Variables used for the dietary quality cluster analysis.

Variable code	Dietary indicator	Type	Levels
Vegetable_Fruit	Vegetable or fruit consumption	factor	0:1
Animal_Source	Animal-source food (ASF) consumption	factor	0:1
Sweet_Beverage	Sweet beverage consumption	factor	0:1
Sugar_Sweet_Drink	Sugar-sweetened soft drink consumption	factor	0:1
Sweet_Food	Sweet foods consumption	factor	0:1
Salty_Fried_Snack	Salty or fried snack consumption	factor	0:1
Whole_Grain	Whole grain consumption	factor	0:1
Pulse	Pulse consumption	factor	0:1
Nuts_Seeds	Nuts and seeds consumption	factor	0:1
Processed_Meat	Processed meat consumption	factor	0:1
All.5	All-5 score	factor	0:1
NCD_P	NCD-Protect score	numeric	0:9
NCD_R	NCD-Risk score	numeric	0:9
GDR	Global Dietary Recommendations score (GDR)	numeric	0:18

FGDS	Food Groups Dietary Diversity Score (FGDS)	numeric	0:10

Table 2. Variables used for the behavioral cluster analysis.

Variable code	Variable	Type	Levels
risk	Urban consumer's risk propensity	numeric	1:10
time	Urban consumer's patience score	numeric	0:10
player.trust	Consumer's trust towards peers (average endowment sent to peers' receivers)	Numerical categories	0;25;50;75;100
player.trust_inst	Consumer's trust towards food value chain (average endowment sent to food institutions)	Numerical categories	0;25;50;75;100

Different clustering algorithms were compared (partition around medoids and hierarchical clustering by Ward's method in the first analysis, while k-means clustering method, partition around medoids, hierarchical clustering by Ward's method in the second cluster analysis). This comparative analysis allowed us to select the best partitioning methods as well as the optimal number of clusters. Four indices commonly used to evaluate the optimal partitioning strategy were used: (i) Calinski-Harabasz index, (ii) Silhouette, (iii) Hubert & Levin C index, and (iv) Davies-Bouldin index.

In the first cluster analysis, the partition around medoids algorithm provides better results for all indices. Concerning the choice of the optimal number of groups, no substantial differences were found when comparing the Silhouette values across the different groupings. We then opted for a partition of the sample that would limit extreme imbalances over the group size. Based on this analysis, the partition around medoids method and a 4-cluster configuration were selected.

In the second cluster analysis, we observed that the Calinski-Harabasz and Silhouette indices reach the maximum value at a four-cluster partitioning for the k-means algorithm. The Hubert & Levin C-index, for which the optimum corresponds to the minimum value, tends to decrease as the number of clusters increases, however a steep reduction is observed at the four-group partitioning, after which the decrease decelerates. Based on this analysis, the k-means method and a 4-cluster configuration were selected.

Once the two cluster analyses were performed, we tested if a series of socio-economic and demographic variables differed significantly between the groups by using the Pearson's chi-squared test. We also tested the results of the behavioural cluster analysis with the diet indicators so to draw relevant parallelism between the consumers' behaviours and their nutritional choices. This allowed us to draw conclusions on how to tailor nutritional recommendations for the different groups of urban consumers.

RESULTS

The first cluster analysis performed on the DQQ variables identified four main groups of urban consumers with different diet profiling (Figure 1):

- Group 1: "*Consumers with unbalanced diets*"

This group includes 1,556 urban consumers (29.8% of the total). The consumers belonging to this group are characterised by having a diet centred on consuming fruit and vegetable (94.3% of the consumers), ASF (79.9%) and sweet beverages (78.5%). Only 2.4% of them consumes the recommended five food groups (all-5), despite the GDR score is relatively high (average of 10.9), indicating that their diet is overall healthy but extremely unbalanced. Ultra-processed food consumption (NDC-R) is in fact the lowest on average across the four groups (1.2)

- Group 2: "*Consumers with unhealthy diets*"
  This group includes 757 urban consumers (14.5% of the total). The consumers belonging to this group are characterised by having a diet mostly made of fruit and vegetables (97.5%), ASF (95.5%) and a series of unhealthy products as sweet beverages (94.7%), sugar-sweetened drinks (72.5%), sweet foods (81.0%), salty or fried snacks (80.6%), and processed meat products (20%). Their food consumption habits are predominantly unhealthy: ultra-processed food consumption (NDC-R) is the highest on average across the four groups (4.1), and only 19.2% of them consumes the recommended five food groups (all-5). The GDR score is also the lowest on average across the four groups (8.7).
- Group 3: "*Consumers with balanced and healthy diets*"
  This group includes 1,445 urban consumers (27.7%). These consumers show a balanced and healthy diet, with 90.5% of them consuming the five recommended food groups (all-5) and showing an above-average FGDS (7.14) and GDR (12.3). The rate of ultra-processed food consumption is the lowest recorded (1.76). They are characterised by having a diet made of healthy and recommended products as fruit and vegetables (100%), ASF (96.2%), pulses (89.0%), except for sweet beverage products (85.7%)
- Group 4: "*Consumers with balanced yet unhealthy diets*"
  This group includes 1,468 urban consumers (28.1%). This group is characterised by urban consumers having a higher-than-average balanced and healthy diet, yet characterised by some unhealthy habits (e.g., consumption of ultra-processed food items). The NDC-R score is high (3.7), despite almost all consume the five recommended food groups (95.3%). Their diet comprises several healthy food products as fruit and vegetables (100%), ASF (98.0%), pulses (76.3%), whole grain products (75.1%), and nuts and seeds (79.3%). However, it also includes several unhealthy products as sweet beverages (87.0%), sweet foods (63.5%), salty or fried snacks (76.2%), and processed meat products (19.7%).

Figure 1. Cluster profiling according to the dietary quality variables considered. Lines indicate the average.

The cluster analysis performed on the behavioural information (e.g., trust, risk, and temporal revealed preferences) identified four main groups of urban consumers with different behavioural patterns (Figure 2):

- Group 1: "*Patient, risk-averse, and mistrusting consumers*"
  This group includes 259 urban consumers (30.7% of the total). The consumers belonging to this group are characterised by high levels of patience (7.8), high risk aversion (4.0), and low trust levels.
- Group 2: "*Patient and risk-taking consumers*"
  This group includes 178 urban consumers (21.1% of the total). The consumers belonging to this group are characterised by high levels of patience (8.8), high risk-taking level (8.2), and average trust levels.
- Group 3: "*Impatient consumers*"
  This group includes 210 urban consumers (24.9% of the total). The consumers belonging to this group are characterised by being extremely impatient (1.6), while moderately risk averse (4.9) and trustful.

  Group 4: "*Trustful and patient consumers*"
  This group includes 196 urban consumers (24.9% of the total). The consumers belonging to this group are characterised by high levels of patience (7.6), moderately high-risk aversion (4.5), and high trust levels.

Results of the chi-square test of independence showed significant relations between clusters and socio-economic and demographic variables. For the first cluster analysis, Significant relationships were found between the groups and the country of origin, the respondent's age, the educational level of the respondent, and the average household income. For the second cluster analysis, significant relationships were found between the groups and the country of origin, the respondent's age, and the respondent's educational level. Finally, the results of a chi-square test of relationship between the clusters and the dietary quality indicators and the urban consumer's propensity towards new local food products show the following significant relationships:

- between the groups and the food groups dietary diversity score (FGDS) (0.009), and the NCD-Protect score (0.016);
- between the groups and the urban consumer's propensity to purchase a new local food product (0.034).

Post hoc comparisons show that urban consumers belonging to Groups 2 and 4 have the highest FGDS, and NCD-P, as well as the highest propensity to purchase local food products.

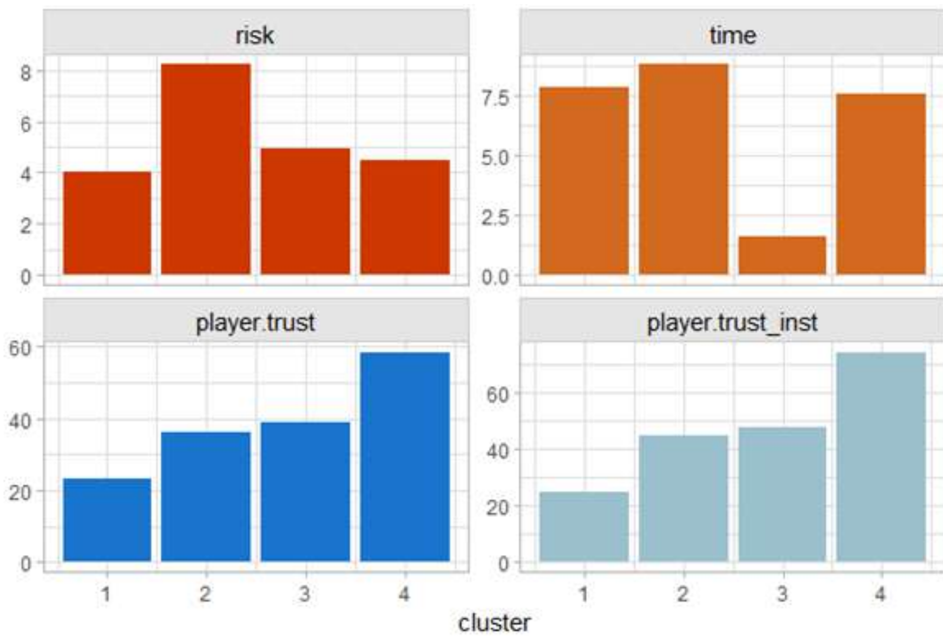

Figure 2. Cluster profiling according to the behavioural variables and preferences.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The results highlighted the diversity of behavioural and dietary profiles across urban consumers in the sampled African cities. The identified groups reacted differently also with regard to their stated propensity to enrich the household diet with new nutrient-dense or new local foods. This suggests that research, business, policy, and communication strategies aimed at fighting malnutrition should be shaped by the complexity and heterogeneity of the consumers' food conditions and the deriving objectives and actions be tailored to meet the consumer group-specific preferences and needs.

Profiling urban consumers according to their dietary conditions and behavioural traits is essential for developing tailored nutritional-oriented policy interventions. Our results suggest the following recommendations:

- public and private initiatives aiming at fighting malnutrition and enhancing healthiness of diets of African urban consumers should prioritize consumers facing food security issues and with most unbalanced diet profiles (e.g., Group 1, cluster analysis 1);

- transparent and clear interventions showcasing the benefits of adopting diets with healthier nutritional intakes (and the long term benefits they can bring to consumers) should be carefully designed and directed towards consumers with highest levels of impatience and unbalanced dietary intakes (e.g., Group 3, cluster analysis 2);
- policy interventions aimed at improving consumers' diet should include actions devoted to: (i) enhancing the diversity of the diets (e.g., promoting neglected and new food items, through support for producers and communication campaigns); (ii) lowering the consumption of unhealthy foods and beverages (e.g., developing communication campaigns comparing the nutritional risks of ultra-processed foods to the benefits of healthy foods, supporting the accessibility and affordability of local and nutrition-dense foods, etc.).

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TRADE-OFF BETWEEN INTEREST IN HEALTH AND SUSTAINABILITY AND THE ADHERENCE TO THE MEDITERRANEAN DIET: EVIDENCE FROM ITALY

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KEYWORDS
Mediterranean Diet; food consumption; health; sustainability; Italy.

INTRODUCTION

Climate change, driven by increased human emission of heat-trapping greenhouse gases (GHG), are threating the people, animal and environment health. To mitigate the negative effects of climate change (e.g., droughts, wildfires, and extreme rainfall) the European Commission established in 2019 the European Green Deal as the strategy to reduce GHG emissions of at least 55% by 2030 compared to 1990 (European Commission, 2023). A pivot role in the European Green Deal is covered by the Farm to Fork Strategy which promotes a transition to a sustainable agri-food system, acknowledging that a plant-based diet contributes to reach this objective (European Commission, 2023). Indeed, within the agri-food sector, the livestock one is the main contributor with emissions estimated at 7.1 gigatonnes of Co2-equiv per year, accounting for about 14.5 % of all anthropogenic GHG emissions, playing an important role in climate change (FAO, 2023).

Thus, contain consumption of meat, especially of the red one (e.g., beef, pork, lamb) and its related products, may be an individual's behavioural strategy to mitigate GHG emissions. According to World Health Organization guidelines, a shift to sustainable diets, with a lower consumption of meat, can reduce food-related GHG emissions of about 20% (Lacroix and Gifford, 2020). Besides that, it is also able to improve the health status by lower the incidence of disease, such as cardiovascular one, diabetes, and some cancers (Lacroix and Gifford, 2020).

An example of a diet rich in plant-based foods and lower in meat content is the Mediterranean one. The Mediterranean Diet (MD), largely spread in Southern European countries, includes a wide variety of foods, mostly plant-based ones (e.g., fruits, vegetables, whole grains) with a moderate consumption of animal-based products (e.g., milk, dairy products) and a limited intake of meat, especially red one and processed meat products (Fondazione Dieta Mediterranea, 2023).

Since the benefits of MD are increasingly recognized, some studies assessed the consumers' adherence to it due to environmental reasons (Biasini *et al.*, 2021) as well as for health-related motivations

(Ruggiero et al., 2019). To the best of our knowledge, no studies analyze the trade-off between Italians' sustainable and health-related motivations in affecting the adherence to the MD.

Thus, the current study aims to explore the main drivers associated with a higher adherence to the MD. Furthermore, it will size the existing trade-off between consumers' sustainable (e.g., interest in animal welfare, environmental welfare, local and seasonal consumption) and health-related motivations in affecting the adherence to the MD, also taking into account for consumers' socioeconomic characteristics.

Then, to reach the research goal a survey on a representative sample of 1800 Italians was employed. It involves the validated Sustainable Food Choice Questionnaire (SUS-FCQ), developed by Verain *et al.* (2021), to gain information about consumers' sustainability motivations in food selection as well as the validated General Health Interest (GHI) Scale, developed by Roininen *et al.* (1999), to explore the consumers' interest in health-related aspects. Finally, the obtained data was analysed through ordered logit regressions, following to principal component analyses.

METODOLOGY

2.1 Questionnaire

Data was collected by means of a web-based survey conducted in 2022 to a representative sample of Italian population (n = 1800), stratified by age, gender, and area of residence. After obtaining informed consent to participate in the study, respondents were asked to complete a survey composed of 4 sections.

The first section aims to collect information about the socioeconomic characteristics of the sample. In the second section participants were asked to complete a semi-quantitative food frequency questionnaire (FFQ). Such questionnaire, developed by Monteagudo *et al.* (2015) measures the individual's level of adherence to the MD via the Mediterranean Diet Serving Score (MDSS). The MDSS ranges between 0 and 24 points (Monteagudo *et al*., 2015). In section three, 13 statements were used to measure sustainable food choice motives. These statements were developed by Verain *et al*. (2020) based on a wide range of sub-factors including animal welfare (5 items), environmental welfare (5 items), local and seasonal (3 items). Respondents were asked to indicate for each statement to what extent these aspects were important to them for the food they eat on a typical day (1 = not all important, 7 = very important). Into the fourth and last section, eight statements, developed by Roininen *et al.* (1999), were used to measure the GHI. Statements were scored on a 7-point Likert scale with the categories ranging from "strongly disagree" to "strongly agree".

2.2 Statistical analysis

To reach the research goal an empirical relation was posed to explore the main drivers able to affect consumers' adherence to the MD. In this empirical relation, the adherence to the MD of the individual i was captured trough the ordered categorical variable $MDSS_i$. The individual behaviour is related to a set of variables: SEC_i is the variables' vector that captures the socioeconomic characteristics of the individual i (e.g., age, gender, education, income); SUS_i is the dummy variable that captures the interest (1) or not (0) in sustainability motivations in the individual i food selection; GHI_i is the dummy variable that captures the individual interest (1) or not (0) in health-related aspects; and, lastly R is a fixed effect that capture a space-variant factor that can shape the individual's adherence to the MD. The following is the expression that illustrates $MDSS_i$ as a function of these variables' vectors:

$$MDSS_i = f\,(SEC_i, SUS_i, GHI_i, R|\,\beta) + e_i \tag{1}$$

The dependent variable was the adherence to the MD identified through the $MDSS_i$ ranging from 0 to 24. Specifically, the $MDSS_i$ was divided into three groups, as follows: a value equal to 0 is given to each individual i who scored between 0 to 8, labelled as "Low-adherence"; a value of 1 is given to each individual *i* who scored between 9 to 16, labelled as "Moderate-adherence"; a value of 2 is given to each individual *i* who scored between 17 to 24, labelled as "High-adherence".

Principal component analysis (PCA), through the Kaiser criterion, i.e., eigenvalues >1, was employed to create three variables which indicated the individual interest for the sub-factors related to sustainability, such as environmental welfare, animal welfare, local and seasonal production. Results obtained for each variable were transformed in a dummy: a score of 0 is given when the value is below the mean and 1 is given for each value equal or above the mean. Similarly, results obtained from the variable that provide information about the individual interest in health-related aspects were transformed in a dummy: a score of 0 is given when the value is below the mean and 1 is given for each value equal or above the mean.

Finally, considered the categorical nature of the dependent variable, the ordered logit regression was conducted to capture the empirical relation, using STATA 14.0.

RESULTS

Results from testing the conceptual models suggested a whole statistical significance. In detail, the Wald X2 for the models estimated ranged from - 1554.3092 to -1432.8237 with a p-value equal to 0.000. Furthermore, the model's cutoffs were statistically different from 0, which supports the use of ordered logit models.

Results from the estimated parameters associated with variables that captured respondents' socioeconomic characteristics were all statistically significantly related to the adherence to the MD.

Female respondents were found less likely to have a have a "low adherence" to MD, than man. Older consumers (i.e., aged between 60 and 69 and over 69 years old), with higher levels of education (i.e., master's degree), and higher levels of family monthly income (i.e., between €2,501 and €3,000 as well as over €3,000) were found more likely to have a "medium adherence" and a "high adherence" to the MD.

Findings from the estimated parameters that captured the trad-off between consumers' sustainability motivations in food selection and the consumers' interest in health-related aspects showed that GHI is the most relevant driver in affecting the adherence to the MD. In detail, results from the estimated parameter measuring the GHI showed that consumers with values of interest in health-related aspects equal or higher the mean were found 2.4% less likely to have a "low adherence" to the MD, than individuals with values lower the mean. While, they were found 1.9% and 0.6% more likely to have a "medium adherence" and a "high adherence" to the MD, respectively. Furthermore, results from the estimated parameter that captured the general sustainability interest showed that consumers with values of sustainability motivations in food selection equal or higher the mean were found 2.2% less likely to have a "low adherence" to the MD, than individuals with values lower the mean. While, they were found 1.6% and 6% more likely to have a "medium adherence" and a "high adherence" to the MD, respectively.

Finally, the estimated parameters associated with variables measuring the multidimensional nature of sustainability were all statistically significantly related to the adherence to the MD except for the environmental welfare. Local and seasonal consumption was found the aspect more relevant in the sustainability's area in affecting the adherence to the MD. In detail, individuals with values of interest in local and seasonal consumption equal or higher the mean were found 3.1% less likely to have a "low adherence" to the MD, than individuals with values lower the mean. While, they were found 2.3% and 0.5% more likely to have a "medium adherence" and a "high adherence" to the MD, respectively. Furthermore, individuals with values of interest in animal welfare equal or higher the mean were found 2.4% less likely to have a "low adherence" to the MD, than individuals with values lower the mean. While, they were found 1.8% and 0.6% more likely to have a "medium adherence" and a "high adherence" to the MD, respectively.

In conclusion, results showed that the consumers' interest in health-related aspects was the main driver able to affect the adherence to the MD. Thus, improving consumers' knowledge on health-related issues is a possible tool for promoting the shift to diets, like the MD one, with a greater consumption of plant-based foods and a lower consumption of meat. Furthermore, within the multidimensional nature of sustainability, local and seasonal consumption was associated with a higher adherence to the MD among Italians. Therefore, increase the consumers' knowledge about the potential environmental benefits of consuming local and seasonal food could be another important strategy to promote the adoption of more sustainable diets.

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STRATEGIE DI CATTURA E DI CREAZIONE DEL VALORE NELLA FILIERA MANDORLICOLA SICILIANA: UN'ANALISI DI CASI STUDIO

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PAROLE CHIAVE
Mandorlicoltura, Valore aggiunto, Catena del valore, Convenienza economica, Valore di trasformazione

INTRODUZIONE E QUADRO TEORICO DI RIFERIMENTO

Nel contesto internazionale da alcuni decenni si assiste a una continua crescita della domanda di mandorle e di prodotti derivati dalla loro trasformazione (inclusi i sottoprodotti, quali malli, gusci e pelle), sia per le loro caratteristiche salutistico-nutrizionali (Barreca et al., 2020) sia per la loro versatilità di utilizzo (Saber and Mahrous, 2023). Dalla trasformazione delle mandorle si possono ottenere, infatti, numerosi prodotti e sottoprodotti che trovano impiego principalmente nel settore gastronomico (mandorle sgusciate intere, naturali o tostate, mandorle pelate, granella e farina di mandorle, latte di mandorle, ecc.), ma anche in quelli cosmetico, medico ed energetico (Sottile et al., 2020). Nel settore della cosmesi, ad esempio, è comune l'utilizzo dell'olio di mandorla (Roncero Heras et al., 2022); in ambito medico è stato, invece, verificato come l'introduzione delle mandorle nella dieta alimentare, contribuisca ad equilibrare il contenuto di colesterolo LDL e HDL, riducendo di conseguenza il rischio di malattie cardiovascolari (Barreca et al., 2020). Infine, in ambito energetico emerge l'utilizzo del guscio delle mandorle per la produzione di biomassa energetica e agro-combustibili, utilizzabili per stufe e caldaie (Kaur et al., 2020). Si tratta, in definitiva, di un comparto capace di offrire una gamma diversificata di prodotti e sottoprodotti che possono contribuire ad aumentare il valore aggiunto della filiera mandorlicola (Barral-Martinez et al., 2021).

In ambito nazionale, la coltivazione del mandorlo ha tradizionalmente trovato ampio spazio in Sicilia, dove può vantare una storia lunga più di due millenni caratterizzando economicamente talune aree dell'Isola (Barone and Sottile, 2019). Dagli anni '60 al primo decennio del secolo in corso la coltivazione del mandorlo ha registrato un calo progressivo in termini di superficie coltivata e produzione, venendo relegata per lo più ad aree marginali (Bacarella et al. 1991; Sottile et al., 2014; ISTAT, 2016). Negli ultimi anni, invece, si sta assistendo ad una inversione di tendenza del comparto, in particolare con la realizzazione di nuovi impianti, come conseguenza della crescente domanda nazionale ed internazionale per il prodotto siciliano dovuta alla qualità e alle proprietà organolettiche e nutrizionali che caratterizzano le varietà dell'Isola (Sottile et al., 2014). Le mandorle siciliane, infatti, rispetto a quelle di produzione estera (californiane in primis), sono dotate di un maggior contenuto di potassio, magnesio, calcio, fosforo e vitamina E, di una maggiore percentuale di oli, nonché di una minore presenza di aflatossine (Barreca et al., 2020). In relazione alle potenzialità del comparto ed alle peculiarità riconosciute delle mandorle siciliane, diviene prioritario per le imprese del settore definire ed adottare strategie efficaci orientate a creare e catturare valore lungo la filiera.

Le teorie della creazione e della cattura di valore rivestono un ruolo fondamentale nel processo di costruzione e cambiamento dei modelli di business. Più in dettaglio, la letteratura definisce la creazione di valore come l'aggiunta di valore economico a un prodotto attraverso attività che forniscono un livello di benefici superiore a quello che i clienti target già possiedono e per il quale sono disposti a pagare (Cucagna and Goldsmith, 2018). In sintesi, l'aggiunta di valore consiste nell'internalizzazione di ulteriori fasi della catena del valore. La cattura del valore, invece, si riferisce al processo attraverso cui le imprese trattengono una parte del valore che creano ed è comunemente definita come la differenza tra i ricavi e i costi di un'impresa e concettualizzata come lo scambio monetario dell'utilità di un bene o di un servizio in un determinato momento (Lepak et al., 2007). La creazione e la cattura del valore devono essere, pertanto, considerate processi distinti, poiché la cattura del valore da parte di chi l'ha creato non è mai garantita; infatti, il valore creato può essere catturato da un altro, secondo un processo chiamato "slittamento del valore" (*value slippage*) (Bowman and Ambrosini, 2000; Lepak et al., 2007).

Un recente studio nel settore del vino identifica quattro processi chiave per la creazione di valore, quali: produzione; marketing e vendite; comunicazione e promozione; innovazione (Broccardo and Zicari, 2020). Alcuni autori identificano il processo di gestione delle risorse come un meccanismo critico attraverso il quale il valore, una volta creato, può essere catturato e sfruttato (Sirmon et al., 2007); altri sostengono che nel processo di cattura del valore acquistano importanza l'innovazione, la creazione di conoscenza, l'invenzione e la gestione (Lepak et al., 2007).

Con riferimento alla letteratura sui modelli organizzativi esiste un importante divario relativo a come le strategie di creazione e cattura del valore si dispiegano nella pratica (Chesbrough et al., 2018; Saebi and Foss, 2015). In quest'ottica, il presente studio si propone di analizzare le strategie di creazione e cattura del valore adottate da due imprese che operano nel comparto mandorlicolo siciliano attraverso la valutazione della convenienza economica della trasformazione delle mandorle in prodotti finiti. Questa fase della catena rappresenta un'opportunità per creare e catturare ulteriore valore all'interno del settore mandorlicolo siciliano; si tratta, infatti, di un anello della catena che coinvolge sia la creazione di valore, attraverso l'aggiunta di fasi di trasformazione che generano prodotti diversificati a più alto valore aggiunto rispetto alle mandorle non trasformate, sia la successiva cattura del valore creato, attraverso strategie aziendali efficaci. Il criterio del calcolo del valore di trasformazione, basato sulla differenza tra il valore di mercato dei prodotti ottenuti e i costi sostenuti per la trasformazione, ben riflette la dinamica di creazione e cattura di valore: il valore di trasformazione rappresenta la misura monetaria del valore aggiunto generato dal processo di trasformazione, mentre il prezzo di trasformazione e il confronto con il prezzo di mercato riflettono la cattura di valore dell'azienda attraverso il processo di vendita dei prodotti trasformati.

Nello specifico, lo studio si propone di identificare modelli di successo che possono rappresentare un'opportunità per aumentare il valore aggiunto dei prodotti finali, con ricadute positive sui redditi degli agricoltori e sullo sviluppo delle aree interessate.

MATERIALI E METODI

Al fine di determinare e analizzare la convenienza economica alla trasformazione delle mandorle in prodotti trasformati ed in particolare le strategie di creazione e di cattura del valore è stato adottato l'approccio metodologico basato sull'analisi di casi studio aziendali (Yin, 2014). In particolare, sono state prese in esame due aziende mandorlicole (in un caso a conduzione biologica) della Sicilia centro-meridionale che effettuano sia la coltivazione sia la successiva trasformazione delle mandorle prodotte e, in parte, acquistate nel territorio.

Le aziende rilevate combinano diversi aspetti relativi alle strategie di creazione e cattura di valore: esse, oltre a differire tra loro per volume di mandorle prodotte e trasformate, hanno un differente grado di integrazione verticale e commercializzano il proprio prodotto a livello regionale, nazionale ed anche internazionale, seppur con quote di mercato significativamente differenti e con canali di vendita diversi. I dati rilevati attraverso interviste face-to-face durante i mesi di novembre e dicembre 2022 si riferiscono alla produzione del 2021.

Per la determinazione della convenienza economica alla trasformazione delle mandorle in prodotti finiti è stato calcolato dapprima il valore dei prodotti trasformati (attivo) e successivamente le spese sostenute per l'ottenimento degli stessi (passivo) seguendo Schimmenti et al. (2021). Secondo i principi generali della valutazione, sia gli elementi positivi che quelli negativi della trasformazione devono essere calcolati con i valori correnti al momento della valutazione e con l'ipotesi che le condizioni e i dati si presumano costanti. In pratica, il valore di trasformazione viene determinato attraverso un conto economico e rappresenta ciò che residua sottraendo al valore di mercato del prodotto trasformato l'ammontare di tutti i costi sostenuti durante l'intero processo di trasformazione, cioè, il tornaconto dell'imprenditore puro (una figura teorica che si approvvigiona all'esterno di tutti i fattori produttivi) che attua la trasformazione. Ciò rende confrontabili i risultati economici ottenuti da imprenditori diversi, anche in relazione all'eventuale diversità dei fattori produttivi effettivamente posseduti, necessari per realizzare la trasformazione stessa. Più specificamente il Valore di trasformazione è stato determinato nel seguente modo:

$$V_t = V_m - K$$

dove V_t è il valore di trasformazione delle mandorle; V_m è il valore di mercato dei prodotti ottenuti; K è il costo della trasformazione.

Rapportando il valore di trasformazione ottenuto (V_t) alla quantità di prodotti trasformati (q), si ottiene il valore di trasformazione per unità, detto prezzo di trasformazione ($P_t = V_t / q$). Se il prezzo di trasformazione così ottenuto è superiore al prezzo di mercato del bene oggetto di trasformazione, si può dedurre che il processo di trasformazione sia economicamente conveniente.

RISULTATI E CONCLUSIONI

Dai calcoli effettuati emerge per entrambe le aziende la convenienza nell'effettuare internamente il processo di trasformazione, piuttosto che nel vendere le mandorle tal quali. Nell'azienda 1 il prezzo di trasformazione è di 2,18€/Kg, ossia 0,23€/Kg più alto rispetto a quello di mercato delle mandorle biologiche in guscio, che è per l'anno preso in esame di 1,95 €/Kg, mentre per l'azienda 2 il prezzo di trasformazione è di 2,23€/Kg, cioè 0,43€/Kg più alto del prezzo del prodotto non trasformato (1,80 €/Kg).

Tabella 1 – Determinazione della convenienza economica alla trasformazione

Voci	**Azienda 1**	**Azienda 2**
Quantità di mandorle in guscio trasformate	20.000,00 kg	90.000,00 kg
Valore del prodotto trasformato	75.245,00 €	354.300,00 €
Costo di trasformazione	31.645,42 €	153.892,06 €
Valore di trasformazione	43.599,95 €	200.407,94 €
Prezzo di trasformazione	2,18 €/kg	2,23 €/kg
Prezzo di mercato delle mandorle in guscio	1,95 €/kg	1,80 €/kg

Analizzando i prezzi di trasformazione delle due imprese oggetto di studio risultano evidenti differenze imputabili a scelte strategiche adottate dalle stesse tra i quali il diverso grado di integrazione verticale: l'azienda 2 effettuando le operazioni di sgusciatura e pelatura internamente riesce ad ottenere risultati economici migliori oltre che una riduzione delle spese per i servizi extra-aziendali rispetto all'azienda 1, consentendo in questo modo di creare e catturare valore attraverso la riduzione dei costi di gestione e l'internalizzazione del processo di trasformazione. I maggiori volumi di prodotto lavorato, peraltro, consentono all'azienda 2 di realizzare delle economie di scala e di poter sfruttare in maniera più efficiente gli impianti di trasformazione. A questo vantaggio, si aggiunge la scelta strategica di adottare un canale di distribuzione corto con la vendita diretta del prodotto alle pasticcerie locali, prevalente nella stessa azienda, che consente di ottenere maggiori prezzi unitari rispetto alla vendita mediante intermediari, che, invece, risulta prevalente nell'azienda 1 (nonostante quest'ultima produca in biologico) evitando la dispersione di valore lungo la filiera. I suddetti vantaggi hanno consentito all'azienda 2 di ottenere un elevato valore di trasformazione.

I risultati ottenuti, seppur non generalizzabili per via del limitato campo di indagine, mettono in evidenza come la creazione di valore attraverso la trasformazione e la cattura di valore tramite l'internalizzazione di alcune operazioni siano strettamente legate all'efficacia delle strategie aziendali, consentendo di identificare modelli di successo per la creazione e cattura di valore aggiunto lungo la filiera mandorlicola basati su: i) elevati livelli di coordinamento verticale, sia nella fase della trasformazione (attraverso l'internalizzazione di tutte le fasi di trasformazione) che nella fase della distribuzione (vendita diretta a dettaglianti e clienti finali); ii) realizzazione di economie di scala. Lo studio condotto offre suggerimenti concreti per migliorare le decisioni degli stakeholder nello sfruttare appieno il potenziale di creazione e cattura di valore nell'industria delle mandorle.

Come emerso dall'indagine condotta, l'integrazione verticale sembra giocare un ruolo cruciale nella creazione e cattura del valore; da questo punto di vista, gli imprenditori agricoli potrebbero trarre vantaggio dall'internalizzazione di più fasi della catena del valore. Ciò, se da una parte può comportare dei costi iniziali d'investimento, dall'altra, aumenterebbe il potere contrattuale dei mandorlicoltori portando a maggiori redditi, specialmente se si realizzano economie di scala. Risulta, altresì, prioritaria l'adozione di tecnologie innovative sia in campo, per migliorare la produttività e la qualità delle mandorle, sia nella fase di trasformazione, che consentirebbero di accrescere il valore complessivo. Altro aspetto da non sottovalutare che potrebbe consentire di accrescere il valore percepito dai clienti è relativo alla definizione di efficaci campagne di comunicazione volte a promuovere le peculiarità salutistico- nutrizionali delle mandorle siciliane rispetto a quelle estere.

Anche la costituzione di strutture associative con il coinvolgimento di produttori e trasformatori potrebbe essere una strategia vincente per le piccole realtà imprenditoriali dell'isola, consentendo loro di condividere risorse, ridurre i costi di trasformazione e competere più efficacemente con le grandi imprese di trasformazione d'oltralpe, aumentando la capacità di catturare valore attraverso una migliore negoziazione dei prezzi di vendita.

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

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Food districts: a methodological proposal for territorial cooperation in agriculture

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PAROLE CHIAVE

Sistemi produttivi, Sviluppo territoriale, Governance, Sostenibilità

INTRODUCTION AND BACKGROUND

This paper originates from a feasibility study on actions that can be activated for the development of sustainable agri-food districts. We present the methodological approach used and our considerations on the analysis techniques adopted to define a development strategy for rural and agricultural systems, while the results of the study are under the copy right of Cariplo Foundation that financed the research. The activities were carried out from March to June 2022 by CREA - Research Centre for Agricultural Policies and Bioeconomy and CRIET - Interuniversity Research Centre in Economics and Territory.

The study is grounded in the recognition that the new development frontier of agricultural systems passes through a multidisciplinary strategy inspired by two fundamental canons. On the one hand, the reconversion and/or strengthening of production systems in a sustainable way with approaches ranging from agroecology to circularity of production processes is crucial; on the other, cooperation and integration in the production chain and between the supply chain and the socio-institutional system of the area must be fostered so that the actions of all actors coincide with the objectives of sustainable development.

The growing interest in the integrated programming of the food production from central and local institutions, and consequently from the economic actors involved, moves from the need to overcome technical and organizational inefficiencies, as well as distortions in the output and input markets in the agri-food sector. If on one side the evolution of the agri-food system has determined an increase in the segmentation and articulation of the agricultural and food productive processes, on the other side global competition has posed the need to solve the inefficiencies of the single firms (farms included) that are not able to: pursue efficient economic goals in the management of the production factors; overcome the over-fragmentation of the production process and consequently of the agri-food supply; improve the contractual power of farmers compared to firms operating up- and down-stream in the food chain; realise economic transactions in reasonable times, giving strength to the stages of product conservation and transportation and making sales and product destinations more stable.

Literature on the industrial districts, and other form of production organisation, is remarkably wide and, from the Seventies on, grew in many European countries and especially in Italy, where social and economic - and later environmental - conditions were particularly favourable, not only in the industry field but also in agriculture and agri-food[1] (Amin, 2000; Becattini, 2000 and 2002; Becattini et al, 2009; Carbone, 1992; CSS,2005). It is particularly interesting to note that the theoretical and analytical construction of districts as a model has been based on their capacity of keeping together an economic, social, and environmental dimension, even before it was recognized the multidimensionality of sustainable development. Such multidimensional features are particularly attractive in the agri-food system and in rural areas, making districts adaptable to both traditional and more conservative environments as well as innovative high-tech ones, big and small dimensions of farms, different categories of specialisation such as food, social, touristic ones, to deep rural and peri-urban ones, showing ultimately a great ductility and versatility (CSS, 2005).

The decline of the productivist paradigm in agriculture and the rising of the multifunctional approach to the primary activity and the farm organisation, supported by the EU common policies, has given new life and meaning to the so-called European model of agriculture based on small-size family farm often part-time and producing a differentiated outcome. Such model has improved the economic, social and environmental role of farms interacting with the territory, supported by a network of external economies, by a common sharing of knowledges and experiences, by the long-lasting personal connection as well as work (sometimes informal) connections, which all have effects on the transaction costs.

In such environment, farms become suppliers of social, recreational, and environmental services, diversifying their activity and products according to the logic of multifunctionality (Henke et al., 2014; Cimino et al. 2022). Districts are a part at of this context, as a viable solution to the segmentation of the productive system, encouraging integration processes and territorial cooperation, providing important opportunities to go beyond the limits of the fragmentation of the agricultural production. Besides its strictly economic function, districts can also supply another relevant function in modifying the levels of sustainability of the productions, in social, ethical, and environmental terms, specifically throughout the improvement of the multifunctional role of the primary activity and, more in general, promoting the improvement of the agro-environmental performance of the agricultural sector along the line of sustainability.

The territorial nature of agri-food districts enhances the pursue of sustainable goals through the support to economic, social, and environmental actors at the local level, which are also the main beneficiaries of the effects of the collective action on sustainability (Donati et al., 2012). The territorial dimension, through a decentralized setting of the decision process, represent one of the main qualifying elements of districts. A collective consultation among institutional and local actors is important to adjust the goals of using financial resources according to the diversity of the local situations. Given that it is an integrated strategy, local public institutions, together with the local economic and social actors, are called for modalities of intervention able to respond in an effective way to the specific questions arisen, included those regarding sustainable development.

Among the various modes of integration, districts can be considered a privileged tool, because they represent a model of “belt” governance (*meso* dimension) that favours relations between the *micro* part of the supply chain, farms and small rural enterprises, and the *macro* part, large processing companies, markets, institutions. The district is an instrument that tends to enhance the organisation of production and territorial systems (structuring), encouraging collaboration between usually competing players and networking for

[1] We refer to the so-called Agrifood districts, the rural districts, and the bio-districts, all operating around the production of food (or organic food) in rural or peri-urban areas.

actors who share a common goal (Becattini, 2001). It is a tool that triggers (where they are lacking) or reorganises (where they exist) governance mechanisms (Cremaschi, 2001; Tarangioli, 2013; Cisilino et al., 2023)

The growing interest in integrated food production planning by both central and local institutions systems, out of the consideration that cooperation arrangements can offer relevant opportunities to overcome the limitations of high fragmentation of agricultural supply and can facilitate endogenous innovation processes in a territory (Toccaceli, 2015; Belmin et al., 2018; Shongwe et al., 2019; Carillo et al., 2023). Governance is generally considered a critical factor in achieving adequate levels of sustainable development, allowing for the coordination of social learning with external actors, public authorities, or other sectors within and outside territories (Mantino, 2014; Quiñones Ruiz et al., 2020). More generally, multi-level governance involving local institutions, actors and productive systems is considered the key to achieving a higher rate of efficiency in land protection, rural development and sustainability, pursuing both a long-term approach and agricultural multifunctionality (Edelmann et al., 2020; Traversac, 2012).

To be defined district, a productive or territorial system comply with certain basic principles (Tarangioli, 2013): bottom-up approach, cross-sectoriality, co-ordinated of policies, presence of a specific development strategy and presence of a structured partnership whose members are representative of the interests of the sectors and territories involved. They aim to concentrate financial resources in homogeneous intervention contexts, to involve socio-economic actors in development dynamics, to foster the process of sharing and communication with local institutions and to support administrative decentralization in order to better orient interventions towards specific local needs. In other terms, the districts support the creation of systemic relations between actors of different natures and propose more complex and structured solutions to sectoral or territorial problems (Garofoli, 2003; 2006).

OBJECTIVES OF THE PAPER

The main objective of this work is to assess the extent to which the district, as an integrated system and a *meso* form of organisation of production, can improve sustainability through its governance capacity. This is a relevant research question for two main reasons: the first is that these policy tools aimed at supporting new and more sustainable forms of production and organisations receive a great deal of attention and financial support in the European Union funded policy planning; the second is that, rather interestingly, they seem to work on the regional territory at very different paces. For instance, some have a solid reputation and are very active as economic, social and even environmental catalysts of specific interests; others barely survive, and their actions have no visibility, thus they are actually perceived as another administrative burden by local actors.

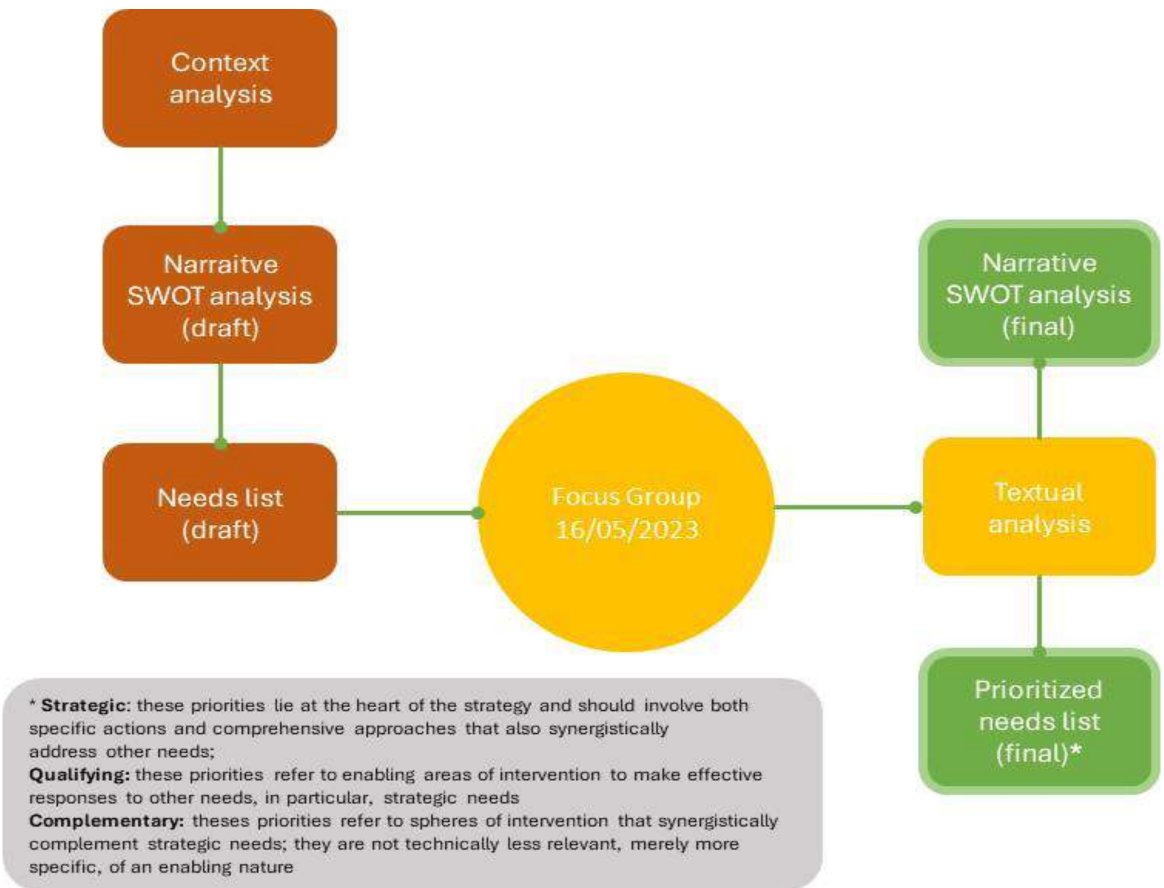
The area under investigation has a high degree of district-type organisation. The Lombardy Region in Italy has recognised 17 districts (8 rural, 4 quality agri-food and 5 supply chain) and 3 Biodistricts. All these experiences have been considered a starting point for the analyses proposed in this paper with the aim of monitoring strengths and weaknesses and identifying needs and practices on which to build the Cariplo Foundation's proposals for intervention. In fact, many of the existing districts are hubs of innovation, while others, on the other hand, have not triggered the expected development processes for different reasons such as the lack of ability to structure a shared strategy, the difficult relationship with the socio-economic context of reference, the ability to make organisational or structural innovations.

METHODOLOGY

The first step of the analysis was to classify the districts according to their missions and relations on the territory. On this basis, we then analysed their main needs in terms of sustainable policies. The reference context was analysed by means of a narrative SWOT analysis with the direct involvement of territorial actors. The needs were defined and prioritised after a discussion with key stakeholders through an organised focus group. Based on the minutes and recordings of the focus group, a computational language software (Iramuteq) was used to identify and disentangle stakeholders narrative, thus fine-tuning the preliminary list of needs. This stage of the work was then developed to formulate a set of operational proposals based on the identification of variables on which specific actions might have an impact.

From the methodological point of view, the analysis is mainly qualitative and is based on careful investigation of available literature strengthened by listening to and comparing with privileged stakeholders and actors. The context analyses were based on official statistical data supplemented by administrative statistics (AGEA, livestock registry database, regional data, etc.).

Figure 1 – Graphical representation of the steps of the feasibility study



RESULTS AND DISCUSSION

Eighteen needs that emerged from meetings with local stakeholders were identified: five related to the economic dimension of sustainability; five related to the environmental dimension and seven related to the social dimension. These needs were correlated with the typology of districts identified earlier, resulting into a matrix of sustainability. Additionally, three different levels of correlation were established: direct: indirect and low.

At the moment, the analysis is purely qualitative, but still sets the basic level of understanding of the problem and knowledge of the latent demand of policies expressed by the local actors, and this will allow for further investigation with a quantitative approach in the near future.

Building on our matrix, and given the expected results of establishing districts in the Lombardy region, a number of policy suggestions were highlighted:

1. Supporting actions to increase the capacity building;
2. Promoting Innovative and short supply chains;
3. Enhancing sustainability brand concerning those (business) activities developed in the district areas;
4. Supporting actions for of young farmers and entrepreneurs;
5. Fostering agreements for the provision of eco-system services.

These actions may potentially be adapted to all the forms of districts, but it must be kept in mind that the specific needs and the resulting policies implemented should be "district-specific" according to its nature and its main economic, social, and environmental features.

Other interesting points concern the supply chains organization, the difficulties affecting farms in accessing land, and the actions needed to support training and digitalization. Planning and integration are keywords to ensure a social function to the district areas, in addition to the commercial one. Furthermore, both public and private institutions could play a very important role both in strengthening communication between district actors and in spreading awareness on current issues concerning environmental emergencies (e.g., soil, water, etc.) that also affect costs and commodity prices.

The work comes at a phase characterized by a strong momentum towards food districts in Italy. It is an opportunity not only to investigate the performances of the phenomenon in Italy, but also to evaluate to what extent and at what scale they are spendable as a development and organisational model in Europe. On the one hand, the new CAP 2023-2027 programming period has relaunched some tools for cooperation in the agricultural sector and integration between supply chain stages. On the other, the current government is promoting a very strong narrative on agri-food quality issues to promote Made in Italy and regional and local specificities. The study opens up interesting research perspectives, particularly with regard to the evaluation of the implementation of actions planned or that can be activated by the food districts. Indeed, it is useful to understand whether and to what extent food districts represent a real tool to foster supply chain integration or whether they are, instead, more symbolic initiatives to promote, even at the level of political culture, a local governance of food systems.

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Using K-Means cluster Analysis for profiling citizens on perception of key factors of food security

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food security; agri-food systems; sustainable food systems; urban food policy; PCA; cluster analysis

INTRODUCTION

Food security is currently at the centre of the global economic and social debates, so it has a crucial role in ensuring economic physical access to food for present and future generations, one of the dimensions of food security (FAO, 2021). Agri-food system security has been reported on in recent years (Ingram, 2011). Conventional agri-food systems actually have limited resilience, being vulnerable to several shocks such as increasing occurrence of extreme natural events (Guo *et al.*, 2021), COVID-19 pandemic (Zollet *et al.*, 2021) and the current Russia–Ukraine conflict (Nasir *et al.*, 2022). This situation threatens the achievement of the Sustainable Development Goals (SDGs), particularly the Zero Hunger Goal (SDG 2), aiming at fighting hunger and granting food security and quality-wise food from sustainable farming systems. Cities have been increasingly involved in the development of food policies and fostering the transition to sustainable food systems. The urban agro-ecological transition, including food policies, may be crucial in facing environmental emergencies and improving agri-food systems, but is also key in solving political and social issues with an agro-ecological approach (Isaac *et al.*, 2018). Metropolitan areas are a key point and must be acknowledged in research and policy (Filippin *et al.*, 2023) (Zasada *et al.*, 2019).

The aim of this study is to identify citizens' profiles of the area of Metropolitan City of Bari (MCB), based on citizens' perceptions on the key factors related to food security and their socio-demographic characteristics. This is the first study attempting to classify citizens into different categories based on their viewpoints on food security. The segmentation and classification of these citizens could provide concrete basis to guide policy makers and other stakeholders toward a more effective creation of the MCB and to propose effective long-term measures aimed at ensuring safe, healthy, sustainable, and nutritious food for residents and surrounding communities.

MATERIALS AND METHOD

Data were collected using an online questionnaire and an initial sample of 600 citizens of the MCB was obtained. The survey was preliminarily tested through a pilot study involving members of the research group and a panel of experts on food security, in order to check the validity and reliability of the questionnaire.

Data collection took place from July to November 2022. Moreover, to make data collection less costly and time-consuming, a convenience sample was applied. The questionnaire included the concept of food security as established at the World Food Summit in 1996 (Mechlem, 2004), as well as the objective of the research. The questionnaire was structured in two parts: the first section containing 46 items on food security taken from the existing thematic scientific literature. For each question, corresponding to the item, participants were asked to assign a score through a 10-point Likert rating scale, explained by verbal anchors (-5 to -1 = obstacle; 0 = irrelevant; +1 to +5 = incentive). Starting from a 5-point Likert rating scale, which is considered the one that produces data of higher quality according to the scientific literature (Revilla *et al.*, 2014) (Robinson, 2018) , we also included negative scores for helping the respondents in evaluating items as obstacles. The second section collected data on the socio-demographic characteristics of the respondents, such as age, gender, education level, employment status and average annual income. A preliminary analysis showed that most of the respondents aged 20-30 years old and >70 years old gave irrelevant answers (0 score) for at least 70% of the items. This may be due to their limited involvement and/or interest in food security issues. Therefore, these respondents were excluded from the sample. The final eligible study sample consisted of 377 respondents.

In this study, data were submitted to two types of analyses. First, a descriptive analysis was carried out to describe the sample, through computation of percentages and cumulative frequencies. Then, two multivariate analyses were conducted: Principal Component Analysis (PCA) and cluster analysis (k-means technique).

PCA was applied to reduce the initial 46 variables into fewer new variables, called principal components (PCs), which can explain maximum variability out of the total variability. PCs were extracted using an Eigenvalue of 1 as a cut-off, according to Guttman-Kaiser criterion. In this research, correlation matrix was calculated.

Then, K-means method was applied and the selection of the number of clusters k has to be chosen a priori; four clusters resulted the optimal number. K-means clustering was carried out based on the resulting PCs; once clusters were obtained, they were characterised, taking into account both citizens' socio-economic characteristics and their perceptions of the key factors related to food security.

RESULTS

Descriptive analysis highlights the characteristics of the initial study sample based on the following variables: gender, age, education, level of income and employment. The majority are males (54%) and middle-aged (30% are 30-39 years old), with a middle-class of income from 25,100 to 40,000 €/year (45%). The most frequent job descriptions were full-time employment (64%); the unemployed, including housewives, were 2%. The majority hold high school degrees (44%) and university or postgraduate degrees (42%). Moreover, the majority of citizens attributed a role of incentive to most of the 46 items. In particular, the main items evaluated as incentives to achieve food security were ICT services (91%), food policy (88%), qualification of workforce (84.7%), quality control (84.2%), EU support and food banks (83.7% and 83.5% respectively). On the contrary, the main items considered as obstacles to achieve food security (from -5 to -1 score) were: price volatility (74.1%), climate change and crop genome adaptation (67.4%), market globalization (51.6%), and large-scale retail (LSR) power (47%). Additionally, about one third of the respondents declared that intensive production system is also considered an obstacle.

PCA, performed using all 46 items and taking into account the final sample, enabled the definition of eight new components. These components showed eigenvalues higher than one, and the cumulative variance explained by the eight new components was 72.2%. Only the first four PCs, were considered, due to their highest significant contribution to explained variance, their easier interpretability and labelling.

According to the factor loading of the variables for each component, the selected four components were labelled. The first component highlighted those social aspects, such as social certification, fighting illegal hiring and food policy, have to be the basis of current and future urban food policy. This component was labelled as a "governance" macro-area.

In the second component, labelled the "market" macro-area, market aspects caused the main drivers of food security. In the third component, environmental certification, quality control, and certification of Protected Designation of Origin - Protected Geographical Indications (PDO-PGI) showed factor loading with maximum scores, in such a way that this third component was labelled the "quality" macro-area. The fourth component was labelled "sustainability of production systems", because it mainly included sustainable production technology, such as food waste recycling technology, intensive production and food loss and waste strategies variables, with maximum factor loading.

The next step was to use these four main components and related items for the application of the k-means clustering. A four-cluster solution according to the components PC-1 (governance), PC-2 (market), PC-3 (quality) and PC-4 (sustainability of production systems) emerged as the optimum for k-means clustering. In particular, cluster 1 was represented by MCB citizens sensitive to components PC-2 (market) and PC-4 (sustainability of production systems), and therefore interested in the market and sustainability aspects of production systems as levers for achieving food security. Cluster 2, instead, was represented by MCB citizens convinced that components PC-1 (governance) and PC-3 (quality) could be drivers for food security. Cluster 3 was represented by MCB citizens believing that only the PC-3 component (quality) was not a driver to achieving food security; finally, MCB citizens belonging to cluster 4 considered PC-1 component (governance) a driver for food security, while remaining indifferent to other PCA components.

The four clusters of MCB citizens were profiled according to the socio-economic variables; only 10 items were considered. The items were grouped in four macro-areas: governance (food policy, food loss and waste, EU support), market (LSR power, price volatility, market globalisation), sustainability of production systems (intensive production, FW recycling technology) and quality (PDO-PGI certifications, environmental certification).

The first group of citizens, identified as cluster 1 and labelled as "Capitalists", represents 15% of the sample. They are mainly males between 30-39 years old, full-time employees with high annual income (more than 60,000 €/year). In relation to the governance macro-area, these citizens showed a negative perception (i.e. barrier to food security achievement) towards the items belonging to this area, namely "food policy" (-0.7), "food loss and waste (FLW)" (-0.1) and "EU support" (-0.9). This result is in contrast with findings by other authors (Minotti *et al.*, 2022) (Calori *et al.*, 2017), who defined governance as key factor for development of urban food policies that support sustainable nutrition and diets, food production availability and distribution and management of food waste. Furthermore, these citizens showed, in relation to the "market" macro-area, a perception of irrelevance (score equal to 0) of "LSR power", and negative scores for the items "price volatility" (-2.7) and "market globalisation" (-0.6). This is in line with other scholars, who found that the seasonal variation in food prices leads consumers to uncertainty and risk (Amolegbe *et al.*, 2021) (Duarte and Ozaki, 2019). Regarding the "sustainability of production systems" macro-area, these citizens showed a positive score for the item "intensive production" (3.3). Indeed, they assumed that intensive production could improve food availability and liberate these economies from the risk of hunger and poverty (Giller *et al.*, 2021). Conversely, they attributed a negative score to the item "food waste recycling technology" (-0.1). Moreover, these citizens attached a negative score for the quality macro-area, in particular for "PDO-PGI certifications" (-0.1 score) and "environmental certification" (-1.0), these items were thus considered barriers to food security achievement.

The second group of citizens, identified as cluster 2 and labelled as "Hedonists", represents 36% of the sample. It includes mainly males with a high education level (university degree or postgraduate) and high-level annual income (more than 60,000 €/year). These citizens showed positive scores for the items within the "governance" macro-area: 3.2 for "food policy", 3.3 for "food loss and waste (FLW)" and 2.8 for "EU support"; these items were thus considered drivers for achieving food security. As suggested by the literature, governance is a key component of sustainable food systems and a requirement for the development of food policies (del Valle M *et al.*, 2022) (Boylan *et al.*, 2019). Moreover, the Hedonists showed negative scores in relation to the "market" macro-area. In particular, the "LSR power" score was −0.4, the "price volatility" score was −3.2 and the score for the "market globalisation" item was −2.8.

Therefore, these citizens identified the "market" macro-area as a significant barrier to food security achievement. A further interesting point is related to the "quality" macro-area. In particular, the citizens of MCB assigned positive scores to the items "PDO–PGI certifications" and "environmental certification" (3.6 and 5, respectively). In this regard, quality certification schemes could reduce consumers' concern for food security (Tran and Goto, 2019). The labelling as "Hedonists" is due also to a negative score attributed to the item "intensive production" (−0.6) as well as to a positive score for "food waste recycling technology" (1.8) within the macro-area "sustainability of production systems".

The third group of citizens, identified as cluster 3 and labelled as "Law-confidents", represents 45% of the sample. It consists of males with an average level of education (high school). These citizens indicated that all the items belonging to the governance macro-area are strong drivers for achieving food security. In fact, the "food policy" score was 3.5, while the scores for both "food loss and waste (FLW)" and "EU support" were 4.0. According to the literature, efficient governance in urban areas can be achieved through the development of EU lighthouse projects focused on food policies and food security issues (Martin *et al.*, 2019) and the implementation of approaches for sustainable management of biowastes (De Boni *et al.*, 2022). Moreover, the "Law-confidents" indicated "intensive production" (score 1.1) and "food waste recycling technology" (score 3.2) as drivers to food security achievement. In this regard, some scholars suggested the bioprocessing of food by-products and wastes (FBPW) as a sustainable strategy for food loss and waste management (Minervini *et al.*, 2022). Positive scores were also assigned to the "quality" macro-area, particularly to the items "PDO-PGI certifications" (3.4) and "environmental certification" (2.9), which are considered important elements for food security achievement.

The fourth group of citizens identified as cluster 4 and labelled as "Conservatories" represents 4% of the sample. They are mainly women with a low-to-medium annual income level (from 25,100 to 40,000 €/year). The items belonging to the "governance" macro-area are considered as significant drivers for food security achievement: the score for "food policy" was 2.9, while the scores for "food loss and waste (FLW)" and "EU support" were 0.8 and 2.9 respectively. In this regard, urban food policies can represent a key factor in achieving food security in European cities (Martin *et al.*, 2019). In addition, strategies and initiatives carried out in EU cities may positively affect the "food waste behaviour" of citizens (Mondéjar-Jiménez *et al.*, 2016). Conversely, MCB citizens attached an irrelevant score (0) to the items "intensive production" and "PDO-PGI certifications; the irrelevance of PDO–PGI certifications may be linked to the contribution of food certification schemes in increasing food sale prices (Tran and Goto, 2019). Moreover, "food waste recycling technology" (score -2.5) and "environmental certification" (score -1.2) are considered barriers to achieving food security. "Conservatories" also considered the market macro-area as an evident obstacle to food security, particularly regarding the item "price volatility" (-5).

CONCLUSIONS

Cities are increasingly involved in the development of food policies, becoming key points in achieving food security and fostering the transition to sustainable agri-food systems. This study is a contribution to advancing knowledge of urban food policies. Indeed, four groups of citizens were clearly characterized taking into account their perceptions of key factors affecting food security, within four macro-areas (governance, market, quality and sustainability of production systems). These overall results may be a starting point for setting up tailored strategies in the framework of the food policy of the MCB.

The proposed approach and results may support EU policy makers in identifying key macro-areas and matters toward which to direct public funding in order to improve food security in urban areas, and to put in place actions enhancing citizens' knowledge and awareness of key issues of food security.

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CLIMATE CHANGE IMPACT ON AGRICULTURE IN ITALY: A LITERATURE REVIEW

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ABSTRACT

This paper provides a systematic literature review regarding climate change impact on agriculture. Applying the systematic literature review, a sample of 44 studies published over the last 20 years was reviewed through descriptive and content analysis. This study shows, both based on projections meteorological for the coming decades and based on meteorological empirical observations over the past decades, the three sectors may be subject to both positive and negative effects of climate change. Positive effects include the possibility of an expansion of areas suitable for cultivation towards higher latitudes or in areas at higher altitudes. Negative effects include an increase in temperature and decrease in rainfall, which will result in crops being affected by earlier phenological phases or alteration of the vegetative cycle, with a decrease in yields and crop quality. For dairy cows an increase in heat stress is foreseen with a consequent decrease in milk production and quality.

1. INTRODUCTION

This paper was born within the research activities of the ADA project co-financed by the European Commission through the Life Program. The project ADA aims at enhancing the capacity of the agricultural sector to define adaptation plans to climate change, thus strengthening farms ability to manage risks and prevent damages[1].

The IPCC in 2021 affirmed the urgency of global action to restrain climate change and address its effects that are difficult to control[2]. Already in 2015, the European Environment Agency (EEA) alerted to the risk of climate change to food security, highlighting possible changes to European agricultural production in different climate zones[3]. Instead, European Severe Weather Database (ESWD) - the European database on extreme weather events – demonstrates in 2022 a substantial increase for cloudbursts, floods, tornadoes, hailstorms, and heat waves compared to previous years[4].

The negative impacts of climate change affect the whole of Europe and in particular the Mediterranean area. Extreme weather conditions cause economic losses for farmers and more generally for

[1] https://www.lifeada.eu
[2] https://www.ipcc.ch/report/ar6/wg1/
[3] https://www.eea.europa.eu/it/segnali/segnali-2015/articoli/agricoltura-e-cambiamento-climatico
[4] https://eswd.eu/

all agri-food chains. In the next decades, the intensification of hard-to-predict extreme weather events will put pressure on the agricultural sector, impacting farmers' incomes and farm's survival.

To cope with future scenarios, farms and production chains need to put in place appropriate adaptation strategies. Farmers, particularly small and medium-sized ones, are highly vulnerable to climate change that directly impacts crop yields and jeopardizes their income and their ability to survive.

This paper analyses the impact of climate change on the three agri-food value chains: wine, dairy (Parmigiano Reggiano), and fruit and vegetables - through a review of the relevant literature. The choice of 3 supply chains is linked to the ADA project which focuses on these 3 representative supply chains of the Italian agri-food sector. For this reason, the analysis of the literature is concentrated in the Mediterranean area.

The literature review for the dairy supply chain was divided into two fields of investigation: i.e. analysis of the impact of climate change on both the yields of productions destined for animal feed and on the yields and quality of milk and dairy products destined for human consumption.

2. METHODOLOGY

The literature review was conducted in Web of Science™, Google Scholar™ and with the Scopus® databases.

Specifically, Web of Science™ and Scopus electronic scientific database (http://www.scopus.com accessed on July 2022) were selected as they cover a wide range of natural science and interdisciplinary index studies. While Google Scholar™ was used to identify the so-called grey literature.

The literature search focused only on studies (peer-reviewed articles and reviews that include empirical applications, measurements, or evaluations) in the context of climate change in the period 2000-2022.

The search terms for each value chain are reported in Table 1.

Table 1 - Summary of the search protocols employed for the selected value chains

Value chain	Search keywords*	Initial count
Viticulture	'viticulture', 'climate change', 'Italy'	N= 49
Fruit and vegetables	'climate change', 'fruit', 'vegetables', 'yield', 'Italy'	N=37
Dairy supply chain (crops)	'impact', 'climate change', 'grain', 'yield'	N=35
Dairy chain (milk yields)	'heat stress index' 'temperate climate' 'dairy cattle'	N=34

*Topic searches on titles, abstract and keywords.

The initial screening process prioritized the selection of studies that specifically investigated and provided insights on Italian regions, or at most other Mediterranean regions if there are comparable conditions.

In the face of a large literature on the impact of climate change in agriculture, the studies that analyse the impact on the yields and incomes of farms in the supply chains and areas considered are few. After screening process our research has selected a total of 44 studies that meet the search criteria used.

The figures (1,2,3,4) include the data relating to temperatures and/or precipitation: in some studies data are general taken from climate models based on emission scenarios, in other or the observed empirical data are reported. Based on these data, we reported the relative results of yields, income, impact on phenology, impact on quality, possible proposal of adaptation measures.

Figure 1 - Literature review of wine supply chain

Source	Country/	Variety	Hypothesis on climate variables		Impacts				Adaptation
	Region		Temperature	Precipitation	Phenology	Yield	Quality	Income	
(Biasi et al., 2019)	Umbria	Grechetto di Orvieto; Chardonnay; Aleatico; Merlot; Cabernet sauvignon; Cabernet franc; Sangiovese	Increase	Increase	Yes	-	Yes	-	No
(Moriondo et al., 2011)	Tuscany	Sangiovese	Increase	Decrease	Yes	Decrease	Yes	Decrease	Yes
(Alikadic et al., 2019)	Trentino-South Tyrol	Pinot neo; Pinot grigio; Merlot; Chardonnay; Sauvignon Blanc	Increase	-	Yes	-	Yes	-	Yes
(Sacchelli et al., 2017)	Tuscany	Sangiovese	Increase	-	-	Decrease	-	Decrease	Yes
(Zhu et al., 2016)	Tuscany	Sangiovese	Increase	-	-	Decrease	Yes	Decrease	Yes
(Bonfante et al., 2018)	Campania	Aglianico	Increase	Decrease	Yes	-	Yes	-	Yes
(Caffarra and Eccel, 2011)	Trentino-South Tyrol	Chardonnay	Increase	-	Yes	-	-	-	Yes
(Leolini et al., 2018)	Europe; Italy	Glera; Chardonnay; Merlot; Cabernet; Sauvignon	Increase	-	Yes	-	-	-	No
(Sacchelli et al., 2018)	Tuscany	Sangiovese	Increase	Decrease	-	Decrease	Yes	Decrease	Yes
(Fraga et al., 2016)	Europe; Emilia Romagna; Lombardy	Pinot nero	Increase	Increase in spring; decrease in summer	Yes	Decrease	Yes	-	No
(Ferrise et al., 2016)	Europe; Italy	Sangiovese	Increase	Decrease	Yes	Decrease	-	-	No
(Lionello et al., 2014)	Apulia	-	Increase	Decrease	-	Decrease	-	-	No
(Teslić et al., 2019)	Emilia Romagna	-	Increase	Decrease	Yes	Decrease	Yes		Yes
(Eccel et al., 2016)	Trentino-South Tyrol	Regional varieties	Increase	Decrease	Yes	-	Yes	-	No
(Caffarra et al., 2012)	Trentino-South Tyrol	Chardonnay	-	-	Yes	Decrease	-	-	No

Figure 2 - Literature review of dairy supply chain (crops)

Source	Country/ Region	Crop	Hypothesis on climate variables		Impacts				Adaptation
			Temperature	Precipitation	Phenology	Yield	Quality	Income	
(Garofalo et al., 2019)	Italy	Wheat	Increase	-	-	Increase	-	-	Yes
(Dono et al., 2013)	Italy	Maize; wheat; soybean; barley; sorghum	Increase	Decrease	-	Decrease	-	Decrease	Yes
(Ventrella et al., 2012b)	Apulia	Wheat	Increase	Increase	-	Increase	-	-	Yes
(Tuttolomondo et al., 2009)	Italy	Barley	Increase/ Decrease	Increase	Yes	Increase	-	-	Yes
(Tubiello et al., 2000)	Italy	Maize; wheat; soybean; barley; sorghum	Increase	-	Yes	Decrease	-	-	Yes
(Mereu et al., 2021)	Italy	Wheat; maize	Increase	-	Yes	Decrease	-	-	Yes
(Cammarano et al., 2019)	Mediterranean area	Wheat	Increase	Decrease	Yes	Decrease	-	-	Yes
(Bocchiola et al., 2013)	Lombardy	Maize	Increase	Increase/ Decrease	Yes	Increase/ Decrease	-	-	No
(Casale and Bocchiola, 2022)	Lombardy	Pasture crops	Increase	Decrease	Yes	Increase	-	-	Yes
(Dibari et al., 2020)	Italian Alps	Pasture crops	Increase	Contrasting patterns	-	Decrease	Decrease	-	No
(Rinaldi and De Luca, 2012)	Apulia	Sorghum	Increase	Increase	Yes	Decrease	-	-	No
(Dono et al., 2016)	Sardinia	Grassland, hay crops, alfalfa, Italian ryegrass, silage maize	Increase	Increase	-	Decrease	-	Yes	Yes

Figure 3 - Literature review of dairy supply chain (milk)

Source	Country/ Region	Animal breed	Hypothesis on climate variables		Impacts			Adaptation
			Temperature	Precipitation	Yield	Quality	Income	
(Bernabucci et al., 2002)	Lazio	Holstein	Increase/ decrease	-	-	-	-	No
(Bernabucci et al., 2015)	Lombardy	Holstein	Increase/ decrease	-	-	Yes	-	Yes
(Bernabucci et al., 2014)	Lazio	Holstein	Increase/ decrease	-	Decrease	Yes	-	Yes
(Summer et al., 2019)	Mediterranean area	Friesian, Brown, Beef and Dairy Cattle	Increase	-	Decrease	Yes	-	Yes
(Bertocchi et al., 2014)	Lombardy	Holstein	Increase	-	-	Yes	Decrease	No
(Vitali et al., 2019)	North Italy	Holstein	Increase	Decrease	Decrease	Yes	-	Yes
(Habeeb, 2020)	World	Fresian	Increase	-	Decrease	Decrease	Yes	No
(Dono et al., 2016)	Sardinia	Holstein	Increase	Decrease	Decrease	Yes	Decrease	Yes

Figure 4 - Literature review of fruit & vegetables supply chain

Source	Country/ Region	Variety	Hypothesis on climate variables		Impacts				Adaptation
			Temperature	Precipitation	Phenology	Yield	Quality	Income	
(Giuliani et al., 2019)	Apulia	Tomato	Increase	Decrease	-	Decrease	-	-	Yes
(Saadi et al., 2015)	Mediterranean area	Tomato, durum wheat	Increase	Decrease	Yes	Decrease	-	-	No
(Winkler et al., 2013)	World	Perennial crops	-	-	-	Decrease	Yes	-	No
(Ventrella et al., 2012a)	Apulia	Tomato	Increase	Decrease	-	Decrease	-	-	No
(Ventrella et al., 2012b)	Apulia	Tomato	Increase	Increase	-	Decrease	-	-	Yes
(Di Bene et al., 2022)	Apulia	Vegetables crops	Increase	Increase/ decrease	-	No effects	Yes	-	Yes
(Bisbis et al., 2018)	Mediterranean area	Vegetable crops	Increase	Increase/ decrease	Yes	Increase/ decrease	Yes	-	Yes
(Bird et al., 2016)	Sardinia	Tomato	Increase	Decrease	-	Decrease	-	-	Yes
(Del Borghi et al., 2022)	Northern Italy; Tuscany; Apulia	Beans, peas, sweet corn, tomato	Increase	-	Yes	Decrease	-	-	Yes
(Ravasi et al., 2020)	Emilia Romagna	Peas	Increase	Irregular distribution	Yes	Decrease	-	-	Yes
(Cammarano et al., 2020)	Campania	Tomato	Increase	Decrease	Yes	Decrease	-	-	Yes

3. RESULTS AND DISCUSSION

3.1 VITICULTURE SECTOR

The results of the literature review for the viticulture sector identified 15 contributions published in peer-review scientific journals that provide quantitative and descriptive data useful for assessing the impacts of climate change scenarios. These studies were specifically focused on the C1, C2, and C3B community wine-growing zones, which encompass a wide range of territories including all of Italy, the southern regions of France, Spain, and Portugal. It is worth noting that these regions are known for their wine production and are considered key players in the global wine market.

The majority of studies address the impacts of climate scenarios by referring to future climate projections and simulations extracted from global climate models (General Circulation Models - GCMs) or Regional Climate Models (RCMs). Future scenarios generally are studied with various climate models under different climate radiative forcing scenarios (Representative Concentration Pathways - RCPs) to account for different possible future evolutions of greenhouse gas emissions, pollutants, and land use.

All studies report changes in climatic variables primarily driven by changes in temperature and precipitation (increasing or decreasing) which can have significant impacts on phenology, yields, and quality of crops, as well as income for farmers.

Some studies have proposed adaptation measures that can help farmers adapt to changes in temperature and precipitation patterns, protect their crops and livelihoods.

Teslić et al. (2019) evaluated the impact of climate change on viticulture in the Emilia-Romagna region in Italy using bioclimatic indices and two RCP scenarios (RCP4.5 and RCP8.5). Under the RCP8.5 scenario, the entire region is likely to be too hot for grape production by the end of the century, while under the RCP4.5 scenario, the region could still be suitable for grape growing, but with changes in grape yield and quality, varietal suitability, and wine types.

Similar results are highlighted in the study by Sacchelli et al. (2017) which reports a reduction in revenues and financial damage due to decreased yields and quality for the Sangiovese variety in Tuscany.

The results of these studies demonstrate the negative impacts of climate change on the viticulture sector in Italy and the need for adaptation measures to protect the yields and quality of grapes, as well as the financial sustainability of the industry.

Moriondo et al. (2011) created an operational framework that includes statistical downscaling of GCM data for the period 1975–2099, use of downscaled data in simulation models, spatial interpolation of model outputs, and an economic and quality model. The findings indicate that as a result of a gradual rise in temperature and a decline in precipitation, there is an increase in the area that may be suitable for grapevine cultivation, a shortening of the grapevine growth cycle, a gradual decline in final yield, and a shift in the production areas of premium wine to higher altitudes.

3.2 DAIRY SUPPLY CHAIN (CROPS)

Regarding crops intended for animal feed, a literature review was carried out consisting of 11 publications. The emerged impacts are different, and they are linked to crops considered (wheat, barley, corn, cereals, soy, sorghum) according to the geographical area in which the study was contextualized (Italy, Egypt, Germany, the Mediterranean Basin, France and Spain). More in detail, the scientific studies analysed were conducted through climate projections mainly concerning two types of adverse climatic events such as temperature variation (extreme maximum and minimum temperatures) and variation in rainfall. The methodology used to quantify the impact of the climatic events consists in the application of Crop Simulation Model (CERES, ISI-MIP), Climate Model (CanESM2, HadGEM2-ES, CCSM4, GFDL-ESM2M, NorESM1-M, EPIC), Circulation Models (HadCM3, CCSM3, ECHAM5), which use quantitative descriptions of eco physiological and atmospheric processes to predict how crop growth and development are influenced by climatic conditions.

The main results show how climate change associated with the presence of prolonged periods without frost leads to the expansion of areas suitable for cultivation with higher yields (Dono et al., 2013; Ventrella et al., 2012a). Otherwise, the overall expected reduction in rainfall and extreme heat waves can negatively affect crop productivity, leading to greater variability in yield and, in the long run, to a change in crop variety and introduction of new cropping systems (Gammans et al., 2017; Garofalo et al., 2019).

3.3 DAIRY CHAIN (MILK YIELDS)

Regarding the impact of climate change on cow milk yields, a literature review consisting of 8 publications was conducted. The studies, carried out on empirical observations, focus on animal heat stress and milk quality as a result of climatic variations (minimum and maximum temperatures and precipitation) and present point results in relation to breeds (Holstein and Holstein) and geographic areas studied (Italy, Belgium, Germany, Lower Saxony, subtropical Mediterranean and climatic zones and zones with similar temperature to the latter found in the USA and Australia). The scientific studies analysed were conducted through data collected in significant time frames on substantial numbers of animals, combined with data from meteorological stations in the areas covered. The methodology used to quantify the impact of climatic events on cow milk yield is based on the classic formula proposed by Berry et al. (1964):

$$\text{decrease in milk yield (kg/day)} = - 1.075 - 1.736 \times NL + 0.0\,2474 \times NL \times THI \quad (1)$$

where NL is the normal level of daily milk production (kilogram per day), recorded in the temperature range of 10 to 18 °C, and THI is the average daily temperature-humidity index.

The results show how extreme weather events related to temperature and rainfall variation affect milk yields and milk quality (fat and protein). In general, dairy cows in heat stress produce less milk than cows in an adequate temperature zone.

Because studies propose temperature range deviations and adjustments of conventional THI for weather data at the seasonal level (Bernabucci et al., 2014; Lambertz et al., 2014). In addition, it has been possible to quantify milk yields under heat stress and cold temperature conditions in a timely manner (Habeeb, 2020; Summer et al., 2019) and to obtain information on changes in milk protein fractions (Hammami et al., 2013) and their relationship to milk dairy properties (Bernabucci et al., 2015). In order to achieve better milk yield and quality, studies agree on adopting better dairy herd management and selecting resilient animals to alleviate the negative effects, in particular, of a hot environment.

3.4 FRUIT AND VEGETABLES SECTOR

For the fruit and vegetable sector, 9 contributions published in scientific journals were reviewed, most of which refer to the national territory while some consider the Mediterranean area in general. The studies analysed also include a global review of climate impacts on perennial crops. The climate change projections considered in the different studies are mainly derived from global climate models and regional climate models that refer to assumptions of different emission scenarios.

All projections predict increases in temperature, otherwise the increase or decrease in precipitation are predicted depending on location. For the assessment of climatic impacts of annual crops on potential changes in yield and production quality, models based on cultivation processes are mainly used. Modelling involves various approaches and, in some cases, field experiments that consider changes in input factors. Most of the results of these models predict an anticipation of phenological stages, a significant reduction in yield and a negative impact on production quality. In the case of some horticultural crops, climatic effects can potentially increase the number of annual cropping cycles, due to the extension of the vegetative period, increasing the overall yield on average (Bisbis et al., 2018).

As reported by Winkler et al. (2013), climate assessments for perennial crops are essentially based on empirical relationships developed between climate observations and plant phenology and, less frequently, between climate observations and yield. However, impact assessments for perennial crops are hampered by the lack of models for yield simulation.

Analyses of the effects of historical climatic variability on perennial crops, while varying by crop type and location, show earlier flowering dates and earlier sprouting. In addition, these analyses indicate changes in fruit quality.

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Exploration of farmers' perception of urban food policies: the case of Bologna farmers' market Regulation

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Farmers' markets, Farmers' satisfaction, Producer characteristics, Alternative Food Networks, Consumer–producer relations

1. Introduction

Farmers' markets (FMs) are increasingly finding recognition for their transformative potential in the current food systems, especially at urban level. The Milan Urban Food Policy Pact clearly states the need for policy support for public food markets in the cities. The food policy currently under development for the city of Bologna makes no exception.

FMs are often portrayed as initiatives with strong social stances, both in the academic literature and in policymaking, to the detriment of the economic benefits. Past literature mainly focused on the consumers motivations to shop at FMs (Neumann & Mehlkop, 2023), while the economic motivation for farmers to be at the market was less explored. Some past studies showed that the commercial motivation is important for producers to be involved in Alternative Food Networks and Short Food Supply Chains, of which FMs are part (Andreatta & Wickliffe, 2005). However, such economic motivations are not analysed in depth.

A similar approach was adopted in policymaking. Several Italian cities approved decrees to regulate FMs, following the introduction of the DM (Ministerial Decree) 20 November 2007, that establishes the requirements and standards for FMs (ISMEA, 2011; Marino & Cicatiello, 2012). We adopted the City of Bologna as a case study, as in November 2022 a new Regulation on FMs (DC/PRO/2022/76) was approved. The DC/PRO/2022/76 frames FMs as fostering local development by strengthening the relationship of trust between citizens and producers. According to the new Regulation, FMs benefits are mainly of social and environmental nature. The sole economic benefit recognised to FMs in the DC/PRO/2022/76 is guaranteeing producers the possibility of an alternative distribution channel and the payment of a fair price – albeit no details on mechanisms to ensure fairness are provided –.

Overall, such formulation seems to be leaning towards beneficial aspects for citizens rather than producers. However, farmers are equally important in the network of FMs, but their perceptions are understudied.

This study aims to fill this gap by answering the following research questions:

RQ1: In what ways selling at FMs in Bologna impacts farmers' satisfaction?

RQ2: Does the Bologna FMs Regulation meet its aims according to farmers' perceptions?

2. Methods

2.1 Data collection

Data were collected at through a survey developed based on previous literature and filled by food producers selling at FMs. A total of 100 answers were collected.

The survey was divided into two main sections. An additional section covered the descriptive characteristics of farmers' participating in FMs, and their farms. Farmers were asked to rate their agreement on a seven-point Likert scale on a series of items.

Surveys were administered in person, before or after market hours.

2.1.1 First survey section

To answer RQ1, the present study developed 6 hypotheses to test. The independent variables created from these hypotheses were tested in relation of the farmers' satisfaction with FMs participation (dependent variable).

In the new Regulation, FMs are portrayed as promoting social innovation, activating new social ties and collaborations at urban and peri-urban level. The academic literature supports this approach, as farmers' markets reportedly serve as vibrant community hubs where citizens come together not only to buy local products but also to meet and build relationships, fostering a sense of community and social cohesion (Diekmann et al., 2020; Marino & Cicatiello, 2012; Warsaw et al., 2022). Such social dimension is important for farmers too, as those joining FMs for social reasons are the ones with the higher retention rate (Montri et al., 2021). Based on these intentions of the DC/PRO/2022/76 and these previous findings, the first hypothesis was developed.

Albeit scarce, the new Regulation mentioned economic advantages among the benefits of the FMs. They reportedly guarantee producers the payment of a fair price and the possibility of an alternative distribution of their products, which does not negatively impact the work in family farms, while at the same time providing consumers the right quality-price ratio. However, limited studies have addressed whether FMs are for farmers the main selling outlet or not, making an effective change in their business model. Based on these intentions of the DC/PRO/2022/76 and these previous findings, the second hypothesis was developed.

In the DC/PRO/2022/76, FMs are described as guaranteeing consumers, through direct meetings with producers, about the quality of the products, with regard to information (origin and price of products), safety and aspects related to food sovereignty, also recognising the seasonality of local products the value of healthiness of the food (food nutrition). The Regulation also states that buying at the FMs increases consumers' awareness towards the issues of farmers and the rural world. Several scholars also highlighted how the relationship of trust created between consumer and producer. Based on these intentions of the DC/PRO/2022/76 and these previous findings, the third hypothesis was developed.

Some studies in the academic literature identified the positive impacts of FMs on the environment (Carolan, 2017; Marino & Cicatiello, 2012). Such impacts are mainly due to the shortening of the food supply chain (Carolan, 2017) as well as the reduction of waste resulting from the use middlemen. Based on these intentions of the DC/PRO/2022/76 and these previous findings, the fourth hypothesis was developed.

Next, the present research investigated whether the impact of being at the FM goes beyond the business model changes and also influences farmers lives. In previous studies, interviewed farmers mentioned the independence and freedom coming from this job (Andreatta & Wickliffe, 2005). Being able to enjoy nature was also one of the main advantages highlighted by farmers (Andreatta & Wickliffe, 2005). Albeit recognising the job's hardships, farmers also acknowledged that the advantages coming from farming were of ethical nature. The self-esteem and self-realisation coming from taking care of the land, and therefore of future generations, was one of the key impacts for farmers (Andreatta & Wickliffe, 2005; Leiper & Clarke-Sather, 2017). Based on these previous findings, the fifth hypothesis was developed.

Farmers are often part of a broader network, such as cooperatives or agricultural unions, and the cooperation among farmers has several positive outcomes, such as resource and knowledge sharing, collective bargaining power and better risk management (Samoggia et al., 2022). However, most scholars (Bonanno et al., 2018; Devaux et al., 2009) focus on how farmers benefit from being in associations, but less studies focus on what happens to those farmers who are not included in any network. Given that the new Regulation allocates markets areas to the associations organising markets for a period of 5 years, it is difficult for farmers to join afterwards causing a lack of turnover. Based on these arguments, the sixth hypothesis was developed.

In the survey, the items proposed to the interviewees to answer the hypothesis above are divided in four topics: economic, social, consumer, environmental items. Three additional items are used as a proxy for overall farmers' satisfaction.

2.1.2 Second survey section

The DC/PRO/2022/76 is considered a good example of policy co-design, as it was developed together with the stakeholders involved in the FMs system, namely the associations organising FMs. However, it remains unclear whether the final result reflects farmers' perceptions of what FMs should be for them and the citizens involved. To answer RQ2, the second set of questions is focused on the process of co-design of the new Regulation, asking about farmers' satisfaction on the process itself, the Regulation, the market areas and the overall attitude of the Municipality towards the support of local supply chains. In this second part too, respondents are asked to rate on a 7-point Likert scale their level of agreement.

2.2 Data analysis

Data analysis consisted of various steps.

First, a factorial ANOVA test was used to analyse the responses to the questionnaire's items. Second, a multiple regression analysis was adopted to test the hypotheses. Data elaboration was carried out using the software SPSS.

3. Expected results

The present research offers valuable insights on the connection between FMs regulations and farmers' perceptions, as well as the influence of their presence at the market on their business models, and more generally into the dynamics of FMs.

The FMs in Bologna are 20, with about 150 producers involved. All the markets are held weekly or more than once a week. Most of the markets have a pool of 15-20 producers taking turns, with between 10 and 20 stalls available.

The markets' outlook was quite diverse. In particular, one of the markets stands out for the number of its activities, such as kids' games, workshops, live music and street food. This FM is known for being focused on tourism and it is the only one located in a private area. Most of the markets are in a middle ground as they carry out some activities, but it their main focus remains the exchange between farmers and citizens. In terms of the DC/PRO/2022/76 Regulation, it was overall well received by farmers, as it highlights social and community aspects that are also the main motivations for farmers to sell there. However, such framing as a social innovation tool was criticised as limiting for the FMs potential, as a narrative more focused on economic aspects would allow to bring more stances for change to the municipality. Not all famers took part in the co-design process of the new Regulation, but those who were more involved were generally less satisfied with the outcome. However, there is consensus on the low quality of services at the market areas, such as access to clean water, toilets and electricity.

As for the farmers' satisfaction with their presence at the FMs, the most important point was the relationship with consumers, which allowed for a direct exchange and smoother innovations in the value proposition. Respondents feel their presence at FMs increases awareness, but they are aware that either it doesn't work or that consumers who buy at FMs are already conscious. Higher earnings are not necessarily the main reason why farmers participate in FMs, and costs and stress level are perceived as equal than in other market outlets. However, farmers' satisfaction with selling at the FMs is overall very high.

The present research also has several policy implications, as it can help further improve Bologna's Regulation and inspire other Municipalities to do the same. Since recently, and particularly after the 2015 Milan Urban Food Policy Pact, several municipalities shown the willingness to support and Short Food Supply Chains. However, how to do so in an effective way remains an open question. Our results highlight how a change in the framework, from social innovation to economic alternative can help FMs to become stronger and farmers to sell a larger share of their products in the city.

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

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Food (in)security, Environmental Sustainability and Europe - Exploring future policy scenarios

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Food security, Environmental sustainability, Policy options, EU Common Agricultural Policy

INTRODUCTION

The European food system is being challenged as never before in recent history by the health crisis (COVID-19), climate change and the Russian war in Ukraine.

The continued pressure exerted by these external factors poses the question of whether sustainability and food security can be pursued without a trade-off between the two. New food policies should be informed of the risks of incompatibility associated with food security and sustainability.

Europe has always been at the forefront when it comes to innovating the agricultural system in the direction of environmental sustainability. The present Common Agricultural Policy (CAP) makes no exception. The introduction of green architecture, merging Pillar I and Pillar II into the eco-strategies, goes in the same direction. Even though the effectiveness of these measures has still to be demonstrated, the EU's commitment to environmental sustainability is unquestionable. Nonetheless, the burden of the agricultural system on the environment must be softened further (Moragues-Faus, Sonnino and Marsden, 2017; Crippa *et al.*, 2021). In this path of transition towards a more sustainable European food system, the fast-changing scenario raises the uncertainty related to different moments of the food supply chain changing, causing a necessity to review the CAP's basic ideas.

Since its birth in 1957 with the Treaty establishing the European Economic Community, the European food system has ensured an increasing quantity and quality of food to citizens. This has been achieved with the combination of technological innovation, generalised economic growth, and the application of effective policies. EU past policies, in particular market direct interventions and coupled payments, increased agricultural productivity to a satisfying level already at the end of the past century. Thereafter, EU policy gradually abandoned these measures because they were no longer necessary; in other terms, food security was no longer of any concern since the beginning of the 21st century. Ironically, food surpluses were more problematic than deficits[1]. Since then, a lot has changed, and new problems and perspectives shape agri-food policy priorities. The new fast-evolving context is characterised by continued shocks of different

[1] It is important to note that this is not the case in many other contexts, where food crises exist, rises in number and provoke severe consequences. To further investigate this aspect: https://www.wfp.org/publications/global-report-food-crises-2022

natures, and today's food system policy is partially directed to enhance the food system's resilience to crisis. The major shocks that pressure the system are climate change, COVID-19 and its economic consequences (even though its effects are almost entirely over) and Russia's invasion of Ukraine. Concerns also come by the rising risk of new similar shocks. Climate change's detrimental impact on agricultural production is known, and literature confirming and measuring this effect is consistent (e.g.,(Schröter et al. 2005, Olesen & Bindi 2002). The COVID-19 epidemic has provoked a severe economic crisis, reducing everyone's access to a balanced and healthy diet. Russia's invasion of Ukraine has had manifold effects on the European (and global) food system (Belik, 2020; Nemes *et al.*, 2021; Xu *et al.*, 2023). First, it has generated an economic crisis due to the rise in the cost of energy. This reflects in higher costs of nitrogen fertilisers and, thus, higher general production costs for agricultural products. Second, both Russia and Ukraine are important export of different food commodities, in particular wheat and sunflower oil. The war influences the possibility of trading these commodities in a normal and easy way.

However, the impact of these shocks on the European food system showed the incredible strength of the latter. During the first COVID-19 outbreak, there was not any shortage of food commodities, if not temporary. The war between Russia and Ukraine did not reflect in any concrete food security problem. "Food supply is not at stake in the EU today". This is what European Commission states in a communication published in March 2022 (European Commision 2022). There the Commission highlights the swift European responses to COVID-19 and the war. On the other hand, it also notes that food affordability for the low-income population is currently threatened. Hence, food security is still 100% accomplished for the European population, but new environmental, geopolitical and health issues raise the necessity to bring back to light the concept.

In order to enhance the resilience of the European food system, a group of experts called the European Food Security Crisis preparedness and response Mechanism (EFSCM) has been created. Moreover, the first concrete actions in this direction are already in place, as noted in the previously cited communication of the European Commission (EC, 2022). Among these the derogation from certain greening obligations. The greening is a list of indications farmers must follow in order to receive the subsidies. To note that all these measures are not aimed at solving the problem of food security but at preparing the food system in order to avoid any future one. In this context of raised attention to food security across Europe (Borychowski *et al.*, 2022), the question of the compatibility of these security measures and the EU sustainability objectives should be fully addressed, and priorities should be stated. Being the food security issue relatively new, literature about the compatibility of the two concepts in the European context is still scarce and not clear (Vågsholm, Arzoomand and Boqvist, 2020). On the one hand, there is the European Commission which states that "Food sustainability is fundamental for food security"; on the other greening obligation are derogated by the same Commission. On the one hand, the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security add sustainability to the six pillars of food security (Clapp et al. 2022); on the other the scientific literature is starting questioning the feasibility and consequences of European Green Deal strategy (Tyczewska, Twardowski and Woźniak-Gientka, 2023).

To conclude, sustainability might increase food security by making the food system more resilient in the medium-long term, but in the short term seems like there could be a conflict between the two concepts. Literature should address the problem to provide policymakers with information to produce better and fully informed policies.

To meet these objectives, a Delphi study is currently being carried on, grouping the opinions of experts in the discipline across different countries. Experts are policymakers and stakeholders from local, regional, country, and communitarian levels. We expect to better explore the relationship between food security and environmental sustainability in the EU policy framework and state priorities and define explicit policy indications for future CAP developments.

METHOD

The lack of literature about the relationship between sustainability and food security in the EU context makes the Delphi study a promising tool to foresee the EU institution's position on the topic and to provide clear indications for policymakers on how to proceed.

The Delphi method is a research technique used to gather and synthesise expert opinions on complex issues (Seuring and Müller, 2008; Doria *et al.*, 2009; Bui *et al.*, 2020). It provides a structured and iterative approach to understanding a subject matter by tapping into the collective wisdom of a diverse group of participants. The method is particularly useful when there is uncertainty, complexity, and a need for consensus among experts. The Delphi method typically involves multiple rounds of data collection and analysis. In the first round, a panel of experts is selected based on their knowledge and expertise in the relevant field. These experts are then presented with a series of questionnaires or structured interviews that aim to elicit their judgments, opinions, and insights on the subject being studied. Once the responses are collected, they are anonymised and summarised by the researchers. In subsequent rounds, the experts are provided with feedback from the previous round, including summaries of the group's responses and any areas of disagreement or consensus. This feedback serves as a basis for re-evaluating their initial judgments and reiterating their opinions. The Delphi method encourages experts to reconsider their positions in light of the collective feedback, leading to a convergence of opinions over multiple rounds. The goal of the Delphi method is to reach a level of consensus or convergence among the participating experts. The method's strength lies in its ability to generate valuable information and recommendations, inform decision-making processes, and provide a deeper understanding of complex issues through the collective wisdom of experts.

We structured an online survey that was sent to the panel of experts. The panel consists of 14 experts. Those were recruited by email and were asked to complete the survey within three weeks. The survey for the Delphi first round was divided into two sections. The first section concerns general ideas and aspects of the European agri-food policies. The other concerns the specific insight of the relation between food security and sustainability in the EU context.

PRELIMINARY RESULTS

From the first round, points emerged that were shared by most of the experts. These are resumed from all the individual answers to the first section of the questionnaire. The shared ideas are reported in Table 1.

Table 1 – Points shared by the panel – first section

One of the CAP's greatest strengths is related to its overall strategy.
One of the greatest strengths of the CAP is related to environmental sustainability goals and achievements in this area.
One of the greatest strengths of the CAP is related to the economic support provided to farmers, which enables the protection of the entire European agricultural sector.
One of the biggest weaknesses of the CAP is that it fails to capture the specificities of the different realities in the EU.
One of the biggest weaknesses of the CAP is having a complicated management and not having highly effective tools for evaluating the results of it's actions.
The most important objectives of the CAP are: efficient natural resource management; Halting and reversing biodiversity loss; Contribute to climate change mitigation.

The current Green Architecture is only partly adapted to Europe's sustainability goals.
A limitation of the current policy with regard to sustainability is that it has to mediate between the interests of different actors in the supply chain.
The current implementation of Eco-schemes by farmers is only partly feasible. There are several reasons for this: a high number of tools and a design that is poorly correlated with production and territorial realities.
Technical and scientific support to farmers is inadequate. In particular, public support structures are lacking and private support is insufficient.

The second section of the questionnaire responses lacks a satisfying level of consensus across all the questions. The points shared by the experts for this section are listed in Table 2.

Table 2– Points shared by the panel - second section

Food security is not at risk in the present situation for EU citizens.
The goals of sustainability and food security are equally important and should be pursued with the same priority.
Although only partially, there may be a trade-off between ensuring food security and pursuing environmental sustainability.

Contrasting points of view emerged from the questions related to the existence and the magnitude of the trade-off between food security and environmental sustainability, showing the complex nature of the topic. For these reasons, a second round is currently ongoing. Only then, it will be possible to draw explicit policy indications for future CAP developments.

(3)

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IS LOCAL BEEF PREFERENCE ASSOCIATED WITH HEALTH-RELATED ATTITUDES? A STUDY ON ITALIAN CONSUMERS

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KEYWORDS
Censored interval regression; Consumer behavior; Local beef; Willingness to pay.

INTRODUCTION

Over the last years, consumers interest towards local food has increased in developed countries (Skallerud and Wien, 2019; Lombardi et al., 2015). This trend appears to be fueled by raised consumer awareness of environmental and societal implications of their food choices. According to the literature local food products are perceived by consumers not only more socially and environmentally sustainable, but also more nutritious and healthier than the conventional, globalized counterparts (Bianchi and Mortimer, 2015; Feldmann and Hamm, 2015). However, while the preference toward local food has been analyzed considering the overall local food category, it is unclear whether and to what extent the preference for local red meat is also associated with health-related factors. Consumers perceive local beef produced following a sustainable production process in environmental and ethical terms, as well as consider it fresher and healthier than its conventional counterpart (Sasaki et al., 2022; Pirsich and Weinrich, 2019; Merritt et al., 2018). Therefore, in line with the local food literature (Khayyam et al., 2021; Birch et al., 2018), it is presumable to expect that even in the case of local meat consumers are quite aware of the implications of their food choices on their health, and therefore, would show positive health-related attitudes. However, the consumption of red meat is highly controversial and widely debated in the public health arena, especially in developed countries, where the overconsumption of red meat is associated with some chronic diseases (Parlasca and Qaim, 2022; WHO, 2015). To the best of our knowledge, no study has assessed if and to what extent consumers are driven by health-related attitudes in their decision-making process of buying local red meat. Therefore, this study tries to fill this gap by evaluating the influence of health-related attitudes, as well as sociodemographic characteristics, consumption habits and meat involvement on Italian consumers' willingness to pay (WTP) towards local red meat. To reach this aim a probabilistic sample of 1179 Italian consumers has been used. Findings should have both theoretical, managerial and policy implications.

MATERIALS AND METHODS

Data of 1179 Italian beef consumers have been collected through an online survey conducted in October 2021 by a professional marketing agency. Respondents are at least 18 years old, responsible (or co-responsible) for household food shopping, and they consume red meat at least once every two weeks. The adopted questionnaire consists of four sections. The first section has been useful to gather information on red meat consumption habits, as well as on previous experiences of buying local meat, on organic consumption frequency, and on place of purchase of red meat. The second section aimed at evaluating the premium price that consumers were willing to pay for one kilogram of local red meat, selecting a value from €15/kg (average price of non-local meat) to €30/kg, with one-euro increments. The third section includes two pre-validated 7-point Likert scales to evaluate health-related attitudes and meat involvement. Specifically, in this section were used the 8-item General Health Interest (GHI) scale (Roininen et al., 1999) to measure health-related attributes, and the 16-item 4Ns (Nature, Necessary, Normal, Nice) scale (Piazza et al., 2015) to infer about consumers' meat involvement. In the last section of the questionnaire sociodemographic variables of the Italian sample of consumers (i.e., age, sex at birth, income, education, number of children under 12 years-old and geographical area) have been gathered.

To evaluate factors affecting consumers' WTP for local red meat, given its interval characteristic, a censored interval regression approach has been performed using STATA 16 statistical software. This is because respondents have chosen their WTP from a list of interval-valued data which differ from each other by one euro. Therefore, this approach can fit a linear regression model on interval-valued data (Billard and Diday, 2000).

Specifically, the adopted model can be expressed as follows:

$$y_i^* = x_i'\beta + \varepsilon_i \tag{1}$$

where y_i^* represents the censored WTP indicated by *i-th* respondent, x_i' is the vector of each explanatory variable, β represents the estimated coefficients that indicate the direction and magnitude of the statistical associations between explanatory variables and WTP for local beef and ε_i is the stochastic error.

RESULTS AND DISCUSSION

Consumers of local beef prefer to buy red meat directly in local butchers or farmers' markets. Additionally local red meat consumers are mainly older people with a medium-high level of income and education and live in Northern Italian, while sex and children presence do not seem to affect local red meat preference. The average premium price that participants were willing to pay is €3.23/kg (S.D. = €2.98). Contrary to what it was expected, the interval regression model has shown that GHI does not have a significant effect on WTP, highlighting that consumers of local beef are not driven by attitudes towards health. Unlike Davidson et al. (2003), local red meat preference is not associated to high meat consumption frequency. Similarly, to what Piazza et al., (2015) and de Araújo et al., (2022) found, it seems that consumers' preference for local red meat it is weakly associated to meat involvement as consumers perceive that it is a nice product for its delicious taste and hedonic pleasure. However, findings have also highlighted that local red meat consumers do not consider it as a natural food for their diets or a normal dish for their social environment, but rather they consider meat as a non-necessary food for their diet.

In contrast, the interval regression model has also shown that consumers' WTP for local beef is influenced by previous experiences with local beef consumption and consumers' high frequency of organic consumption. This seems to highlight that local beef is recognized by Italian consumers as a sustainable food category in environmental, ethical and healthy terms. But also with a sensory profile appreciated by consumers that allows for the creation of a consumer experience (de Araújo et al., 2022; Sasaki et al., 2022; Telligmann et al., 2017).

CONCLUSIONS

The findings of our study highlight that even if Italian consumers are willing to pay a price premium for local red meat, their preferences neither depend on health-related attitudes nor on meat involvement. This may have interesting implications both for research, practice, and policy. From a theoretical point of view, findings of the current study can enrich the literature by clarifying whether health related attitudes affect the consumption of local red meat, or if this preference is associate with other factors. In this regard, the representativeness of sample provides significant empirical evidence on consumer perception towards a food characterized by controversial debates. From a policy perspective, current findings may be useful for policymakers to encourage policy interventions suitable to encourage a more sustainable diet also in the context of short supply chains. The adoption of alternative food networks, in fact, represent a valid tool to promote local food reaching a more socially and environmentally sustainable production process.

Finally, for red meat farms these results could shed light on the local red meat attributes that need to be emphasized in other to realize effective marketing strategies aimed at favouring more sustainable products and diets.

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The analysis of partnership in the new CAP through Text Mining and Sentiment Analysis: preliminary results

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PAROLE CHIAVE
Inserire in questa sezione alcune parole chiave (4-6) per il contributo.

Introduction and Objectives

The concept of multi-level governance is applied to policy areas, such as agriculture and the environment, that involve the simultaneous participation of different levels of government (supranational, national and sub-national) in the planning and management of policies regulating them.

The new Common Agricultural Policy (CAP) provides for a governance model characterised by a higher level of subsidiarity and focused, more than in the past, on the actual performance of the agricultural sector and rural areas, aiming more at the realisation of objectives planned at the European level (performance), than at the compliance of individual Member States (MS) with EU regulations (compliance). Within this institutional framework, in line with the Green Deal, new and more ambitious goals for multidimensional sustainable development have been set.

The main programmatic tool to enable the achievement of these objectives in each MS is the CAP Strategic Plan (CSP), which provides greater flexibility and decentralisation between European institutions and MS in the planning phase, through an improvement of subsidiarity, allowing MS to make choices based on their specific needs and territorial contexts. At the same time, however, this new approach entails greater responsibility for MS, as a consequence of managing a single planning tool that encompasses the two pillars, reducing the role of local institutions The implementation of a single plan is particularly challenging for those MS that have decentralised agricultural and rural development policies to the sub-national level, amongst which Italy (Mazzocchi et al., 2022). This complexity is exacerbated by the fact that the logic of MS intervention must be adequately defined using clear and transparent methods, preferably favouring participatory approaches (Matthews, 2021; Erjavec et al., 2018).

The Italian case well exemplifies the many challenges related to the multi-level policy governance. In fact, on the one hand, Regions play crucial roles in the policy-making process; on the other hand, the heterogeneity of Italian agricultural models makes the design of the CAP particularly complex, which is reflected in a high level of pressure from territories, food chains and socio-environmental associations on governing bodies (Henke et al., 2018).

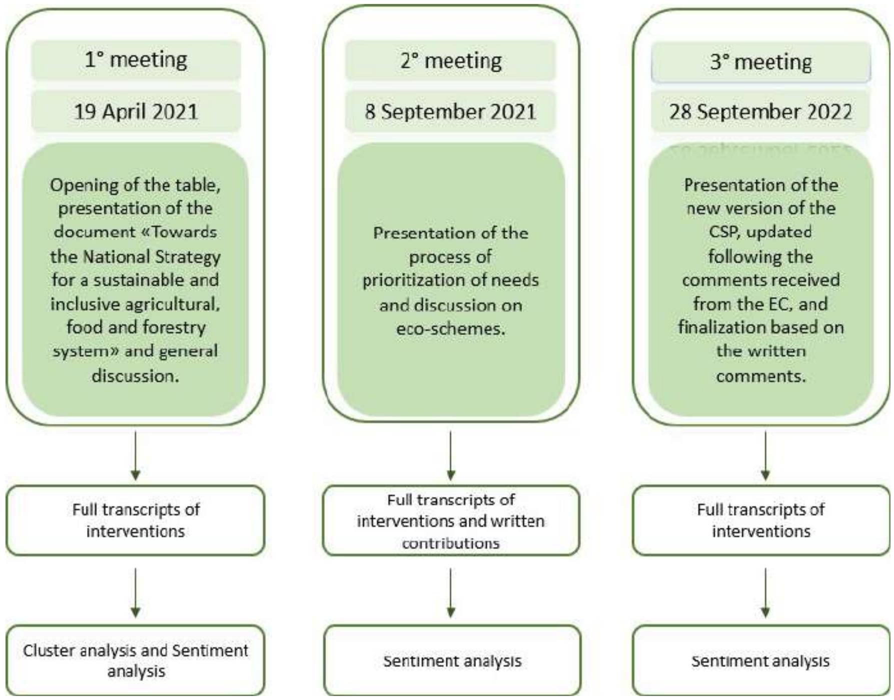
The main objective of this paper is to analyse the role and the importance of the partnership approach in the decision process about the new CAP reform. In our view, this is relevant in the research on the role of institutions in the policy implementations for two different reasons. Firstly, we consider interesting from a research point of view to investigate the multi-actor decision-making process in a complex policy such as the CAP. Secondly, this reform marks a benchmark in the decision making, so that the participative approach becomes a necessary and appropriate step in the future making of policies for agriculture and rural areas. Indeed, environmental, social, and economic challenges Europe is facing within the 2023-2027 CAP cannot be faced without considering participated approaches.

The paper will focus on the main positions of the Italian stakeholders, representing different interests and several institutional level of governance, in the making of the national CSP and on some specific innovative elements of the new CAP, such as the eco-schemes and their evolution over time along the succession of meetings, within the CSP implementation process. The aim is to identify common behaviours and contrasting opinions, and also to show the process of construction of a common view and how this was influenced by the positions of the stronger actors and their capacity to take the lead in the Partnership Table (ToPPT).We think that the insights of this research can provide significative advancements on the approaches and the methods of the partnership in the policy decision making.
It is worth emphasizing that the choice of the subjects invited to the various meetings and the management of the meetings themselves was entirely in the hands of the Ministry of Agricultural, Food and Forestry Policies (MIPAAF) as an obligatory step in the reform process. The Ministry involved the partners according to three main criteria: some were present "by default" (institutional partners, such as other Ministries); a second group was selected and involved on the basis of their specific interests (trade unions, professional organizations, consumer associations, etc.), and a third group selected through a call based on the "expression of interest" (scholars, academics, environmentalists, rural associations, etc. lit). We chose to report about three distanced meetings in order to represent the evolution of the decision process and to focus on the meeting when the relevant issues of the eco-schemes were discussed. This is motivated by the fact that they represent a new policy tool introduced by this reform and one of the most important in terms of potential impact on the main results of the primary sector and on the opinion of the economic and social actors about the CAP.

Methodology

For this two-fold purpose, three different meetings separated in time of the PT, organised by the MIPAAF, were analysed to represent the evolution of the decision-making process (Figure 1). Stakeholders were divided, according to the classification made by the MIPAAF, into four different groups: national associations, trade unions, environmental associations and sectoral associations.
The textual data base used was derived from the full transcripts of the three PT analysed, as well as the official written feedback provided by the parties concerned to the Ministry following the second table, in which more in-depth and structured judgements were made on the topics discussed during the meeting.
An innovative approach was adopted for the analysis, jointly using Text Mining (TM; Gupta & Lehal, 2009; Younis, 2015) and Sentiment Analysis (SA; Liu, 2012; Sharma et al., 2014) as computational methods to analyse the textual data obtained from the PT transcripts.
TM is an automatic process designed to analyse unstructured textual data, combining techniques of data mining, statistics, and computational linguistics to uncovering relationships and patterns in unstructured textual data resources (Gupta & Lehal, 2009; Younis, 2015) In this work, it was staged as a clustering text data mining to explore and reveal groups of words and text segments that are homogeneous within themselves from a semantic point of view,concerning the viewpoint of the stakeholders The analyses conducted were based on hierarchical descending classification (HDC) known as textual co-occurrence analysis (Illia et al., 2014). Each cluster consists of concatenated text segments that produce a similar meaning. Consequently, the clusters are internally homogeneous but dissimilar to each other, since the vocabulary within them is also distinct from that of the other clusters. The mechanism starts from the whole text with a descending partition into two large clusters with the most dissimilar word usage, then the algorithm divides these clusters into other parts that are again dissimilar, though less than the first ones, and so on until the partitions are no longer statistically significant (Illia et al., 2014).

Figure 1 - Schedule and contents of ToP and methodology used for the analysis

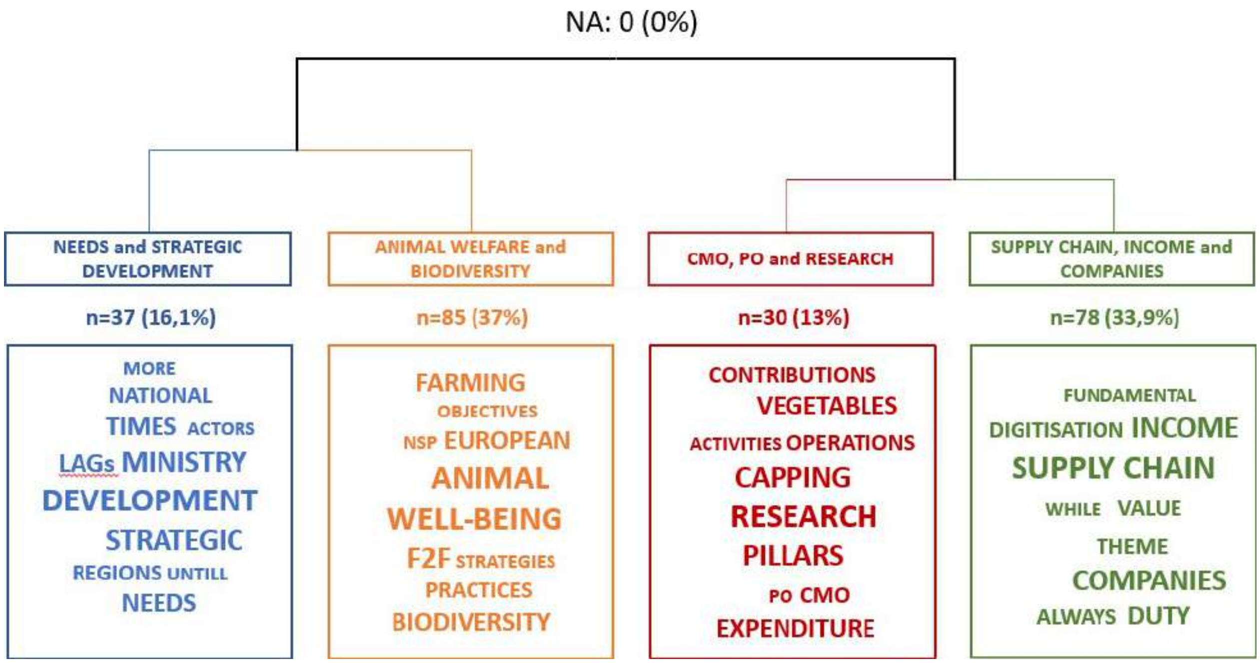


SA is part of Natural Language Processing (NLP) and its aim is to classify sentences, opinions and natural language expressions by assigning a positive, negative or neutral polarity. This analysis methodology uses sentiment dictionaries in which each word is associated with a score relative to its polarity. In this work, we employed a dictionary-based approach to SA, using a computational linguistic resource called MAL (Morphologically-inflected Affective Lexicon; Vassallo et al., 2019). Thus, while cluster analysis was used for the dual purpose of highlighting which issues were most important and by which stakeholders, SA allowed us to analyse their position on them. The results of the latter were organized into four different levels of judgement: 'very positive', 'positive', 'negative', 'very negative'.
A Cluster Analysis (CA) was implemented on the transcripts of the first table, since being an opening meeting, the debate was kept on a more generic level: rather than addressing specific issues or providing opinions and judgements on certain proposals, the stakeholders expressed their views and interests on the reform and, in particular, on the construction of the CSP. The CA, consequently, made it possible to group the main topics that were dealt with, giving an idea of the different interests existing among the stakeholders who participated in the Table. Subsequently, a SA was implemented on the most significant words of the four different clusters in order to highlight the different positions of individual stakeholders on these topics. However, only sentiment analysis was used in the other two tables since the stakeholders present expressed opinions on specific aspects of the reform and thus the only purpose of the analysis was to analyze their opinions.

Results and discussion

The results of the CA (Figure 2) led to the definition of four different groups of topics, representing the relevant aspects of CAP reform as indicated by the Italian Ministry. Each analysed text segment was assigned to one of four groups (Not Assigned:0). To each cluster was assigned a label, reflecting the topics most frequently discussed within the group.

Figure 2: The results of the Cluster Analysis (elaboration based on the interventions).



Looking at the figure, the cluster "Animal welfare and biodiversity" and "Needs and strategic development" are closer to each other, since they are positioned near to the second level of the dendrogram branches. The same applies to the clusters "Research, PO and CMO" and "Supply chain, income and companies". This means that there is less logical distance between the themes of the first and second cluster and between those of the third and fourth.
The first two concerns have more to do with governance strategy and goals, in particular the first cluster dealt with the need to combine the definition of all aspects related to the three pillars of sustainability in a single CSP. The second cluster, on the other hand, reflects positions that put at the centre of the CAP reform the need for a greater effort to reduce the impact of the primary sector on the environment, calling for an improvement in this sense of agricultural and livestock breeding practices for a greater protection of biodiversity and animal welfare in line with European objectives other two look at policy instruments and economic results; they reflect more on production issues and related measures, linked to the need to ensure an adequate income for farmers.
These positions reflect somewhat more conservative positions within the Reform debate, in line with what the CAP has historically represented: a policy for farmers, strengthening their role within the supply chain, guaranteeing income support. The results, in line with expectations, show that the environmental associations placed most emphasis on the issues of the second cluster, while the national and sectoral associations paid particular attention to the protection of supply chains and specific sectors of interest, issues contained in the last two clusters.
One of the most debated topics during the consultations was that of eco-schemes, which represent a new innovative policy tool introduced by this reform and one of the instruments that could potentially have the greatest impact on the environmental performance of the primary sector and on the opinion of economic and social actors regarding the CAP. This is a voluntary form of greening, which aims to incentivize farmers to make specific commitments that are considered environmentally beneficial, above cross-compliance

standards. In the second TP, MIPAAF presented seven proposed eco-schemes for oral and written feedback. The former contributions, provided during the meeting, were aimed at assessing how well the eco-schemes met the needs of the partnership in relation to both the objective to be achieved and the instrument identified for this purpose.

Figure 3: Sentiment and final choices regarding eco-schemes.

Eco-scheme	Commitment	Prevailing Sentiment	Final choice
Eco 1	Payment for veterinary drug reduction	Negative	Confirmed
Eco 2	Organic farming	Negative	Not confirmed
Eco 3	Integrated production	Negative	Not confirmed
Eco 4	Weeding of permanent crops	Positive	Confirmed
Eco 5	Management of pastures and permanent grassland	Positive	Not confirmed
Eco 6	Crop rotation	Negative	Confirmed
Eco 7	Increase in non-productive areas and elements	Neutral	Not confirmed

Regarding the sentiment on the eco-schemes and the final choices made in the CSP, looking at the entire public consultation process, although it is not possible to determine exactly to what extent the opinions of the economic and social partnership influenced the policy makers, we can still see that in some cases the judgments made during the TPs coincided with the final choices.
For example, the eco-scheme that received the least appreciation, number 3, was ultimately not confirmed. Many of the stakeholders who commented on this eco-scheme criticized the decision to assign a specific eco-scheme to integrated production, even calling for its elimination.
Eco-schemes 1, 2, and 6, on veterinary drug reduction, organic production, and crop rotation, respectively, were also discussed. In this case, the nature of the eco-scheme itself was not criticized, but rather the commitments made in relation to the targets set were considered insufficient or at least improvable. In this case, however, the commitment related to organic production was the only one not confirmed.Finally, with regard to the remaining three eco-schemes, compared to the initial proposal, only number seven was not confirmed, although the commitment regarding the expansion of non-productive areas remained within the enhanced conditionality.

With regard to the overall results of the three different SA implemented, a reduction in the positive attitude of stakeholders was noted during the different rounds of the institutional table. This is probably due to the general level of discussion at the first meeting and the greater specificity of the second, during which each topic was discussed in more detail, particularly the eco-schemes. This shows that while the general principles of the CSP were shared and agreed upon, when the discussion shifted to specific technical details, differences in the views and interests of national stakeholders emerged. The different types of contributions analysed also showed different results: while the oral interventions across the tables were more positive, the written contributions revealed a higher degree of criticality. This difference can be explained by the fact that the latter mode allowed for a more thoughtful and elaborated argumentation, which allows for a broader and more substantial criticism. Critical positions are mainly related to environmental associations, to which more radical views of the CAP objectives are linked. On the contrary, generally positive assessments seem to be associated with more conservative positions, which advocate a vision of agricultural policy focused on the economic sustainability of farming activities and an improvement and stabilisation of farmers' incomes. Thus, positive judgements come mainly from those who see socio-economic and environmental objectives as trade-offs and not as win-win policies. This last point reflects the need, also emphasised by the European Commission in its evaluation of the CSP, for more organic and structural attention to environmental issues, which must also be integrated into socio-economic programmes, rather than being seen as a trade-off with sectoral growth and rural development.

Concluding remarks

Environmental, social, and economic challenges Europe is facing within the 2023-2027 CAP cannot be dealt without considering participated approaches. With regards to this, the NDM on one side ensures more flexibility and decentralisation between European institutions and MSs through an improvement of subsidiarity; on the other, it brings the planning level back at the national level, reducing the role of local institutions, and at the same time introducing elements that can weaken the innovative approach of the EU in favour of a relaunch of national interests and elements of path-dependency (Henke et al, 2018).With respect to the representativeness of the partnership in the CAP reform process, the MIPAAF has pledged to ensure the widest possible participation. Nevertheless, this led to two types of difficulties, which should be considered in the implementation of programming. The first was the lack of a guideline aimed at favouring or limiting participation to 'hat' organisations expressing the positions of a wider number of actors: this led to the multiplication of opinions of the same tenor and direction, often expressed by actors belonging to the same alliances, coalitions, or steering groups. The second was the lack of a method of animating, leading, and synthesising the PT. In fact, despite a favourable approach to the expression of individual organisations, the MIPAAF often limited to listening and collecting opinions, without providing a final framework of synthesis or commitment with respect to the most urgent and most represented issues. From this point of view, it must be acknowledged how the MIPAAF, having to manage a national agricultural policy for the first time after the regional programming of recent decades, may lack an appropriate administrative culture of participation in the construction of public policy.

Results have shown that the positive attitude towards the reform was somehow reduced along the meetings (positive evaluation going from over 90% in the first meeting to around 63% in the second). This is probably due to the general level of discussion in the first meeting, while during the following each subject was discussed more in details, especially eco-schemes. This shows that despite a general consensus around the new CAP principles, the discussion and the divergences grew around specific technical details. In fact, after the second meeting the negative attitude had grown up to 47%. These findings show that, despite a broad consensus on the need for a resilient EU agricultural sector, actor groups varied in the preferred policy actions they endorsed and promoted other types of targets, challenges, purposes and reasons (Buitenhuis et al., 2022). In fact, in the written contribution the polarization in values has grown: a positive attitude had grown for national associations and unions, while environmentalists and sector associations remained sceptical about the whole set of the CAP reform. Such negative positions are referred to the environmental contents of the CSP but also to organisational reasons. In general, the negative judgments are connected to a more radical view of the CAP goals themselves, while a general positive evaluation of the new reform seems to be associated to a more conservative view, claiming that an agricultural policy should pursue as a main goal the economic sustainability of the farming activities and an improvement and stabilization of farmers' revenue (Guth et al., 2020). In practice, the positive judgments come especially by those who consider socio-economic and environmental goals as trade-offs and not as win-win policies coherent to the Green Deal approach of the decoupling of economic growth from the use of natural resources. This final point highlights an issue that was also underlined the EU Commission in evaluating the CSP: a more organic and structural attention to environmental issues that need to be integrated also into social economic goals, rather than been considered a trade-off to sectoral growth and rural development. These findings are coherent with Lillemets et al. (2022), which demonstrate limited or inconclusive evidence about the impact of CAP on economic diversification, regional cohesion and civil participation.

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CITIZENS-CONSUMERS' WILLINGNESS TO PAY FOR SUSTAINABLE FUNCTIONAL FOODS: AN EXPLORATIVE ANALYSIS IN ITALY

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PAROLE CHIAVE
Consumer, functional food, wtp, best-worst

INTRODUCTION AND THEORETICAL BACKGROUND

Over the last decades, citizens-consumers deeply changed their food consumption behavior and lifestyles, essentially driven by the socio-cultural developments in modern economies (Marotta *et al*., 2014). In particular, factors such as the increase in food-related diseases and the associated increase in health expenditure, the environmental implications of food production, have led to a greater awareness of the relationship between health, sustainability and dietary habit (Paiano, 2012). As a consequence, there has been an increase in consumption of foods capable of positively affect not only the health of individuals but also the environment, contributing, at the same time, to encourage the food industry to produce products for the health and wellness market (Mtewa *et al*. 2020; Bonanno 2012; Sirò *et al*., 2008). In this context, functional foods may play a fundamental role: they not only satisfy hunger and provide individuals with the necessary nutrients, but also prevent diseases related to nutrition and increase physical and mental well-being (Menrad, 2003).

The concept of functional food was first used in the mid-1980s, in Japan, when the Japanese government provided financial assistance for research projects focused on the creation of foods enriched with special components, which were able to influence the physiological functions of individuals (Litwin *et al*., 2018; Stanton *et al*., 2005; Kwak and Jukes, 2001).

After Japan, other countries also expressed an interest in functional products. In particular, in the USA, in 1994, the Nutrition Labeling and Education ACT (NLEA) was applied, which allowed the use of health claims in foods for which the Food and Drug Administration (FDA) established, on the basis of scientific evidence, the correlation between their contribution and the treatment/prevention of specific diseases (Hrelia, 2010; Roberfroid, 2000).

In Europe, on the other hand, the interest in functional foods has emerged more recently, as until the Eighties scientific contributions on the topic were mainly oriented to the study of diseases related to nutritional deficiencies. Only later, there was a growing interest in the issue of disease prevention through the consumption of foods in support of the relationship between nutrition and health (Aiello, 2011).

Several scientific contributions addressed the issue of the definition of functional foods. Some suggest that any type of food that presents a message about health benefits can be considered as functional (Hollingsworth, 1999; Riemersma, 1996); others define only fortified foods as functional, enriched or to which has been added a component that has beneficial effects beyond the basic nutritional characteristics

(IFIC Foundation 2006, Kleinschmidt, 2003). Some definitions, however, are relatively simple, such as the one which considers all foods (or their components) that have a positive impact on health or that can reduce the risk of certain diseases to be functional (National Research Institute for Food and Nutrition, 2000).

Another broad field of studies has focused on the analysis of citizens-consumers' attitudes towards functional products. In particular, several studies emphasize that the acceptance by individuals of functional foods depends mainly on the carrier product used as a support for the functional element (Kraus, 2015; Hailu*et al*, 2009; Williams *et al*, 2008; van Trijp and van der Lans, 2007). Among the most relevant functional components are vitamin C, calcium, dietary fiber and omega-3 fatty acids (Kraus, 2015; Bornkessela *et al*., 2014); the preferred products-carriers, instead, are dairy products, bread, cereals, fruit/vegetable blends and functional meat products, the latter with great market potential (Kraus, 2015; Olmedilla-Alonso *et al*., 2006).

The increase of awareness in the population of the link between nutrition, health and disease prevention has led consumers to perceive and associate greater added value to those products that report health claims on the label or whose consumption inspires a positive effect on physical well-being. To these elements the consumer more and more associates an increase of usefulness for which he is willing to pay a premium price (Verbeke 2005; Lusk, Hudson, 2004).

Several studies focused on the analysis of citizens-consumers' attitudes towards functional foods, by detecting the willingness to pay (WTP) a price premium for such products (Migliore *et al*., 2022; Di Pasquale *et al*, 2011).

Also food systems sustainability, which is at the heart of the debate that sees Europe as the first climate-neutral continent by 2050, represent a relevant attribute in citizens-consumers' choices. In fact, over last decades, they showed an increasing interest toward environmental and social issues, generating new consumption demands including intangible needs (Marotta and Nazzaro, 2012). With regard to the purchase of sustainable foods, there are many contributions highlighting the positive attitude of citizens-consumers towards them (Aprile and Punzo, 2022; Gracia and Gòmez, 2020).

Despite this, literature lacks contributions considering both the health-related and the sustainability attributes. Therefore, the purpose of this study is to investigate citizens-consumers attitude towards functional products, in particular characterized by high antioxidant, mineralizing, detoxifying value, realized through the application of mild technologies, which allows to improve the environmental and energy sustainability of production.

METHODOLOGY

In order to achieve study's aims, data were collected using an online survey approach, including both qualitative and quantitative variables. In particular, the ten minutes lasting questionnaire consisted of five sections. In the first section, citizens-consumers' awareness and perception concerning functional foods were detected. In the second section, citizens-consumers' purchasing habits were investigated, in particular concerning functional foods. The third section concerned a Best-Worst Scaling analysis (Stanco *et al*., 2020), including eleven attributes among those considered most relevant in literature (i.e. antioxidant properties; realized without palm oil, hydrogenated fats, preservatives, dyes, GMOs; high vitamins intake; anti-inflammatory properties; organic; high protein; quality/price ratio; Italian; energizing; 100% recyclable packaging; vegan). In the fourth section, we detected, through the Multiple Price List (MPL) mechanism (Andersen *et al.*, 2006), citizens-consumers' WTP for functional bars characterized by high antioxidant, mineralizing, detoxifying value, realized through the application of mild technologies.

Lastly, we detected socio-demographic (i.e. gender, age, education level, employment, income, living area) and psychographic characteristics of respondents. The latter were assessed by using three scales: the green consumer value scale (Bearden *et al*., 2010); the health consciousness scale (Gould, 1988; Hong, 2009); the consumer novelty seeking scale (Manning *et al*., 1995).

In order to detect the variables affecting citizens-consumers' WTP for functional bars under analysis, a linear regression was carried out.

RESULTS AND DISCUSSION

The questionnaire was administered to a sample of 1,524 consumers, equally distributed in the gender (49% females and 51% males), with an average age of 50 years (min 28; max 76). These are individuals with a low income (mostly between 20,000 and 40,000 euros), mainly employees, with a high level of education. They come from all over Italy (north-east:19.16%; north-west: 26.57%; center: 22.77%; south: 20.8%; islands: 10.7%).

As regards respondents' awareness concerning functional foods: 79% of them stated they knew about functional foods, while 21% never heard of them. About 60% of the sample buys functional bars, mainly through retail and online channels. The consumption of bars, however, occurs mainly at home, at work and at the gym. On average, for the purchase of a functional bar, the sample pays between 1.50€ and 2.00€.

The results of the Best-Worst analysis show that the presence of antioxidant properties is the most important attribute for the sample. Following the absence of palm oil, hydrogenated fats, preservatives, dyes and GMOs, and the high intake of vitamins.

Despite this, the sample, on average, declares a WTP of 2.10€ for the purchase of the functional bars under investigation. So the price does not differ from the amount the sample, on average, pays for the purchase of a generic functional bar.

The linear regression model shows that the variables affecting such WTP are: gender (women are more likely to spend more); income (as income increase, WTP increase, too); and health consciousness scales (the more individuals care about health, the more they will be willing to pay for the purchase of the functional bar under investigation). Also the consumer novelty seeking scale is statistically significant, and affects WTP positively: the more the consumer is inclined to buy innovative food products, the higher his WTP for the functional bars studied will be. Green consumer value scale is not statistically significant: such result shows that the purchase of functional bars is still closely linked to the healthy properties of the food, and not to the production process behind its production.

CONCLUDING REMARKS

This study contributes to the advancement of knowledge in providing new evidence regarding citizens-consumers' attitude towards sustainable and healthy foods, and in particular functional bars characterized by antioxidant and sustainability attributes. The results show that citizens-consumers have a positive attitude towards such foods, but it is mostly due to their beneficial properties for health, while the sustainability attribute is still not significant. The study provides insights for public and private actors to carry out actions to encourage citizen-consumers' purchase.

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INSIGHTS INTO CONSUMER VIEWS ON NUTRI-SCORE LABELLING: A COMPREHENSIVE ANALYSIS USING Q-METHODOLOGY

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KEYWORDS
Nutri-Score labelling; Front-of-package labelling; Consumer behavior; Q methodology;

INTRODUCTION

In recent years, the escalating burden of non-communicable diseases (NCDs) has posed a significant challenge to global public health (Ramesh and Kosalram, 2023). The rising rates of cardiovascular diseases, diabetes, cancer, and other NCDs have emphasized the importance of adopting effective preventive measures to mitigate the impact of these conditions on individuals' health and healthcare systems. In response to this issue, several European countries have implemented Front-of-Pack (FOP) nutritional labelling systems, which involve clear indication of nutritional information on the front of food packaging, with the aim of empowering consumers and facilitating healthier food choices (Mazzù et al., 2022). Among the various FOP systems adopted, the Nutri-Score system has gained considerable popularity in Europe, particularly in France, where it was developed and introduced for the first time (e.g., Julia et al., 2022). The Nutri-Score system was designed to provide consumers with easily understandable information about the nutritional quality of packaged food products (Włodarek and Dobrowolski, 2022). By combining a letter grade (ranging from A to E) and colour coding (from dark green to red), the Nutri-Score system offers an immediate visual indication of the overall nutritional quality of a product. However, although the Nutri-score seems to allow consumers to evaluate the healthiness of a product immediately, it is also widely criticized as it overly simplifies the concept of nutrition, leading to a reductionist approach to food choices. For instance, the system can penalize products rich in healthy fats, such as olive oil, due to the presence of total fats without considering their specific lipid composition (Hau et al., 2023). Additionally, the Nutri-Score system excludes certain important nutrients that play a key role in promoting health (Santos et al., 2023). Some experts also raise concerns about potential confusion with the colour coding, as consumers may mistakenly interpret lighter-coloured products as automatically healthier without considering the complexity of complete nutritional information (Fialon et al., 2022).

If the fundamental reason for implementing the Nutri-Score system is to facilitate healthier food choices for consumers, it is essential to question whether this tool is truly suitable for guiding consumers. Among the various aspects to consider, knowing the consumers' opinion on the Nutri-Score system is important for several reasons. Firstly, public opinion is a fundamental aspect of a democratic society. To assess the acceptance of a new tool like Nutri-Score, it is important to involve citizens and gather their opinions. This ensures that the decisions made reflect the desires and interests of the majority of the population. Additionally, Nutri-Score is primarily considered a food labelling system that can provide clear and understandable information about the nutritional quality of a food product. Lastly, transparent food labelling is essential in assisting consumers in making informed decisions about their diet. Knowing the consumers' opinions on this tool can help to explore the distinct perspectives towards its usefulness and understand how the Nutri-Score can improve consumer trust in labelling and nutritional information. If consumers understand and accept the system, they will be more likely to trust the information it provides.

Therefore, drawing on these considerations and recognizing that the issue is still underexplored in the literature, the present study aims to investigate the perspective of Italian consumers regarding the adoption of the Nutri-Score system. The obtained results could further contribute to improving FOP labelling initiatives, including the Nutri-Score system, bridging the gap between public health objectives and individual needs.

MATERIALS AND METHODS

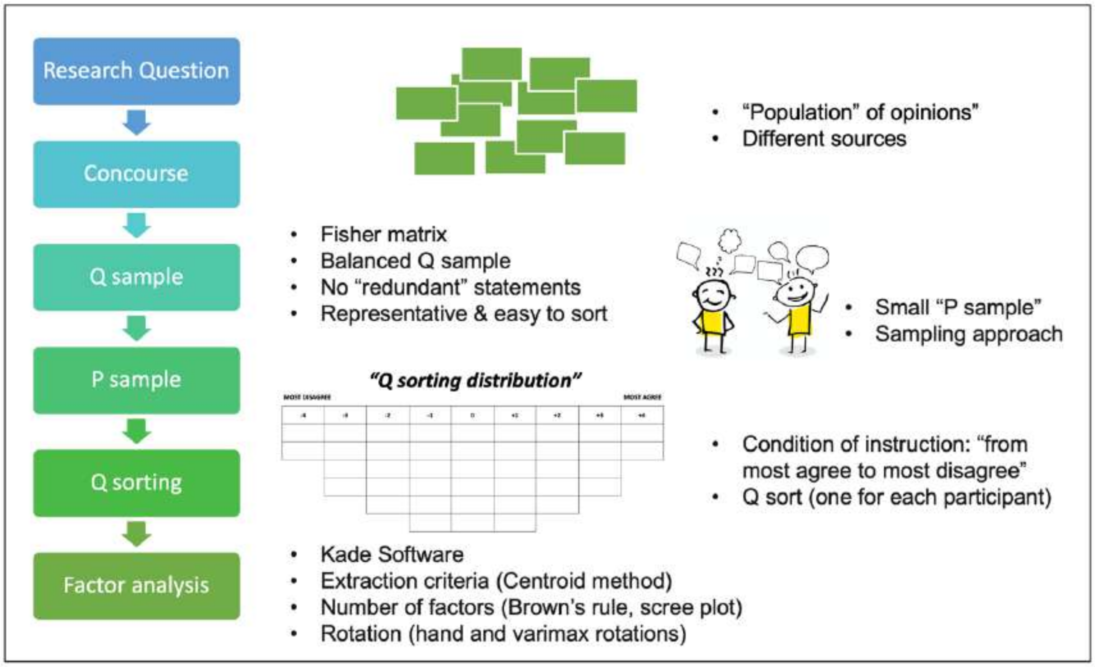
Consumers' subjective opinions on the Nutri-Score system were investigated through the Q methodology (Brown, 1980). Q methodology is a research method that combines both qualitative and quantitative approaches to accurately analyse individuals' subjective perspectives towards any topic (Mandolesi et al., 2022). Also, this methodology is particularly suitable when exploring the diverse perspectives in new debating discourse, like nutritional preferences and the adoption of FOP, where opinions can vary significantly from individual to individual (Dieteren et al., 2023). The output of a Q study is represented by the few most relevant "views" or "factors", which emerge from an "inverted" factor analysis (Stephenson, 1935), where individuals are factor analysed and grouped into factors. Consequently, each factor extracted resumes a shared way of thinking among a group of participants (Brown, 1980).

A Q study consists of five steps 1) the creation of the "concourse"; 2) the selection of the statements which form the "Q sample"; 3) the definition of the appropriate "P sample"; 4) Q sorting (collection of "Q sorts"; and 5) factor analysis and interpretation (McKeown and Thomas 2013). The main steps are described in Figure 1. This study involved a participant sample of 29 participants, invited to evaluate a selection of items ("statements") related to the Nutri-Score system according to personal perspective. A small sample is enough since participants in a Q study are sampled non-randomly; they are assumed to have different opinions towards the topic. The participant sample ("P sample") was evenly divided between individuals with non-communicable diseases and healthy individuals while considering a balanced representation across different age generations. Two hundred ninety self-referent statements which formed the general "concourse" were generated using secondary sources or 'ready-made' materials (McKeown and Thomas 2013), such as websites, newspaper articles and social networks. Those statements, representing the entire "population" of opinions about the topic under investigation, were reduced using a structured approach to overcome the risk of over-under sampling certain components. The "Q sample" layout was structured with five dimensions: Health, Political, Economic, Technical, and Usefulness. The dimensions were split into positive and negative opinions, and four statements were selected for each group of the structured matrix (5x2x4 = 40 statements).

Participants were then asked to rank the statements on a quasi-normal distribution ("Q sorting distribution"), ranging from most agreement ("+4") to most disagreement ("-4"). This q-sorting process generates a "Q sort" - the attitude or the opinion of the individual - which is the raw material for the subsequent factor analysis. The emerging factors express shared "attitudes held by different individuals" (Stephenson, 1965). In other words, participants who similarly ranked the statements are grouped into the same factor. Centroid factor analysis was used, followed by both hand and varimax rotations (McKeown and Thomas, 2013). Two methods were used to guide the selection of factors. First, the point at which the line - representing the eigenvalues for each factor (i.e., the scree-plot) - changes the slope indicates the cut-off point and, consequently - the number of factors to extract. Then, Brown's rule (1980) was also used.

According to this rule, the factors with at least two factor loadings – correlations between Q sorts – statistically significant at the 0.05 level, i.e., those exceeding ±0.3099 (±1.96 × standard error [SE]; with SE = 1/√ (No. of statements)) were extracted.

Figure 1 – Q study by steps



RESULTS

The average correlation between Q sorts is 0.11, indicating participants are rather heterogeneous regarding their viewpoints about the Nutri-Score system. To extract the correct number of factors, an iterative approach was followed. Finally, a two-factor solution was the one that identified the most relevant viewpoints, explaining 50% of the total variance. Twenty participants loaded significantly on Factor 1, eight on Factor 2, and one was not assigned to any factor. Post-sorts interviews were used to interpret the factors.

The first perspective (F1: *"Health Focused"*) focuses on health aspects and the Nutri-Score system's capability to help consumers identify and compare the nutritional quality of foods they purchase. Health aspects are the main drivers, and the Nutri-Score system is seen as a valuable tool to easily discriminate foods which should be limited (e.g., rich in fat) from those considered to be in line with dietary guidelines. The Nutri-Score is considered a positive attempt by policymakers to put first public health over economic interest. The second perspective (F2: *"Skeptical Teachers"*) opposes the Nutri-Score system. According to this view, no label can guide consumers' food choices. Using this system to discriminate the nutritional quality of food is perceived as an overbearing hypothesis. A balanced diet depends on many factors, and policymakers should adequately invest in communication and education. Main criticisms arise from the algorithm, which is considered incomplete (e.g., additives) and incorrect. Despite the divergence, both views do not believe that the scope of introducing the Nutri-Score is discriminating against traditional local foods. All believe that industry-leading food companies will not use this system to influence consumers' food choices, but it will increase the competitiveness in the market.

CONCLUSIONS

The results of this study provide a meaningful overview of consumers' opinions regarding the implementation of the Nutri-Score system. The obtained information could have significant implications. First, the results could be used to assess whether the system is achieving its goals of improving consumers' nutritional awareness and promoting healthier food choices, thereby assisting policymakers and healthcare decision-makers who could utilize the results to enhance the effectiveness of the Nutri-Score system and other front-of-package labelling initiatives. Additionally, food companies could benefit from this information by adapting their marketing and communication strategies to better meet consumer needs.

However, it is important to consider also the limitations of the study. The study was distributed in Italy, where the Nutri-Score is mostly unknown. Regarding the sample size, Q studies typically use small sample sizes and the results are not used to count "how many" people think a certain way. This means that the generalisation should be thought in terms of the universe of subjectivity rather than in terms of the population of persons. Despite the inherent limitations of the study, the obtained results would serve as a valuable guide for implementing the Nutri-Score system, taking into account consumers' opinions and highlighting the need for a personalized approach based on individual consumers' needs.

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The Empirics of Freshwater Ecosystems: a Global Meta-Regression Analysis

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INTRODUCTION

The recently published System of Environmental Economic Accounting-Ecosystem Accounting (SEEA EA) framework represents a significant step towards making visible the contributions of nature to the economy and people (Edens *et al.*, 2022). The purpose of developing ecosystem accounts, encompassing both physical and monetary aspects, is to quantify and effectively communicate the economic significance of natural capital and ecosystem services to policymakers, with the aim of enhancing the sustainable management and utilization of these resources. The inclusion of monetary valuation provides valuable information for decision-making, allowing for direct comparisons with other goods, services, investments, and impacts within the economy and society. However, challenges such as ensuring consistency in monetary values, accounting for spatial variability and context dependence, and addressing methodological uncertainties must be addressed when valuing ecosystem services (Brander *et al.*, 2022).

The aim of this study is to evaluate the economic values associated with the ecosystem services provided by freshwater ecosystems on a global scale. The comprehension of these values is of utmost importance as it enables the comparison with the opportunity costs associated with the management of these ecosystems. Research suggests that approximately 2.4 percent of the Earth's land surface consists of freshwater ecosystems (Van Klink *et al.*, 2020). These ecosystems possess unique biodiversity and contribute essential services such as water and food provision, climate regulation, and recreational opportunities (Janse *et al.*, 2015). However, they are particularly susceptible to degradation due to their role in integrating the impacts of activities occurring within their respective watersheds, encompassing rivers and lakes (Kummu *et al.*, 2011). Given the escalating global anthropogenic pressures, the restoration and conservation of freshwater ecosystems emerge as urgent environmental priorities (Carvalho et al., 2019).

Existing studies so far have employed a myriad of diverse procedures and different types of ES conceptualization to estimate economic value (Bateman *et al.*, 2011; Brander *et al.*, 2006; Brouwer *et al.*, 2013; Costanza *et al.*, 1997, 2017; Grammatikopoulou and Vačkářová, 2021; de Groot *et al.*, 2002; Navrud and Strand, 2018; Schild *et al.*, 2018). Consequently, summarizing the burgeoning literature effectively and developing stylized facts has become challenging. Furthermore, due to the diverse conditions present in various studies, it is difficult to determine to what extent specific methodological choices can determine estimates of the economic valuation of ES.

This study undertakes a synthesis of the existing literature on the economic valuation of freshwater ecosystem by employing a meta-regression model. The objective is to identify the study characteristics that account for the observed variation in the empirical literature and to generate a set of results on the economic value of freshwater ecosystems that are not conditioned by the specifics of a single study.

MATERIALS AND METHODS

Systematic review

A comprehensive search of published articles regarding the economic value of freshwater ecosystems was conducted in major academic journal publishers' databases (Scopus, Science Direct, Web of Science) using the query terms consisting of: *TITLE-ABS-KEY ("ecosystem service*" OR "ecological service*" OR "environmental service*") AND TITLE-ABS-KEY ("freshwater" OR "river*" OR "river delta*" OR "lake*" OR "marshe*" OR "swamp*" OR "floodplain marsh*" OR "peat*" OR "anthropogenic freshwater" OR "constructed wetland*" OR "canal*" OR "drain*" OR "rice padd*") AND TITLE-ABS-KEY ("market pric*" OR "mitigation cost" OR "replacement cost" OR "avoided cost" OR "production function" OR "travel cost" OR "hedonic price" OR "revealed preference" OR "stated preference" OR wtp OR wta OR wts OR "choice model*" OR "choice experiment" OR "group deliberation" OR "benefit transfer" OR "shadow pric*" OR "simulated exchange")*. Once this list of documents was compiled, various criteria and a quality checklist (Page *et al.*, 2021) were used to determine whether to include a study in this analysis.

Database compilation

The way values are reported in primary studies varies considerably (Brander *et al.*, 2006). Some studies present economic values per hectare, while others use biophysical units or per visit measures. This variability is clearly dependent on the specific ES under examination. There was also diversity in the specification of biomes, ES, and evaluation methods, necessitating an effort to standardize the data. We assigned each freshwater biome according to the International Union for Conservation of Nature's Red List of Ecosystems (IUCN-RLE) and valuation methods were classified in line with the SEEA EA framework (UNEP, 2015; UN, 2017) .

To allow comparison of economic values, we have standardized them in international monetary units, specifically International $ dollars per hectare per year in 2020 price level, to equalize values estimated in different years and different currencies.

Finally, the studies were evaluated based on the ecological status of the target area (highly degraded or intensively managed, intermediate, well-functioning or extensively managed), the type of beneficiaries of the specific ES (residents or global), the scale of application (local, regional, or national), the socio-economic characteristics (GDP per capita Purchasing Power Parity (PPP) (constant 2017 international $), population density, share of rural population, belonging to a protected area) and the geographics ones (latitude, longitude, study area).

Meta-regression model

Our empirical meta-regression model is specified in a semi-log functional form (Eq. 1), where the dependent variable (y) is a vector of values in International $ per hectare per year at 2020 price level. The coefficients measure the proportional change in the dependent variable for a given absolute variation in the value of the explanatory variable. The explanatory variables are presented in Table 1 and are grouped into three main parts, namely site and socio-economic characteristics (Xs), study characteristics (Xst), and biome and ES characteristics (Xes). The estimated model is the following:

$$\ln y_i = \alpha + X_{si}\beta_s + X_{sti}\beta_{st} + X_{\$si}\beta_{\$s} + \varepsilon_i \quad (1)$$

where α represents the constant term, the vectors β refer to the coefficients associated with their respective explanatory variables to be estimated, ε is a vector of independently and identically distributed residuals, and i corresponds to the individual monetary value estimated in the study.

Table 1. Summary statistics of explanatory variables

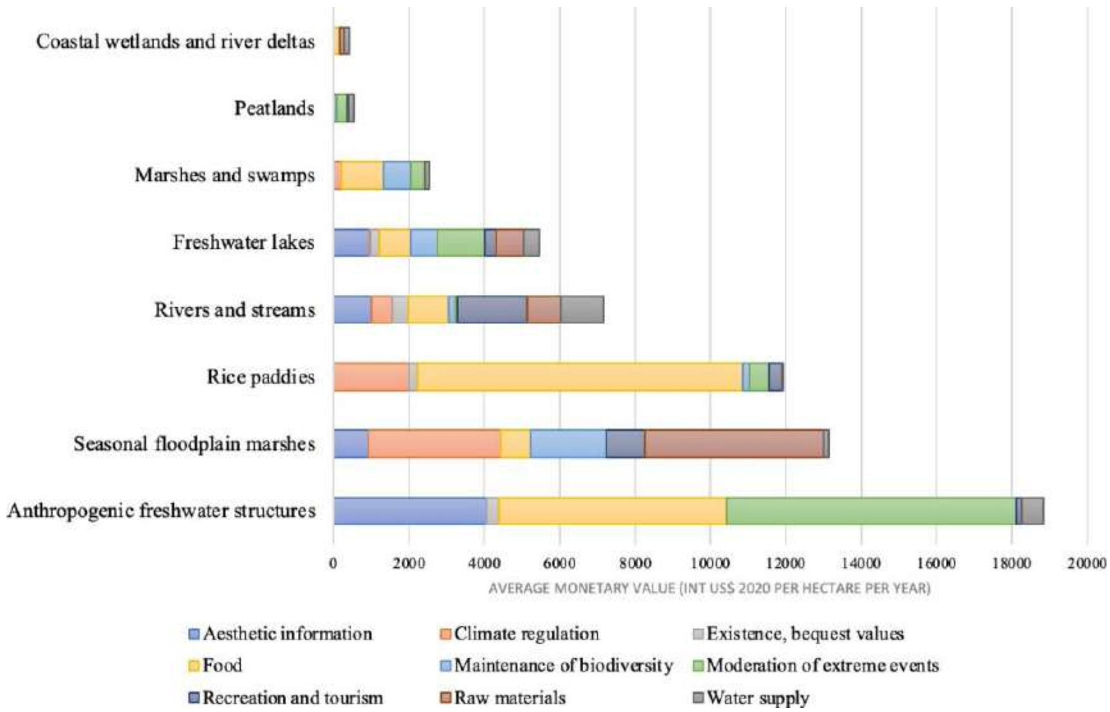
	Explanatory Variables		Obs	Mean	Std. dev.	Min	Max
Site and socio-economic characteristics (Xs)	GDP per capita (PPP 2017)	(a)	446	18899.980	17314.160	1571.180	63027.680
	Population density (people per km^2)		446	218.909	230.740	3.335	1286.172
	Rural population (% total population)		446	43.973	23.016	7.764	82.573
	No Protected		446	0.388	0.488	0	1
	Area (km^2)		446	1301.985	3326.615	0	25900
	Latitude		446	20.228	23.196	-45.408	54.500
	Longitude		446	47.210	53.112	-110.568	146.130
	National scale	(b)	446	0.020	0.141	0	1
	Regional scale		446	0.103	0.304	0	1
Study characteristics (Xst)	Residents	(c)	446	0.316	0.465	0	1
	Year		446	2010.850	6.152	2000	2022
	Choice experiment	(d)	446	0.058	0.235	0	1
	Contingent valuation		446	0.197	0.398	0	1
	Hedonic price		446	0.013	0.115	0	1
	Market price		446	0.352	0.478	0	1
	Production function		446	0.105	0.307	0	1
	Travel cost		446	0.043	0.202	0	1
	Value transfer		446	0.135	0.342	0	1
Biome and ES characteristics (Xes)	Higly degraded or intensively managed	(e)	446	0.188	0.391	0	1
	Well-functioning or extensively managed		446	0.345	0.476	0	1
	Rivers delta	(f)	446	0.025	0.155	0	1
	Lakes		446	0.265	0.442	0	1
	Marshes		446	0.038	0.192	0	1
	Peatlands		446	0.045	0.207	0	1
	Rice paddies		446	0.070	0.255	0	1
	Rivers and streams		446	0.415	0.493	0	1
	Seasonal floodplain marshes		446	0.094	0.292	0	1
	Aesthetic information	(g)	446	0.074	0.262	0	1
	Climate regulation		446	0.054	0.226	0	1
	Existence, be-quest		446	0.022	0.148	0	1
	Food		446	0.296	0.457	0	1
	Maintenance of biodiversity		446	0.076	0.266	0	1
	Moderation of extreme events		446	0.049	0.217	0	1
	Recreation and tourism		446	0.121	0.327	0	1
	Raw material		446	0.103	0.304	0	1

RESULTS

Preliminary descriptive results

Considering the entire sample, we found an average value for freshwater ecosystem services of 7,536.76 US\$2020 ha^{-1} year^{-1}. The median value is 407.83 US\$2020 ha^{-1} year^{-1}, indicating a skewed distribution with a tail of higher values. The average value of biomes varies depending on the typology (Fig. 1). The average value of Anthropogenic freshwater structures is 18,841 US\$2020 ha^{-1} year^{-1}, significantly higher than the corresponding value for Rivers and streams biomes (7,168 US$2020 ha^{-1} year^{-1}) and Freshwater lakes biomes (5,464 US$2020 ha^{-1} year^{-1}). On average, the values found for ES provided by Freshwater lakes are much higher than those reported by Reynaud and Lanzanova (2017) (315.1 US$2010 ha^{-1} year^{-1}). Additionally, it is possible to assess how a specific type of ES associated with the biome contributes to the economic valuation. Anthropogenic freshwater structures, for example, receive the highest contribution concerning the evaluation of Moderation of extreme events service (40.8% of the value) and only a small part (3.1%) for the Water supply service (Fig. 1).

Figure 1. Average monetary value for each biome and relative contribution of the associated ES



The evaluation methods were classified into 10 categories (Fig. 2) (SEEA EA, 2021). The data showed a preference in the choice of evaluation method based on the type of ES to be assessed, as also highlighted in Grammatikopoulou and Vačkářová (2021). For instance, the Market Prices method is consistently preferred for provisioning services related to food, raw materials, and water supply. On the other hand, the Contingent Valuation and Value Transfer methods have the highest number of observations for the Maintenance of biodiversity service (Figure 2).

Figure 2. Economic evaluation methods used and associated ES

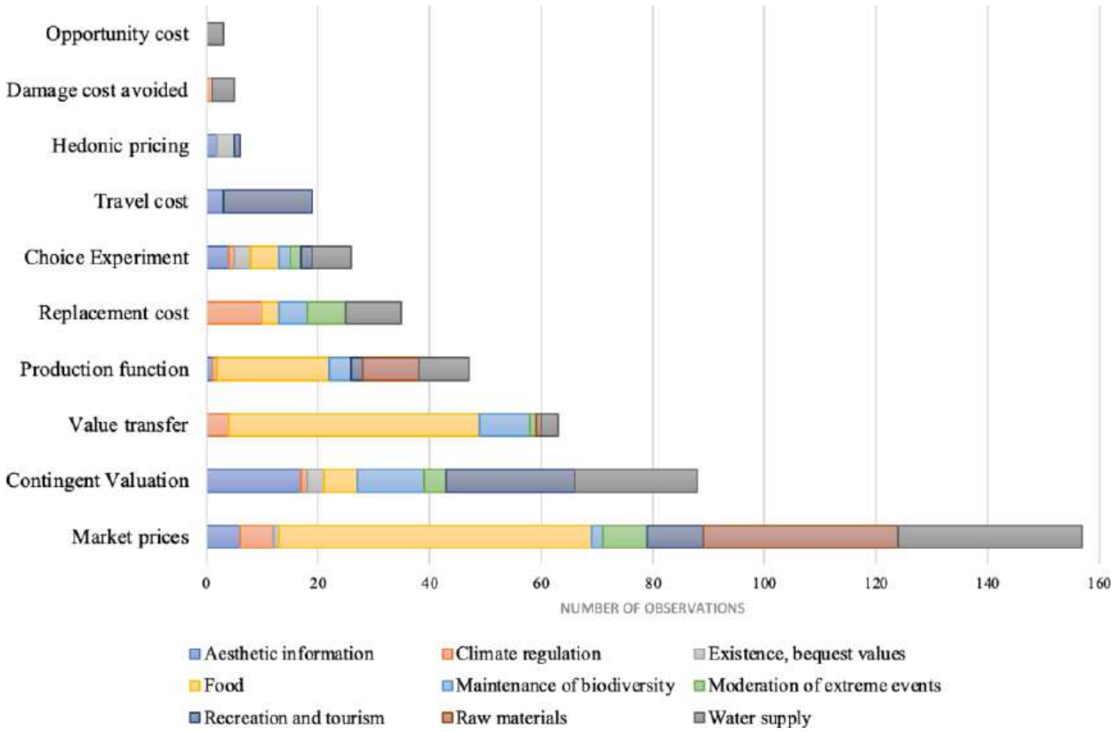


Table 2 presents the average ES values per evaluation method. Recreation and Tourism service received a higher average valuation (12,503.563 US\$2020 ha^{-1} year^{-1}) compared to Climate regulation service (1,564.291 US\$2020 ha^{-1} year^{-1}) or Water supply service (7,006.841 US\$2020 ha^{-1} year^{-1}). Particularly noteworthy is the average valuation received by Recreation and Tourism service through the Choice Experiment evaluation approach (54,725.894 US\$2020 ha^{-1} year^{-1}), significantly higher than the values obtained from other applied methods. This indicates considerable diversity in the valuation outcomes depending on the method used. The large standard deviations recorded, in general, describe this heterogeneity (Tab. 2) as also highlighted in Reynaud et al. (2017) and Grammatikopoulou and Vačkářová, (2021) among others.

Table 2. Mean value of ES per applied valuation method (international US$2020 ha^{-1} $year^{-1}$)

	Choice Experiment	Contingent Valuation	Damage cost avoided	Hedonic pricing	Market prices	Opportunity cost	Production function	Replacement cost	Travel cost	Value transfer	Obs.	Mean (St.dev.)
Recreation and tourism	54725.894	10880.303	/	294.546	1888.773	/	4235.690	/	2996.177	/	54	12503.563 (19173.950)
Food	2.681	13127.787	/	/	9530.620	/	3281.386	32958.661	/	8991.247	132	11315.396 (10589.504)
Raw materials	/	/	/	/	6686.902	/	24068.537	/	/	140.470	46	10298.636 (10096.916)
Moderation of extreme events	0.918	4508.153	/	/	29906.688	/	/	1358.866	/	3270.179	22	7808.960 (11156.834)
Water supply	10.526	5820.175	1039.110	/	2452.726	36649.603	2659.222	5638.430	/	1784.939	91	7006.841 (11365.773)
Aesthetic information	979.750	12287.272	/	642.824	15060.576	/	0.086	/	7574.079	/	33	6090.764 (5971.506)
Maintenance of biodiversity	1136.270	12132.911	/	/	490.195	/	238.521	2943.807	/	480.744	34	2903.741 (4224.978)
Existence, bequest values	3.830	222.796	/	4762.385	2856.044	/	/	/	/	/	10	1961.263 (1968.548)
Climate regulation	38.550	0.234	4.273	/	528.636	/	141.175	9925.289	/	311.884	24	1564.291 (3418.029)

Meta-regression model post-estimation diagnostics and results

The model explains 43.2% of the variance in the dependent variable, as indicated by the R-squared value. OLS regression was performed using White-adjusted standard errors, as the Breusch-Pagan test indicated that the variance of residuals is not constant, rejecting the null hypothesis of homoscedasticity (Prob > χ^2 = 0.0201). Multicollinearity was assessed by examining the Variance Inflation Factor (VIF), which had an average value of 2.93 and no independent variable presented a value of 1/VIF above the tolerance threshold of 0.1. To test for model misspecification, the Ramsey Regression Equation Specification Error Test (RESET) was performed on the omitted variables. This involved creating new variables based on the predictors and re-estimating the model using these new variables to see if any of them were significant. The test results allowed for not rejecting the null hypothesis that the model has no omitted variables (Prob>F = 0.6523), also providing confirmation of the correct functional form choice (Ramsey, 1969; Ramsey and Schmidt, 1976). The non-independence of estimates from primary studies has been recognized as a crucial methodological issue in the meta-analysis literature. This is because individual studies often produce multiple values, and observations drawn from the same study may therefore suffer from within-study correlation (Nelson and Kennedy, 2009). The use of ordinary least squares (OLS) with cluster-robust standard errors has been the adopted solution to address this problem.

The OLS with cluster-robust adjusted standard errors model results are displayed in Table 3.

Table 3. Meta-regression model results

		Coefficient	Robust std. err.	P>|t|
Site and socio-economic characteristics (Xs)	GDP per capita (PPP 2017)	-0.00004	0.00003	0.164
	Population density (people per km^2)	-0.001	0.001	0.296
	Rural population (% total population)	-0.061	0.016	0.000***
	No Protected	0.718	0.468	0.127
	Area (km^2)	-0.00010	0.00005	0.048**
	Latitude	0.033	0.015	0.036**
	Longitude	0.009	0.005	0.079*
	National scale	3.740	1.263	0.004***
	Regional scale	-0.440	1.110	0.693
Study characteristics (Xst)	Residents	0.645	0.570	0.259
	Year	-0.084	0.036	0.021**
	Choice experiment	-5.687	1.279	0.000***
	Contingent valuation	-2.190	0.639	0.001***
	Hedonic price	0.318	0.983	0.747
	Market price	-1.073	0.497	0.033**
	Production function	-2.019	0.775	0.011**
	Travel cost	-2.166	0.961	0.026**
	Value transfer	2.161	0.978	0.029**
Biome and ES characteristics (Xes)	Higly degraded or intensively managed	-0.861	0.637	0.179
	Well-functioning or extensively managed	-0.290	0.470	0.538
	Rivers delta	-7.043	1.154	0.000***
	Lakes	-0.513	0.616	0.407
	Marshes	-1.179	1.198	0.327
	Peatlands	-3.896	1.753	0.028**
	Rice paddies	0.563	0.964	0.561
	Rivers and streams	-1.786	0.566	0.002***
	Seasonal floodplain marshes	1.384	0.695	0.049**
	Aesthetic information	1.016	0.671	0.132
	Climate regulation	-0.882	0.630	0.164
	Existence, be-quest	-0.839	0.842	0.321
	Food	0.777	0.477	0.106
	Maintenance of biodiversity	-0.591	0.642	0.358
	Moderation of extreme events	-0.262	0.734	0.721
	Recreation and tourism	1.203	0.691	0.084*
	Raw material	0.307	0.686	0.655
	Constant	179.686	72.504	0.015**
	N	446		
	R-sqaured	0.432		
	RMSE	2.604		
	F(35,120)	17.520		
	Prob>F	0.000		

In the group of variables of site and socio-economic characteristics, GDP per capita did not show a statistically significant effect, unlike what was highlighted in Brander et al. (2006) and in line with Reynaud et al. (2017). As indicated in previous studies for other types of ecosystems (Chiabai *et al.*, 2011; Ojea *et al.*, 2010), the size of the area has a negative and statistically significant coefficient indicating decreasing returns to scale, but the result could also be related to the fact that the smallest ecosystems in our database are in Europe, a region for which we would a priori expect high values for freshwater ES. Studies conducted on a National scale led to higher ES values, with a significant marginal effect of 3.740(y_i).

Among the study's characteristics, numerous explanatory variables were able to explain the variation in value at a statistically significant level. The results from the dummy variables of the evaluation methodology revealed that the value estimates derived from market-based and stated preference approaches were lower compared to the reference methods based on costs, with a consistently significant statistical level. Similar findings were reported in Brander et al. (2006) regarding the direction of the estimated effect. The Value Transfer methodological approach was the only one to yield higher estimates, with a significance statistical level of 5%.

Among the freshwater biomes, Seasonal floodplain marshes and Rice paddies have been associated with higher per hectare values, but only the former showed statistical significance. Noteworthy is the evaluation of Rivers and streams in comparison to Anthropogenic freshwater structures, which is 178.6% lower with a statistical significance level of 1%. Regarding the ES coefficients, we observed that none of the categories showed statistical significance compared to the omitted variable of Water Supply, except for the Recreation and tourism service, which received high estimates, as also depicted in Table 2. The coefficients for Maintenance of biodiversity, Climate regulation, and Moderation of extreme events, showed smaller negative estimates, although not statistically significant. Similar results are reported in Brander et al. (2006).

CONCLUSION

Although several studies have been conducted to investigate the economic value of ES associated with freshwater ecosystems, assimilating the results from the existing literature is difficult. This study performs a meta-analysis of 121 studies reporting a total of 446 valuations worldwide. Across all studies, researchers have, on average, assigned a value ranging from 1564.291 to 12503.563 US\$2020 ha^{-1} $year^{-1}$ for the various analyzed ES. However, several factors have significantly influenced this value estimate. Particularly, concerning the methodological approach employed, market-based and revealed and stated preference approaches all exhibit a negative correlation with the variability of estimates when compared to cost-based approaches. The appeal of these findings lies in the fact that they are not based on the results of a single study but are cumulatively derived from a series of different studies conducted by various authors in diverse locations. These studies evaluate different ES using various methods. It is evident that further research is needed to fully comprehend the determinants of value attribution for such ecosystems. Nevertheless, we are encouraged by our model's ability to effectively synthesize the existing literature.

Furthermore, future research should investigate the possibility of integrating primary valuation studies with external spatial data (e.g., GIS data) to model the effects of substitutes (varying in space), distance, and geopolitical boundaries. The increasing availability of georeferenced information and big data analytics provides an ideal context for developing spatially explicit function value transfer approaches. While key spatial information is already collected and standardized in existing tools, implementing a meta-analytic value transfer function for accounting could be a crucial step (Grammatikopoulou *et al.*, 2023).

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The role of upstream actors in the management of fresh fruit & vegetables surplus and losses

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PAROLE CHIAVE
Fruit and vegetables, food losses, prevention, innovation, Q methodology, Producers' Organization

1 INTRODUCTION

The fruit and vegetable (F&V) value chain is essential for the global food system. Yet F&V wastage still occurs along the value chain despite their necessity for a healthy diet (FAO,2019). Prevention and reduction of food losses and waste (FLW) in the agrifood sector is one of the main challenges of recent years to avoid the wastage of resources and nutritious products. According to FAO (2019,2021), the term "food losses" is referred to the reduction in edible food mass during the upstream phases of the agrifood value chain (production, post-harvest, and processing phase) while "food waste" is the discarding of edible food at retail and consumer levels. Food losses is an economic issue for the all the actor of the F&V value chain, with special implication for farmers. In Europe, to strengthen farmers' collective bargaining power and support their investments they can organize their business to participate in Producer organisations (POs) or associations of producer organisations (APOs). This allows farmers to concentrate the supply and improve their marketing powers. Farmers, POs and AOPs, together with broker and expert can be considered the main actors during the upstream phases of the agrifood value chain. In the EU, the OCM regime supports POs for implementing Operational Programmes with funding contributions (Reg. 1308/2013). The operational program has a duration of 3 to 5 years, each year a PO or AOP may set up an Operational Fund to finance the investments included in the operational programme. The operational fund is financed jointly by the financial contribution of members (or the PO itself) and the EU financial assistance. It is possible to finance different types of measure through Operation Fund, yet investments in measure to reduce food surplus and losses is still residual compared with other types of investments (OERSA,2020). The choice about the type of investments to be included in the operational program is made jointly between the farmers and the PO's corporate structure (European Commission, 2013). This joint decision-making process ensures that the investments align with the interests and needs of all parties. Nonetheless, the actors in the F&V value chain have different expertise and backgrounds, and this may hamper their knowledge on the topic of food losses prevention. In general, there may be a willingness to address FLW but, from a business perspective, wasting food might be rationale without a supportive framework and a positive trade-off between the cost of introducing an innovation and the expected impact (Tort *et al.*, 2021). Cooperation, also defined as 'co-innovation', among actors is reported to be an element of success for innovation in the food industry, but there are only a few studies in the literature on the perception of innovations along the F&V value chain, compared to the existing literature on assessing consumers opinions of new food and technologies (Tort *et al.*, 2012; Mandolesi *et al.*, 2015). This is one of the first study on the perception of a sample of upstream actors on the F&V value chain towards innovation to prevent food losses and improve the management of surplus products. The purpose of this study is to contribute to the narrative of sustainable F&V value chain and to extrapolate indication about which strategies and related innovative operations management, if pursued with a shared preference, would have greater success and adhesion among operators. A Q methodology framework is set to collect, assess, and discuss the similarities in the viewpoint of the actors and to report their opinion towards innovative practices that shall enhance their operation's sustainability.

2 THEORETICAL FRAMEWORK

The prevention of food waste in the F&V supply chain is a pressing challenge with significant economic and environmental implications. In this study, we propose a multidimensional theoretical framework that integrates key concepts starting from Rogers' Innovation Adoption Theory (Rogers, 1962), Value Chain Management Theory by Porter (Porter, 1985) and The Circular Economy theory. Rogers' seminal work on the diffusion of innovations offers valuable insights into how individuals or organizations adopt new ideas or practices. In the context of this study, stakeholders' preferences are considered to influence their assessment of the relative advantage of innovative solutions within operational program, perceived compatibility with existing practices, complexity, and observability. Understanding stakeholders' perspectives on these attributes will guide the design of investment plans and encourage the adoption of sustainable practices (Rogers, 1962; Van Huylenbroeck *et al.*, 2018). The concept of value chain management emphasizes the importance of collaboration and coordination among supply chain actors to reduce waste and maximize value creation. Stakeholders' preferences are critical in identifying investment opportunities and developing operational program that align with the principles of sustainable F&V value chain. Coordinated efforts along the supply chain can enable the implementation of circular practices, such as waste reduction initiatives and the adoption of resource-efficient technologies (Porter, 1985; Beamon *et al.*, 1998). The circular economy approach focuses on minimizing waste generation, promoting resource reuse, and closing material loops. Stakeholders' preferences towards specific circular economy practices, such as investments in sustainable packaging, waste valorisation, and recycling technologies, will be pivotal in designing operational program that drive the transition towards circular practices in the F&V value chain (Ellen MacArthur Foundation, 2015; Geng *et al.*, 2019). The exploration of stakeholders' preferences is made using the Q methodology, which provides a unique approach to capturing individual perspectives within a complex decision-making context (Stephenson, 1935; Brown, 1980). By combining insights from relevant economic theories about the adoption and diffusion of innovations with material collected from interviews with experts, the aim of this research is to gain a comprehensive understanding of the factors influencing stakeholders' preferences and willingness to invest in sustainable practices through operational programmes.

3 METHODOLOGY

This work was conducted as part of the H2020 project [omitted for review]. One of the institutional partners involved in the project had a key role in improving the recruitment of a sample of experts and organizations to be interviewed by offering information collected on digital platform provided in the project. The methodology adopted for this study was developed in the 1930s by W. Stephenson to shift from variable factor analysis, R methodology, to person factor analysis, Q methodology. The Q methodology allows to use information collected from subjects to identify common and/or divergent patterns on a given topic. During the data collection process, each subject is invited to explain their personal preferences in their own words, allowing the possibility of identifying relationships by interpreting the subject's point of view (Mandolesi *et al.*, 2015). Q methodology implementation consists of five steps: construction of the concourse, development of the Q sample, selection of the P set, Q sorting, and Q factor analysis. The concourse refers to "the flow of communicability surrounding any topic" (Brown, 1993): a collection of all the statements about the topic of the study. In this research, the narrative around innovations to improve the management of surplus and prevent food losses in the fresh F&V value chain was developed by combining scientific research, grey literature, direct interviews with supply chain experts, consultant and researcher involved in [omitted for review] project. More than 300 statements were collected and analysed. A deductive factorial design was employed to classify all viable assertions into theoretical categories and then organized into a 9-cell matrix (3x3) to reduce the amount to a representative yet manageable set of statements (Table 1). For the aim of this study, the theoretical class "Type of innovation" includes three approaches to innovations, as described by the Oslo Manual (OECD,2018). The "Scope of the actions" category is derived by the "Waste hierarchy framework" in the F&V sector (WRAP, 201). The final Q sample is composed of 34 statements to represent the concourse.

Table 1 – Sampling Matrix

		Type of innovation		
	Q sample (n = 34 statements)	Technological & Product Innovation	Organizational Innovation	Marketing Innovation
Scope of the actions	Prevention of food losses	4	4	4
	Optimization of F&V products	4	4	4
	Food losses recycling and recovery	3	4	3

After a pilot test, the Q sample was refined, and the statements were reorganized to include all the possible feedback. As suggested by Webeler & Danielson (2009), the P set (participant sample) was structured to include subjects with knowledge and/or roles coherent with the topic who are invited to freely express their opinion (Table 2). POs (also representing farmers point of view), APOs, and supply chain experts (e.g., agronomists, innovation brokers, and intermediaries) are part of the final sample. The participant in the sample were randomly chosen to assure the representativeness of different points of view. As reported in Table 2, the P sample is composed by 14 participants of which 42% is women. Most of the participant have more than 10 years of experience in the sector, and different role in the innovation process: adopter (those directly involved in the decision about the adoption of an innovation), non-adopter, and innovation broker (Clark *et al.*, 2002; Winch *et al.*, 2007).

Table 2 - P Sample

Q-sort ID	Value chain level	Main occupation	Gender	Age	Experience in the sector	Role in the innovation
1	AOP	Association Service Manager	F	40-45	> 15 years	Adopter
2	AOP	Operational Plans Manager	M	50-55	> 10 years	Adopter
3	OP	Operational Plans Manager	M	60-65	> 20 years	Adopter
4	OP	Association Service Manager	F	40-45	>10 years	Adopter
5	OP	OCM manager	F	40-45	>10 years	Adopter
6	OP	Market Withdrawals Manager	F	35-40	> 5 years	Adopter
7	OP	CEO	M	60-65	> 20 years	Adopter
8	Entrepreneurs	Buyer	M	45-50	> 15 years	Non-adopter
9	Research sector	Expert	M	30-35	> 5 years	Innovation broker
10	Research sector	Agronomist	F	30-35	> 5 years	Non-adopter
11	Research sector	Expert	F	40-45	> 15 years	Innovation broker
12	Research sector	Agronomist	M	40-45	> 15 years	Innovation broker
13	Entrepreneurs	Expert	M	35-40	> 5 years	Adopter
14	Entrepreneurs	Buyer	M	40-45	>15 years	Innovation broker

The *Q sorting* process consists of data collection organized by one-to-one remote interviews. The online tool Miro (https://miro.com/it/) was used to present the statements in the form of digital cards and to sort each one on the Q sorting grid (Table 3).

Table 3 - Q sorting grid

Mostly Disagree				Neutral				Mostly Agree
+1	+2	+3	+4	+5	+6	+7	+8	+9
+1	+2	+3	+4	+5	+6	+7	+8	+9
	+2	+3	+4	+5	+6	+7	+8	
		+3	+4	+5	+6	+7		
			+4	+5	+6			
				+5				

Firstly, the interviewees were asked to read the cards and divide the statements into 3 groups: the statements with which they most agree, the statements with which they don't agree, and the statements with which they feel neutral. Then they were asked to sort the 34 statements, following the sorting condition**:** "*For each statement, indicate, based on your preferences, if you agree, disagree, or are neutral to the effectiveness of the practice or innovation for the management of production surpluses and preventing food losses*", from the "most like" (+9) to the "least like" (+1), starting from the extremes, "forcing" a normal distribution. During and after the Q sorting process, the participants were invited to explain their point of view and express their subjectivity. The analysis of the Q sorts was conducted using the Kade Q software. The Q sorts were analysed using a Principal Component Analysis, adopting a varimax rotation analysis to maximize the amount of study variance explained (Watts and Stenner, 2012). Following a scree plot test on the eigenvalues, three factors have been chosen to be analysed, representing 61% of the explained variance. The factors are the individualized opinions that result from the Q sorting process, so each factor represents a subjective point of view shared by the participants with a similar Q sorting. Then, a factor estimation based on factor loading value is made to perform the varimax rotation. Each Q-sort is related to each factor and as suggested by Brown, the number of Q-sorts to be rotated was based on the value of the factor loading (correlation between Q sorts) that were statistically significant at the 0.05 level (±1.96 x 1/√*n. of statements*, e.g., ±0.34). As showed in Table 4, those Q-sorts that present a statistically significant factor loadings are selected to be rotated. This technique is used to extract from each factor the objective point of view expressed by the Q sort.

Table 4 - Factor loadings

N. Q-sort ID	Q-sort	Factor 1	Factor 2	Factor 3
8	Exp	0.9214*	0.1415	-0.0753
14	Exp	0.9105*	0.0878	-0.0907
9	Exp	0.8964*	0.0351	0.1281
5	OP	0.5409*	0.0742	0.3653
3	AOP	0.1089	0.9382*	0.1175
2	OP	0.1100	0.9217*	0.1135
4	AOP	-0.0576	0.6136*	0.0109
1	OP	0.2328	0.4424*	-0.0132

7	OP	0.2594	0.4081*	0.0711
6	OP	-0.1562	0.3515*	0.1918
12	Exp	-0.1515	0.0949	0.8879*
11	Exp	0.1873	0.0992	0.8068*
10	Exp	-0.162	0.3917	0.7053*
13	Exp	0.3611	-0.0907	0.6136*
	N. of defining variables	4	6	4
	% explained variance	28	19	14
	Cumulative % explained variance	28	47	61

Each factor is characterized by distinguish and consensus statements (those sorted in similar position by the participants in the factor) that gives an indication about the shared attitudes, or points of view, on the debate surrounding the subject under study and allows the study of the discourse (subjective point of view shared by the participant in a factor). To represent graphically the positions represented by the three-discourse extracted from the sample a Discourse positioning diagram is showed in the next paragraph (Table 5).

4 RESULTS & DISCUSSION

The interpretation of factors proceeded in terms of factor arrays. Each extracted factor represents a different point of view on the topic of the study, and it is shared by those Q sorts that sorted a statement in the same position (Figure 4).

Factor 1 – Valorisation of F&V losses

This factor high ranked the efficacy of valorisation innovations as a solution to improve the management of food losses. In their opinion coordinated actions of all the actor in the value chain to promote the recovery of food losses is the key for a step towards more circularity in the sector. Furthermore, they call for more experts in the field of circular economy to find valuable path to prevent and valorise food losses. On the contrary, they low ranked the possibility to negotiate new type of contract with the retailer in the case of adoption of strategies to reduce food losses and waste. They main reason for this is that they “do not believe that is feasible to negotiate such type of contracts” because of their low market power.

Factor 2 – Optimization of surplus management

Factor 2 point of view is focused on the management of surplus products and promotion of prevention actions. The distinguish statements of this factor are related to innovations which focuses on the redistribution of surplus food and the participation in digital platform to enhance the use of funds and innovations. On the contrary, this factor low ranked innovation at farmer level to produce energy from food losses. This factor showed high agreement towards the role of innovation to promote the quality of food products.

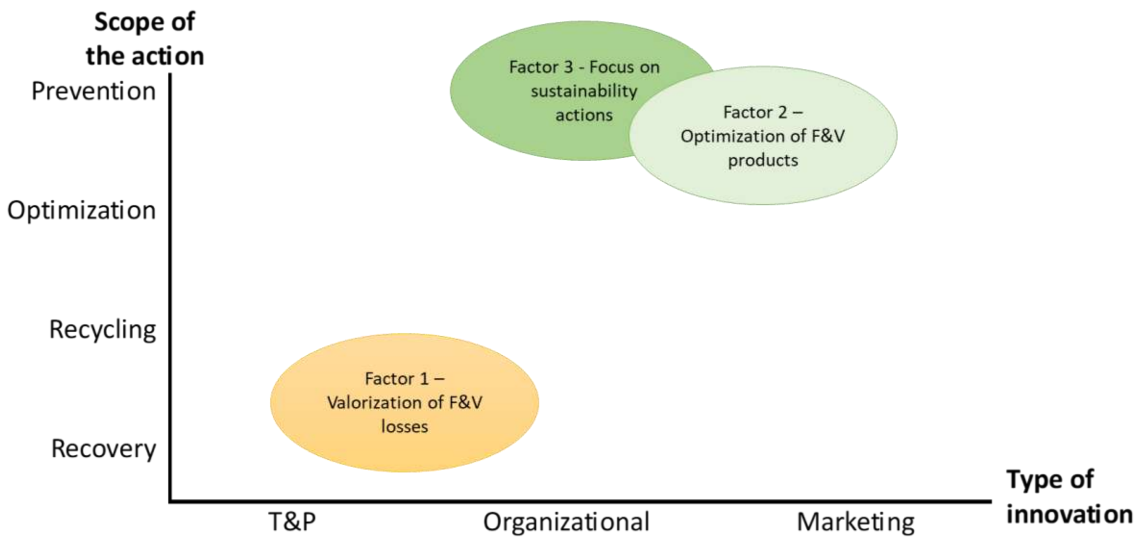
Factor 3 – Focus on sustainability actions

This factor is composed only by the Q-sorts of experts. Factor 3 is composed only by the Q-sorts of experts. They high ranked those statements which emphasize new market approaches to optimize the surplus of product and to prevent food losses. The point of view of this factor aligns with sustainability actions, reflecting the academic expertise of the experts and the commitment for the development of sustainable practices.

Discourse positioning diagram

The factor analysis reveals three distinct viewpoints within the context of food loss prevention and surplus management innovations. Factor 1 focus on the importance of valorisation actions, Factor 2 emphasizes the improvement of surplus management and prevention strategies, and Factor 3 centres on sustainability actions. These results underscore the heterogeneity of viewpoints among stakeholders within the F&V value chain. According to the framework developed for this Q methodological study a Discourse positioning diagram was created to assess graphically each factor in respect of the category of innovation underneath (Table 5)

Table 5 - Discourse positioning diagram



The graphical analysis of the discourses shows us different approaches towards the prevention of F&V losses. While Factor 1 is more oriented towards the improvement of the recovery chain, giving an added value to by-products and waste, Factor 2 and Factor 3 viewpoints on innovations are more focused on prevention and optimization action by the development of new market channel and cooperative business model.

5 CONCLUSION

Funds to improve the efficiency and sustainability of the operations are ready and available through European and national funding programs, but the intensity of research and development within the agrifood sector is reported to be still relatively low compared to other key sectors (European Commission, 2022). At the same time, the European policy framework asked for actions to prevent the volume of FLW generated from improving food security and granting an income to farmers. Although the findings of any Q study cannot be generalized to the population because they are only specific to the participants, the various and relevant points of view included in the current study offer a valid representation of the potential range of the main relevant perspectives in the general population. The point of view emerged from the factors can be a reference for future policies to move towards collaborative value chain processes and participatory research methods, which will also make it easier to embrace innovations and serve as a springboard for new regulations (Iofrida *et al.*, 2018). The main key message emerged from this study is that the efficient management of food products is affected by different factors and collaborative strategies using digital tools together with the introduction of expert in circular economy. At the same time, valorisation practice shall be considered and improved to gain an added value also from the fraction of food losses that is still unavoidable. The shared insights bear significant implications for policy development, as they provide a deeper understanding of stakeholders' preferences and priorities Also, this research can contribute to the identification of drivers for change and valuable opportunities for innovations to be introduced into the F&V sector. Indeed, promoting policies and actions which do not encounter the agreement of the actors who are in charge to implement them is not efficient nor it can finally exert a real impact on FLW reduction.

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Sustainable pest management practices: an experiment on Apulian olive-growers

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KEYWORDS

Sustainable pest management, nudging, behavioural experiment, farmers, driving factors.

INTRODUCTION

Pest management is crucial for agricultural productivity. Since the green revolution (1940-1970), pests control happened through the intensive use of chemical pesticides. Unfortunately, this led to the disruption of the natural ecosystem's equilibrium, the onset of resistance among pests populations and the increasing impact of the agricultural sector on the environment and climate change. Recently, also the cost of pesticides increased, thus making their intensive use less sustainable economically besides environmentally (*e.g.*, Hamlyn, 2015). For these reasons, researchers have been investigating alternative pest management strategies. One of these is the "adulticide fight" (also called "low impact strategy"), incorporating a wide range of control techniques: monitoring, mass trapping, poisoned baits, attract-and-kill fight and inert powders – such as kaolin (Daane and Johnson, 2010; Yokoyama, 2014; Daher *et al.*, 2022, 2023). This strategy aims at fighting adults to prevent damage caused by larvae. Despite its interesting advantages, farmers are not willing to adopt it (Daane and Johnson, 2010; Daher *et al.*, 2022).

AIM OF THE STUDY

This study aims to explore drivers and barriers to this strategy’s adoption. Apulian olive growers’ willingness to adopt the adulticide strategy against the olive fruit fly (*Bactrocera oleae*) is the selected case study since all the needed knowledge and materials are available to implement it. Moreover, the olive fruit fly (*Bactrocera oleae*) is a key pest in commercial olive groves worldwide, especially in the Mediterranean basin (Dugo *et al.*, 2005; Daane and Johnson, 2010; Vargas, Piñero and Leblanc, 2015). Additionally, the resistance to some common pesticides led to the need for new control strategies against this pest (Daane and Johnson, 2010). Italy is among the leading olive-oil producers (Fiume and Argentiere, 2003), and the Apulian region is one of the most devoted and productive areas in this field (Fiume and Argentiere, 2003; Dugo *et al.*, 2005; Piccinonna *et al.*, 2016), also representing a cultivar biodiversity conservation place (Squeo *et al.*, 2021).

METHODOLOGY AND THEORETICAL FRAMEWORK

The study was carried out through an online questionnaire survey on a sample of Apulian oil-olive-grower. The selected theoretical framework is the *Trans-theoretical model* (TTM), allowing one to distinguish the stages of the behavioural change in which the farmer is (Lemken, Spiller and von Meyer-Höfer, 2017). In fact, the adoption of this low-impact strategy represents a deviation from the actual behaviour, say, the use of chemical pesticides. The TTM has four stages (Michels, von Hobe and Musshoff, 2020): pre-contemplation (1), contemplation (2), preparation (3), and action (4). In the *pre-contemplation* stage, there are neither intentions nor motivations to change the actual behaviour. During the *contemplation* stage, there is an initial intention to deviate from the ongoing behaviour. The intention change during the *preparation* stage when there is also a concrete changing plan. The *action* stage is the last one, in which the behaviour has already changed.

Moreover, there was a nudging experiment with a between-sample approach, randomly splitting the olive growers into two groups: a control and a trial treatment. According to the literature (Ferrari *et al.*, 2019), green nudges are effective in inducing sustainable behaviour among farmers. Therefore, the treatment was a nudge based on descriptive norms, according to Dessart *et al.* (2019). The selected descriptive norm is the peer and neighbour effect. Indeed, several authors found that farmers are easily influenced by peers because of several reasons (*e.g.*, natural advantage, information sharing, social learning, social capital, and tendency to conform to the majority - Asch, 1956; Marra, Pannell and Abadi Ghadim, 2003; Barreiro-Hurlé, Espinosa-Goded and Dupraz, 2010; Lapple and Kelley, 2015). Therefore, nudging rough this descriptive norm should allow to increase the adoption rate among the oil-olive-growers. This is relevant also because farmers generally act due to inertia and have difficulties in changing their behaviour and operative activities (Öhlmér, Olson and Brehmer, 1998; Dessart, Barreiro-Hurlé and Van Bavel, 2019). In this experiment, farmers subject to the treatment survey were told that other farmers were expected to adopt the adulticide strategy, also due to normative changes (*i.e.*, the Common Agricultural Policy (CAP) 2023-2027).

Furthermore, innovation is often considered risky, so farmers' risk aversion could impact innovation adoption (Dessart, Barreiro-Hurlé and Van Bavel, 2019). This is particularly true when considering pest management, due to its great impact on agricultural productivity. This feature is very relevant, considering that several studies found that farmers are generally risk-averse (Pennings and Garcia, 2001; Gardebroek, 2006; Rieger, Wang and Hens, 2015). To collect farmers' risk aversion, we used two different instruments: a self-assessment question ad an adapted risk aversion scale (based on Bao, Zhou and Su, 2003). These two instruments are expected to lead to correlated results (Meraner and Finger, 2019), but the self-assessment can catch the farmers' self-perceptions. On the other hand, using an adapted validated scale can collect a more objective risk preference.

The study applied a snowball sampling procedure, thanks to contact lists of oil-olive-grower made available by several producers' organisations, and other stakeholders. The survey was an online questionnaire on Google Forms. An online software tool assigned each participant to the control or the treatment survey, guaranteeing the random nature of the assignment procedure (Fergusson, 2016).

The questionnaire had eight sections: 1) inclusion criteria; 2) adulticide strategy knowledge; 3) adulticide strategy adoption (according to the TTM); 4) farmer’s characteristics; 5) farm’s characteristics; 6) risk preference and perception, perception of climate change, risk management tools; 7) barriers and risks to the adulticide strategy adoption and behaviour towards chemicals; 8) innovation and sustainability preferences and attitudes.

The model to analyse the data will be the ordered logit model, as the dependent variable is a numerically ordered one (Lemken, Spiller and von Meyer-Höfer, 2017). The independent variables will be socio-demographics, farm characteristics, and behavioural preferences:

$$y_i * = \beta X_i + e_i \tag{1}$$

Where y_i* is the unobserved dependent variable, β is the vector of the coefficient to be estimated, X_i is the vector of independent variables, and e_i is the error term (Michels, von Hobe and Musshoff, 2020).

Here following, how the gradual stages of the adoption (y_i) can be observed:

$$y_i = \begin{cases} 0 & if \quad y * \leq \mu_1 \\ 1 & if \quad \mu_1 < y * \leq \mu_2 \\ 2 & if \quad \mu_2 < y * \leq \mu_3 \\ & \vdots \\ J & if \quad \mu_j < y * \end{cases} \tag{2}$$

Where J represents the number of the gradual stages of adoption (Michels, von Hobe and Musshoff, 2020), μ_j is a parameter containing the endpoints of every observable stage (Verbeek, 2008), and y_i is the dependent variables (with four possible values, according to the four TTM stages – Table 1).

Table 1 - Description and of the TTM's states of change

State of changes	Assumed Value	Description
Precontemplation	0	No intention to change
Contemplation	1	Intention to change
Preparation	2	Concrete plan of action to change
Action	3	Changed behaviour

Note 1 - our elaborations based on Lemken, Spiller and von Meyer-Höfer (2017).

Thus, in this study equation (2) can be rearranged as follows:

$$y_i = \begin{cases} 0 & if \quad y * \leq \mu_1 \\ 1 & if \quad \mu_1 < y * \leq \mu_2 \\ 2 & if \quad \mu_2 < y * \leq \mu_3 \\ 3 & if \quad \mu_3 > y * \end{cases} \tag{3}$$

The effect of the explanatory variables on the dependent variable follows this specification:

$$TTM_i = \beta_0 + \beta_1 X_i + \beta_2 Z_i + \beta_3 B_i + e_i \tag{4}$$

Where TTM_i is the Trans-Theoretical Model variable, X_i is the vector of the farms' characteristics variables, Z_i is the vector of the sociodemographic variables, B_i is the vector of the behavioural variables, and e_i is assumed to be the error term with a logistic distribution (Michels, von Hobe and Musshoff, 2020).

DATA

The experiment is still ongoing, and more surveys are still being collected, so at the moment, there are only preliminary data concerning a restricted sample. Each participant randomly received the control or treatment version of the questionnaire. The control group had the 35.71% of respondents, whereas the treatment one 64.29. The random assignment tool will automatically correct this difference.

Table 2 and Table 3 report the summary statistics and frequencies of the collected variables. Here is the description and some comments on the variables with the main differences between the sub-samples.

The mean age of the farmers is 51 years in the whole sample, 57.25 years in the control group and 48.22 in the treatment group. However, the t-test shows the difference is not statistically significant (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.1967). The difference in the cultivated olive acreage is also not statistically significant (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.2657), as the one in the plant density (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.5329), and the annual phytosanitary expenditure (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.8646). Farmers in the treatment group pretend to be less generally risk-averse than the ones in the control group. In contrast, the scale shows that farmers in the control group are less risk-averse than the ones in the treatment group while considering risks related to risk management. However, the last cited differences are not statistically significative (Ha: diff ≠ 0; Pr(|T| > |t|), respectively = 0.1795; 0.1153), as the one of the sustainability concern scale (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.4105). It is worth noting that farmers received the treatment before the data collection, possibly influencing their answers. Thus, there could also be statistically significant differences in the final sample.

Table 2 – Summary statistics of the sample

Variables	**Unit**	**Whole sample F = 100%**	**Control Group f_c = 35.71%**	**Treatment Group f_t = 64.29%**
Age	Years	51 (11.33)	57.25 (6.02)	48.22 (12.28)
Year of experience in the olive sector	Years	24.85 (10.96)	28.75 (13.15)	23.11 (10.22)
Olive acreage	ha	12.54 (20.9)	2.5 (1.73)	17 (24.10)
Plant density	N° plant/ha	284.92 (200.01)	230 (57.15)	309.33 (237.92)
Annual phytosanitary expenditure	€/year	5984.62 (7797.01)	6575 (12287.76)	5722.22 (5858.28)
Risk-aversion self-assessment (min = 0, max = 8)	-	4.69 (2.29)	6 (1.83)	4.11 (2.32)
Risk-aversion scale (min = 3, max = 21)	-	10.43 (4.62)	7.8 (6.02)	11.89 (3.14)
Adulticide fight's perceived risks scale (min = 0, max = 20)	-	5.79 (4.31)	5.6 (5.13)	5.89 (4.14)

Sustainability concern scale (min = 14, max = 98)	-	57.29 (58.75)	48.4 (39.55)	62.22 (22.01)

Note 2 – our elaborations, standard deviations in parenthesis.

Farmers in the sample are predominantly male, full-time farmers, with high school education (prevalently not in agricultural subjects), unspecialised farms with the conventional cultivation regimen, using chemical pesticides. Most of the sample do not use external consultancy in their agricultural activities and declare their farm to have the same profitability as analogous ones. The most frequent annual income classes are those under 50,000€. The main differences between the control and treatment groups concern the educational level, agricultural education, cultivation regimen, profitability self-assessment and annual income classes. Still, these differences are expected to be lost with the data collection progression and the sample enlargement.

Table 3 - Frequencies of the main variables

Variables	**Classes**	**Whole sample F = 100%**	**Control Group f_c = 35.71%**	**Treatment Group f_t = 64.29%**
Male farmer	Yes	92.31%	100%	88.89%
Adulticide fight knowledge	Yes	46.15%	50%	44.44%
Full-time farmers	Yes	92.31%	75%	100%
Educational level	Primary school	0%	0%	0%
	Middle school	7.69%	25%	0%
	High school	46.15%	75%	33.33%
	Bachelor's degree	15.38%	0%	22.22%
	Master's degree	30.77%	0%	44.44%
	Specialization/PhD/Master	0%	0%	
Agricultural education	Yes	38.46%	50%	33.33%
Specialised firms	Yes	7.69%	0%	11.11%
Cultivation regimen	Conventional	53.85%	50%	55.56%
	Integrated	23.08%	50%	11.11%
	In conversion	0%	0%	0%
	Organic	23.08%	0%	33.33%
External consultancy	Yes	46.15%	50%	44.44%
Profitability self-assessment (compared to similar firms)	Much less profitable	0%	0%	0%
	Less profitable	15.38%	0%	22.22%
	Same profitability	69.23%	100%	55.56%
	More profitable	15.38%	0%	22.22%
	Much more profitable	0%	0%	0%
Chemical pesticides use	Yes	69.23%	75%	66.67%
Annual income	Less than 15'000€	38.46%	75%	22.22%
	15'000-50'000€	38.46%	25%	44.44%

	50’001-100’000€	7.69%	0%	11.11%
	100’001-250’000€	15.38%	0%	22.22%
	250’001-500’000€	0%	0%	0%
	More than 500’000€	0%	0%	0%

Note 3 - our elaborations.

PRELIMINARY RESULTS

Table 4 shows the frequencies of farmers in each TTM’s state of change. It is worth noting that the treatment group shows better behaviours toward the adulticide fight, highlighted by the decrease in the precontemplation stage frequency and the increase in the frequencies of the contemplation and preparation stages. This difference is statistically significant at the 5% level according to the t-test (Ha: diff ≠ 0; Pr(|T| > |t|) = 0.0299). The absence of farmers in the action stage underlines the low adoption level of the low-impact strategy adoption.

Table 4 - Frequencies of the TTM's states of change in the whole sample and in each sub-sample

State of changes	**Whole sample** **F = 100%**	**Control Group** **f_c = 35.71%**	**Treatment Group** **f_t = 64.29%**
Precontemplation	15.38%	50%	0%
Contemplation	69.23%	50%	77.78%
Preparation	15.38%	0%	22.22%
Action	0%	0%	0%

Note 4 - our elaborations.

Further expected results are the identification of drivers and barriers to the adoption of the adulticide fight and the peer effect captured by the implemented nudging. Farmers' and farms' characteristics are expected to be influential on this practice's adoption. Meanwhile, the peer effect should enhance the adoption. Additionally, some farmers' behavioural features should affect adoption. For example, risk aversion is considered to be one of the main barriers to the practice’s adoption. According to Dessart *et al.* (2019), risk aversion has a mediating effect on sustainable practices adoption. On the other hand, sustainability concerns should promote the adoption.

CONCLUSIONS

The final results of the study will provide pivotal information to policymakers to reach an efficient adoption rate of sustainable pest management practices. Moreover, the literature highlights the role of policies’ architecture in affecting its efficiency. Therefore, identifying adoption’s drivers and barriers is crucial to implement appropriate policy instruments, whilst nudges’ efficacy information could suggest how to present these tools to “subconsciously” promote them. The study’s results will allow to understand how to better implement policies aiming at promoting sustainable practices to manage key pests in specific and delicate agricultural frameworks. The preliminary data collection stage already reveals the lack of farmers adopting the adulticide fight even if there is average knowledge and interest in it. This circumstance highlights the need for understanding how to promote sustainable pest management strategies and what are the main adoption drivers and barriers.

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Governance in policy mix for sustainable transition: insights from a rural Region in Southern Italy

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PAROLE CHIAVE
Sustainability transition; Policy mix; Rural areas; Governance ; Bibliometric analysis; Local Action Group

BACKGROUND

The transition towards sustainability represents the central issue of the Green Deal document that stimulates the efficient use of resources promoting the circular economy (Muscio & Sisto, 2020). The centrality of the sustainable management of natural resources and the need to address the sustainable transition represent the focus of many policy documents as highlighted by the clear link between the 17 SDGs of the Agenda 2030 (United Nations, 2015) and the 10 key objectives of the Common Agricultural Policy for the period 2023-27 (Matthews, 2020). However, notwithstanding the complex nature of the sustainability issue, the related policies still focus on single specific issues (Wilts & O'Brien, 2019), while in such complex frameworks, many scholars (Geels et al., 2017; Milios, 2018; Schmidt & Sewerin, 2019; Uyarra et al., 2016) emphasize the need of adopting policy mixes instead of single specific policies. This issue is even more evident when such policies require initial top-down planning and subsequent adjustment based on experience and a bottom-up view (Mazzucato, 2018). Furthermore, the influence of governance on facilitating a sustainable transition can be shaped by the intrinsic characteristics of an area and its specific elements, as highlighted by Mantino & Vanni (2019) and Milhorance et al. (2020). From this point, it remains to be explored whether several administrative boundaries and multiple policy initiatives, such as the Rural Development Program, Regional Complement for Rural Development and Local Development Strategy, contain references regarding the elements and effective characteristics supporting territorial governance. These governance elements are necessary to support and guide a territory's pursuit of sustainable transition.

The study focuses on a Local Action Group (LAG) because it represents the smallest territorial unit for rural development planning. This choice is motivated by several factors: the pivotal role of rural areas in multifunctional development and circular economy processes, along with the consistent recognition of these regions as the "beating heart" of the European economy (Vávra et al., 2022). Moreover, in recent years, the role of the LAG has been evolving, taking a broader perspective. Nowadays, these units have a crucial responsibility in defining and implementing comprehensive policies. While historically, the focus was on aspects such as territorial animation and social inclusion; contemporary LAGs are tasked with actively driving sustainable transition. They are now charged with navigating the intricate multidisciplinary scenarios inherent in these regions (Vávra et al., 2022).

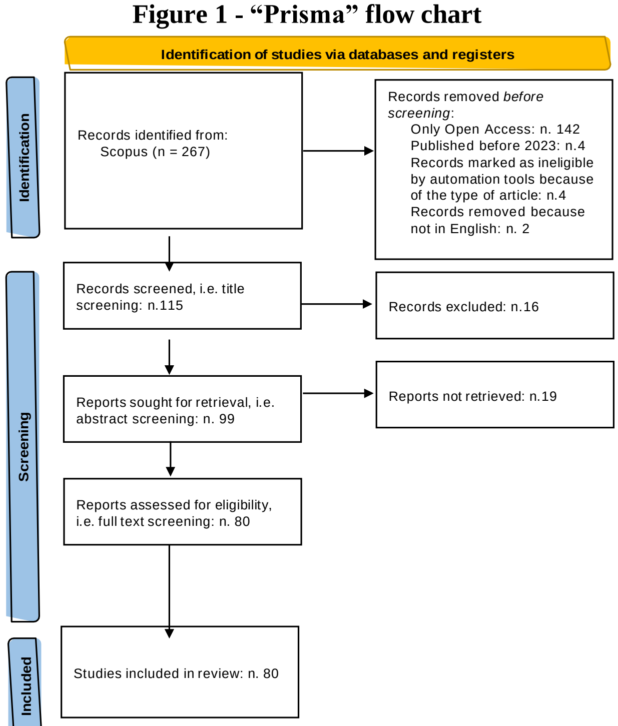
RESEARCH OBJECTIVE

In this scenario, this study aims to provide an overview of tools based on the governance factors that could influence the policy mix implementation.

DATA AND METHODS

The aim is addressed by means of a bibliometric analysis. More specifically, the VOSViewer software was used to define a starting point and to identify the factors on which an effective policy mix could be implemented. To this aim, a query was created by matching principal keywords e.g. “polic* mix*", "polic* portfolio*" with "governance" through the use of Boolean operators. From the initial database search, 267 articles were identified. The process for selecting papers followed the scheme suggested by the guidelines of the PRISMA extension for scoping reviews (Figure 1). The inclusion screening criteria were i) using open-access sources, ii) selecting papers written in English, and iii) considering documents published in scientific journals. Consequently, a total of 152 studies were excluded. Subsequently, after assessing the abstracts, 80 pertinent articles were recognized and imported into the VOSviewer software.

Figure 1 - “Prisma” flow chart



Source: Page et al., 2020

PRELIMINARY RESULTS AND CONCLUSION

The VOSviewer outcomes reveal that an amount of the 80 chosen documents lack connections or linkages. In fact, the bibliometric analysis revealed a total of 71 suitable papers, which were then categorized into four distinct clusters. The earliest selected paper dates back to 2001, but an increase in publications in this area started since 2018. These articles encompassed four macro areas of problem analysis. The largest group comprised 22 articles, followed by a set containing 21 articles, while the last two collections included 20 and 8 papers, respectively.

Therefore, the findings from the literature review reveal that the first cluster identifies the governance enabling factors for the policy mixes' implementation. In contrast, the second cluster must cover obstacles to achieving a well-rounded policy mix through governance. Moreover, the third cluster underscores the essential tools required to construct a policy mix that is both effective and coherent. Lastly, the remaining articles highlight the importance of involving stakeholders actively and participating in the process.

Preliminary results of this study confirm that the performance and interaction of policy mixes components are conditioned by the specific governance contexts and the place in which policies emerge and evolve (Mantino & Vanni, 2019). An implication of this is that a policy mix should be structured considering the territory's features and the historical period (Milhorance et al., 2020). In the first cluster, a meaningful correlation has been proposed between policy design and the successful implementation of a policy mix (Clarke & Craft, 2019; van Geet et al., 2021). Policy design is a strategic approach to defining and attaining policy objectives through specific tools (Howlett et al., 2015). In particular, policy design thinking overcomes traditional governance models that are more closed and concentrated on specific programs and policies (Clarke & Craft, 2019).

The connection between policy design and policy mix is strong because policies must address the complexities of governance and stakeholder relationships. Experts emphasize the importance of policy coherence, which means policies should logically work together without contradictions.

Another very relevant research strand is related to New Governance Arrangements (NGAs), based on the idea of integrating the existing, sometime in contrast, policy strategies into a cohesive strategy aimed at coordinating the activities of different local individuals (Mantino & Vanni, 2019). This last research point highlights the relevance of developing a shared awareness among local stakeholders to coordinate their actions and generate a common learning platform supporting step by step a concrete socio- technical transition. In addition, some authors have emphasized the importance of preserving policy coherence within a policy mix to achieve a sustainable transition (Kanda et al., 2022). Notably, a considerable proportion of policy coherence studies focus on European cases, suggesting a limitation in the generalizability of results (Aurenhammer, 2020; Fitch-Roy et al., 2020; Mann & Plieninger, 2017; Watkins et al., 2016).

Although the central role of governance in helping achieve policy coherence has been recognized, further investigation is needed into the facilitating conditions political and intrinsic aspects that influence policy coherence (Weitz et al., 2017). Carbone (2008) outlines four categories of policy coherence: (1) horizontal coherence between different policy subsystems, (2) vertical coherence between the European Union and member states, (3) internal coherence, which concerns the coherence of objectives within the same policy subsystem, and (4) multilateral coherence, which concerns interactions between international organizations.

Examining policy coherence can mitigate conflicts between different policy areas and improve effectiveness, particularly in allocating public funds.

Moreover, after reading the papers, some variables that can limit policy mix implementation emerged. Such as, i) the binding nature and rigor of the policy framework to address the multiple barriers and drivers of transformation, ii) the intentional or conscious nature of policy design that deliberately improves outcomes; iii) attention to the actors involved in the design and a shared consensus among stakeholders; iv) discretion and bureaucratic autonomy; v) administrative cohesion (Oberthür & Von Homeye, 2023; Clarke & Craft,2019). In addition, some obstacles have also emerged that can hinder the implementation of a policy mix at the governance level. For example: i) not taking into account the connections between sectors could worsen resource scarcity and induce conflicts; ii)unclear rights and responsibilities and their different institutional frameworks; iii) policies should be coherent with each other, but different actors have their own needs and desires, so policy coherence is not always realized because each stakeholder looks at its requirements; iv) unpredictability and instability of policies as the main obstacle (Weitz et al., 2017; Kanda et al., 2022).

These preliminary results confirm the need for a balanced or comprehensive policy mix. The policy mix implementation can simultaneously target the same groups, potentially reinforcing or conflicting with one another due to the different instruments from various policy domains or governance levels (Uyarra et al., 2016).

In conclusion, this study elucidates critical elements that could help define effective governance, supporting a sustainable transition grounded in a policy mix. The outcomes of this study bear multiple implications.

They have implications for local businesses and stakeholders within different LAGs. Examining governance and the fundamental factors in policy mix implementation necessitates the efficient allocation of financial resources and optimization of other territorial assets. Furthermore, this analysis underscores the pivotal role played by various actors within the region in shaping effective, long-term strategies. Integrating the insights derived from this analysis into territorial governance can accelerate and enhance the requisite sustainable transition. Furthermore, this study helps policymakers at different levels. Awareness of critical considerations and recognizing barriers to navigate when aligning governance with current challenges can mitigate adverse outcomes. Lastly, this study has implications for scholars because this toolkit introduces a novel approach to assess LAG operations, offering a comprehensive alternative to existing methods that might only partially capture the adaptation efforts undertaken by LAGs. Moreover, the study's potential contribution lies in identifying universally applicable elements that could be extended to several geographical contexts in future research.

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Fostering farmers towards ecological transition through nudges. A systematic literature review

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Introduction

The agricultural sector contributes significantly to resource depletion and negative environmental impacts. Thus, there is an urgent need to drive farmers towards more conscious and environmentally friendly practices. To succeed in this endeavour, nudge interventions are gaining popularity for their ability to trigger changes in farmers' pro-environmental behaviours. Compared to traditional policy instruments, nudging is a cost-effective policy instrument, able to steer individuals' pro-environmental behaviour in the short run (Brown, 2018). Nudging leverages psychological mechanisms that gently push individuals without prohibiting any options or modifying their economic incentives (Thaler and Sunstein, 2008). When applied to mitigate negative environmental impacts, it's termed "green nudging" (Carlsson et al., 2018). Recently, the use of nudging has gained traction in environmental policy to encourage behaviors that reduce negative externalities (von Kameke and Fischer, 2018). Blumenthal-Barby and Burroughs (2012) identified six types of nudging interventions aimed at guiding better decisions: incentives, norms and messaging, defaults, salience, priming, and commitments and ego.

All these nudges listed have been successfully applied in the context of consumer studies, proving effective in various environmental and health programs (von Kameke and Fischer, 2018; Caso and Vecchio, 2023). However, despite the promising potential of nudge interventions to foster sustainable goals, current evidence from the literature returns conflicting results, depending on the context in which the nudges are applied and the target population (Wu and Paluck, 2021; von Kameke, and Fischer, 2018). Indeed, it is presumable that responses to the nudge among economic operators in business activities, such as agriculture, may differ from consumer responses (Chabé-Ferret et al., 2019). Some studies have found evidence that some nudging interventions could negatively impact farmer behaviour who, instead of taking the desired path, takes the opposite direction (Czap et al., 2019; Chabé-Ferret et al. 2019). Therefore, the decision context plays a critical role in the direction and effectiveness of nudges (Brown et a., 2012). The current SLR has two core objectives: 1) provide a systematic and updated overview of the literature on the effectiveness of nudges in encouraging agricultural ecological transition; 2) understand which contextual factors may influence the direction and effectiveness of nudging interventions. The results of this review offer insights that should be relevant for future research and the development of future policy interventions.

Materials and Methods

2.1. Selection process

A specific protocol was applied for the study (Brereton et al., 2007), functional to the development of a research strategy and the definition of the algorithm. The protocol includes the selection of primary studies (using specific keywords), the definition of the admission criteria in the review, and the synthesis of the results. The selection of primary studies testing green nudges among farmers began in February 2023, using specific keywords in both Scopus (using the "Article Title, Abstract, Keywords" filter) and Web of Science (using the "Topic" filter) databases. Specifically, keywords related to agriculture, ecology, entrepreneurship, and Blumenthal-Barby and Burroughs' (2012) classification of nudges (social norms and social comparison, salience, default, priming, incentive, and commitments and ego) were chosen for the selection process. This allowed the generation of a query structured as follows:

((("green nudg") OR ("social norms" AND nudg*) OR ("social comparison" AND nudg*) OR ("salience nudg*") OR ("default nudg*") OR ("priming nudg*") OR ("incentive nudg*") OR ("message fram*")) AND ((farm* OR agricultur*) OR (sustainab* OR ecologic* OR green))) .*

2.2 Study selection criteria

To select the primary studies included in the present study, the key steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) were adopted, which represents an evidence-based guide composed of a checklist and a flowchart (Page et al., 2021).

The algorithm yielded 255 studies in Scopus and 244 in Web of Science, selecting only English language studies published in indexed journals. Furthermore, only studies reporting the results of primary data collection were included in the analysis, as they are suitable for collecting useful information functional to reach the present SRL goal. Subsequently, a manual screening of the remaining studies was performed by reading titles and abstracts, excluding duplicates and off-topic articles. Of the articles screened, 21 were deemed suitable. Subsequently, full texts were reviewed, removing irrelevant studies, including those conducted on agricultural students instead of actual farmers. After this review, 15 eligible studies remained. Subsequently, 3 more studies, discovered through references cited in the 15 selected manuscripts, were incorporated into the review process. Finally, a total of 18 studies were deemed eligible for the current systematic literature review (SLR).

Results and discussion

The review of the selected manuscript showed that the study of nudges in the agricultural sector is quite recent and of growing importance among scholars. In fact, among the selected studies the first manuscript was published in 2015, while in the following years, especially in 2022, the studies on nudges encouraging ecological transition among farmers increased. The 18 manuscripts included in the SLR refer to studies carried out in five different countries. Most of the studies were carried out in Europe (9 studies), of which five were carried out in Germany, and four studies in France. Following are the United States with six studies, and Vietnam and Ethiopia with two studies and one study, respectively. From the overall interpretation of the nudges used in all the studies examined, it follows that the most tested nudges in stimulating the ecological transition in the agricultural sector were salience nudges, and salience nudges coupled with social comparison nudges. Next, we found social comparison nudge, followed by social norms nudge, and incentive nudge. It is important to note that no study on default, priming, and commitments and ego nudges was found among the selected manuscripts. Specifically, in this SLR only studies on farmers have been included, while those referring to agricultural students have been removed as they do not have the same level of economic involvement as farmers when making business choices (Peth et al., 2018). Of the 18 manuscripts reviewed, nudge interventions almost always had an effect, except for 7 studies revealing no effect or backfiring.

Conclusions

This SLR is the first to provide an up-to-date overview of the literature on the effectiveness of nudging interventions in promoting ecological transition in the agricultural sector. Additionally, it sheds light on which contextual factors might influence the direction and effectiveness of nudging interventions directed to farmers. The findings should have both theoretical and policy implications. From a theoretical point of view, the evidence collected provides support to scholars aiming to analyse the effects of nudging interventions on the ecological transition of the agricultural sector. The results of the current SLR have highlighted that nudge interventions do not always have a positive impact on farmers' behaviour. In fact, while in many reviewed studies nudge interventions were effective in stimulating ecological transition, in some studies, the application of nudges has produced contradictory results, depending on how the message has been framed and above all on the context in which the farmers operate. Specifically, has been shown that the effectiveness of nudge interventions depends by the motivational structure of farmers' behaviour and by his/her cultural and religious background. This support the notion that nudges are not always a one-size-fits-all out-of-the-box tool. Caution needs to be paid when applying social comparison nudge interventions. Although information about the contribution of other to public goods showed to be effective in trigging pro-environmental behaviour (Michels et al., 2023; Boun My et al., 2022; Czap et al., 2019; Brown, 2018), finding of the current SLR reveals that social comparison nudge is highly-context dependent. At the policy level, the current results provide insights that contribute to the ongoing debate on the most effective measures to promote the transition towards ecological or sustainable agriculture. Understanding nudge effectiveness in stimulating ecological transition in the agricultural sector and the moderating role of contextual factors would enable the development of more appropriate and effective agri-environmental policies. Findings of the current SLR reveal that green nudging interventions are useful complement of the existing policy instrument adopted by the European Commission to further encourage the farmers' pro-environmental behaviour.

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THE COMMUNICATION TO CONSUMERS OF THE CHARACTERISTICS OF DEALCOHOLIZED AND PARTIALLY DEALCOHOLIZED WINES THROUGH COMPANY WEBSITES

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KEYWORDS
Wine, Dealcoholization, Hedonic model, Communication, Internet

INTRODUCTION AND AIM
Interest in moderate alcohol consumption has seen consistent growth over the last decade. Self-moderation is trending worldwide, with over one-third of regular wine consumers stating they have lessened their alcohol intake. This trend is particularly prevalent among younger demographics, including "Generation Z" and "Millennials". Various factors fuel this change, including an increasing focus on healthy living and proper nutrition, heightened public awareness regarding responsible alcohol consumption due to health advisories and campaigns against alcohol abuse led by public institutions. This awareness has fostered the development of non-alcoholic and low-alcohol wines, made from fermented and subsequently dealcoholized grape must. Main consumers of these low-alcohol and non-alcoholic wines include those who abstain or limit alcohol intake for reasons such as pregnancy, undergoing therapeutic treatments, recovery from alcohol-related issues, professional drivers, and individuals abstaining due to dietary or religious reasons. Wine Intelligence reports a third of American wine consumers moderating their alcohol intake, with comparable figures in Japan (36%), Switzerland (58%), and Australia (56%). However, Italy trails behind these countries. Non-alcoholic beverages market is more mature in Germany and Spain, with the United Kingdom and the United States showing the most dynamic growth. The US non-alcoholic wine market is projected to witness a Compound Annual Growth Rate (CAGR) of 9.6% from 2021-2031, according to Fact.MR website.
The International Organization of Vine and Wine (OIV) has set guidelines for this trend with two resolutions. OIV-ECO 432-2012 and OIV-ECO 433-2012, for full and partial dealcoholization of wines. These beverages can be sourced from wine or special wine and must undergo specific treatments. Resolution OIV-OENO 394A-2012 defines the permitted dealcoholization techniques, including partial vacuum evaporation, membrane techniques, and distillation. The beverage obtained from the dealcoholization of wine may have an alcohol content by volume lower than 0.5% vol., while the beverage obtained from the

partial dealcoholization of wine may have an alcoholic strength by volume equal to or greater than 0.5% vol. and lower than the minimum applicable alcoholic strength by volume of wine or special wine. In the European Union, Regulation 2021/2117 allows the marketing of products under the legal name of "dealcoholized wine" or "partially dealcoholized wine". However, this regulation does not apply to PDO and PGI wines, which can only be partially dealcoholized following a modification of the relevant production regulations.
The scientific literature on dealcoholized products focuses primarily on understanding consumer behavior and the motivations underlying the choice of dealcoholized wines, with particular attention to sensory aspects. However, it is also necessary to understand how much consumers are willing to pay for these products and the relationships between the selling price and the main attributes of such products. The present study aims to scrutinize the offerings of companies producing wines that are fully or partially dealcoholized, through the analysis of product attributes communicated via the company's website and to estimate the effects that such attributes can have on the price communicated to consumers.

METHODOLOGY

The methodology employed in this study is the "hedonic price model" applied to a specific sample of products. The model's underlying theory relates the price of any good to its quality attributes, suggesting that every product comprises a bundle of attributes defining its quality. Each attribute bears an implicit price, and the aggregate of these implicit prices establishes the actual price of the product.
The analysis focused on a sample of 360 fully or partially dealcoholized wines showcased on 43 company websites. Data collection mirrored the approach of potential consumers gathering product-related information from company’s website. Factors considered included retail prices, company location, type of wine (still or sparkling), color, grape origin, grape variety, container capacity, packaging material, alcohol content, alcohol removal technique, awards/recognitions, certifications, availability of conventional wines in the company portfolio, availability of other alcoholic beverages in the company portfolio, purchase locations (virtual and physical), and social media presence. The collected data was compiled into a database for statistical analyses pertaining to the considered variables. Each variable's relationship with product prices was examined. Following a preliminary statistical analysis, the hedonic price model was applied using the gathered data to formulate a regression equation wherein the wine's price is the dependent variable, and its attributes are independent variables. This analysis intended to explore the market equilibrium, evaluating the features of dealcoholized and low-alcohol wines that consumers are willing to pay a premium for, by applying the hedonic price methodology.
In order to choose the variables to include in the econometric model, a correlation analysis was carried out between the price variable and all possible regressors (i.e., the independent variables). Only variables for which there was a statistically significant correlation were considered.
The variable “Price” is the dependent variable and represents the price of the product expressed in euros per liter. Both the price and the regressor “Capacity”, which expresses the quantity of wine of the product, have been considered as continuous variables. The others, being of a qualitative nature, have been coded using dichotomous or dummy variables.
Since the economic theory does not solve the problem as to which is the most suitable functional form of the hedonic price function, it is a decision that researchers must make empirically. Among the functional forms suggested, the literature proposes linear, semi-logarithmic, double-logarithmic and linear-logarithmic. Using a Box-Cox test, we have chosen to use a double-logarithmic (log-log) functional form.

RESULTS

Statistical analysis results indicated that 21% of the considered companies are based in Germany, 16% in Spain, and 14% in Italy (figure 1).

Figure 1. Distribution of companies by Country

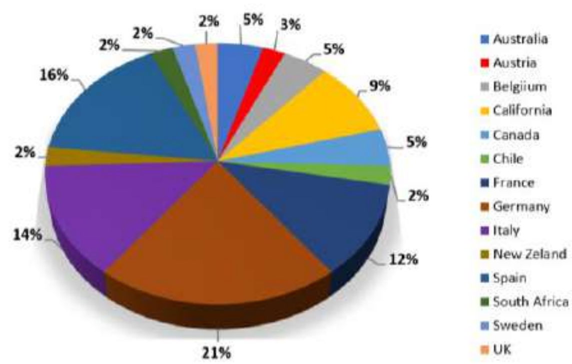
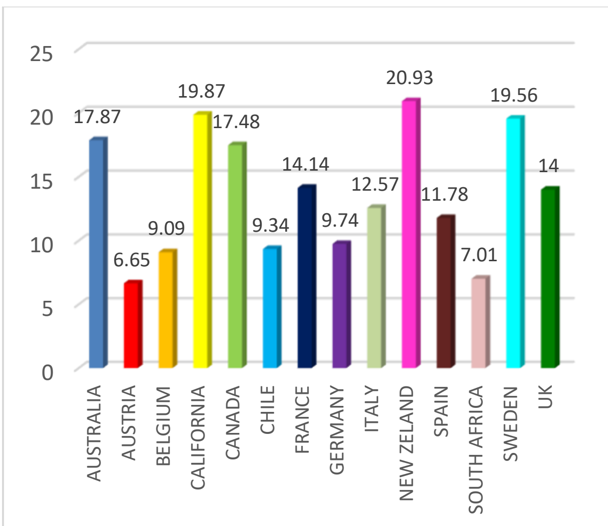


Figure 2 shows the average wine prices distributed by country. The highest average price, at 20.93 euros, is found among companies based in New Zealand, while the lowest average price of 6.65 euros is associated with companies based in Austria.

Figure 2. Average wine prices distributed by Country



For 114 references, the origin of the grapes is not indicated on the website: 25% of the wines are made from grapes produced in France, while 18% use grapes from Spain. Concerning acknowledgments, 70 references had received an award, with an average price of 13.79 euros. Products having both Halal and organic certifications show a higher average price, likely due to increased production costs tied to certification procedures and added value signifying buyer willingness to pay a premium. It was observed that 61% of the references fall into the 'Still wine' category, with the remaining 39% belonging to the 'Sparkling wine'

category. The latter has a higher average price of 3.55 euros compared to the wines in the 'Still' category. Most wines are produced from a single grape variety (204 references), showing a lower average price; conversely, wines not specifying the grape varieties in the website present higher prices. The 'Multivarietal with specified varieties' category shows 46 references, indicating wines produced from different grape varieties that are specified on the website. Lastly, 11 references were produced from a blend of different, unspecified grape varieties. The 'Multivarietal with specified varieties' records a higher average price (14.07 euros), meanwhile, the average price for 'Blend' appears to be the highest (15.91 euros). It was also observed that 0.75-liter containers and glass packaging are dominant. Smaller containers and cans are less common, primarily because they incur higher company purchase costs and as the quantity purchased by the customer increases, companies offer discounts reducing the unit price. Considering the alcohol content, '0%' is the most common, accounting for 65% of the observations, followed by '< 0.50%' (25%). The differences in prices are significantly noticeable: references with an alcohol content of 0% and < 0.50% have a higher average price than the others. On the other hand, wines with an alcohol content of 0.50% command the lowest average price. The spinning column technique is the most common dealcoholization method. The least expensive technique, low-temperature evaporation, presents the lowest average price, unlike the more expensive spinning column technique. Regarding distribution channels, all companies sell their products through wine-specialized platforms, however 70 percent of them sell even through their corporate websites showing the highest average price. Sales through the websites of large-scale retail and discount stores are less prevalent. The lowest price is associated with wines sold on discount stores' websites, which is not much lower than the price of wines sold through large-scale retail websites. Finally, it was observed that all companies are present on the main social media platforms, with Facebook being particularly popular, underlining the significant role of social media in product promotion and sales.
The hedonic model application's results have highlighted that the variables which have the greatest influence on price are the country where the company is based and the indication of grape origin. For the variable "Company Location Australia", the model showed significance and, in particular, there's a price increase of 28%. The ability of companies to sell at a higher price is probably due to the fact that in Australia, consumption of this type of wine is already widespread, there's a consolidated and higher demand compared to other countries, and a strong market growth is anticipated. For the variable "Company Location Canada", a statistically significant price increase of 14% can also be observed. Lastly, regarding the variable "Company Location New Zealand", the model showed significance; that is, if the wine is produced by companies based in New Zealand, the price increases by 41%. This is because in New Zealand, the population is increasingly following the trend of de-alcoholized beverages; therefore, the product is highly requested and companies can sell at a higher price. Moreover, there is a price increase of 18.3% if the company is based in Sweden. The price rise in this case is probably due to the fact that there are still relatively few companies producing dealcoholized wine in Sweden and Canada, so they can sell at a higher price.
Regarding the origin of the grapes, it is observed that the variable "Grape Source Napa Valley" is very significant. This could be explained by the fact that the geographic indication is very specific and points to a region well-known for conventional wine, thus attracting more consumers and allowing companies to sell at a higher price. On the contrary, the variable "Grape Source Europe" is negatively significant, as the price decreases by 23.6%; this is probably due to the origin being too generic and not identifying a specific territory.
Other variables that influence the price are bottle size, distribution channels (selling through the company's website or through physical retail outlets), and whether the wine has multiple certifications.
Considering the variable "Company Website", if the wine can be purchased on the company's website, the wine price increases by 14.4%. This could be due to various logistics, shipping, and packaging costs that the company has to bear to ship its products to customers in what can be considered a global market. On the other hand, for the variable "Physical Store", result indicates that the possibility to physically purchase the wine leads to a price decrease. This might be attributed to the fact that physical retail locations often

implement pricing strategies that correlate with the range offered in relation to the product category and that foresee discounts depending on the time of year and the location of the sales point. Furthermore, larger manufacturing companies can leverage economies of scale and thus sell high volumes of product at a lower price.
In the case of the variable "Multicertifications", if the wine has both the organic and Halal certifications, the price increases by 17.6%. This is easily explained since the certification gives the wine added value, and the company also incurs various costs to obtain these certifications.
Some dealcoholization techniques require higher costs compared to others, and this is directly reflected in the price of the wine. The variable "Low-temperature evaporation dealcoholization technique" is also significant but in a negative way, meaning, if the wines are produced using this technique, the price decreases by 35%. In fact, this dealcoholization method is the least expensive, unlike the spinning column technique, which is the most expensive. The variable “Log(capacity)”, which refers to the logarithm of the amount of wine contained in the bottle or can, indicates that there's an inversely proportional relationship between the quantity of wine in the packaging and the price: as the quantity in the package increases, the price decreases by 22%. This is explained both because bottles and/or cans with a smaller capacity have a higher purchase cost for the company and also because as the quantity purchased by the customer increases, the company offers discounts that result in a reduction of the unit price.

CONCLUSIONS

In conclusion, it can be stated that dealcoholized and low-alcohol wines are offered in the market to meet the needs of specific consumer categories. Among them are those who, for religious and/or health reasons, cannot consume alcohol, as well as those who temporarily abstain from alcohol for professional or health reasons. The data shows that in some countries, the market for dealcoholized wines is already developed and continuously growing, while in countries with low prevalence of such products, companies should analyze the market and develop suitable strategies to maximize their product's value. The "country" effect is probably determined by the different prevalence of non-alcoholic beverage consumption worldwide. In fact, as it has been pointed out, there are countries where the consumption of these products is more widespread, and for this reason, companies are able to sell their product at a higher price. Italian companies still do not have a positive approach towards this type of wine, both due to the association with the culture and tradition of conventional wine and because they fail to adequately understand the actual potential of the market. Furthermore, the production of dealcoholized wines requires the use of specific techniques different from those used for conventional wine, so Italian companies are very cautious and do not invest because they do not know how the Italian market will develop. A useful tool for companies could be conducting market analysis to understand consumer perception, purchase motivations, and willingness to pay. Finally, it is necessary to underline that the study conducted has limitations, common to similar studies conducted on samples of companies or consumers. In fact, only a sample of dealcoholized wine-producing companies was analyzed, which represents only a portion of the total number of companies worldwide. Furthermore, the information considered for the study was solely derived from the observation of websites, so it was not possible to gather data from individual package labels.

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Sparkling wines throughout Europe. Studying their demand to characterize potential export markets

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KEYWORDS
Sparkling wines; Demand analysis; Wine market; Wine export; Almost Ideal Demand System; Cluster analysis

INTRODUCTION

From the turn of the century, the international trade of sparkling wines witnessed a decisive growth, also resisting slowdowns of the wine sector (Pomarici, 2016), like COVID-19 in recent years (Wittwer and Anderson, 2021). This growth is often attributed to the strong symbolic component that characterizes this type of wines, which is appreciated in contemporary societies, where a higher importance is attached to experiential and symbolic functions of wine (Charters and Pettigrew, 2008). So far, economic literature investigating sparkling wine mainly consisted of consumer-related studies (e.g., Charters *et al.*, 2011; Adalja *et al.*, 2021). Conversely, the analysis of the demand structure has been devoted scarce attention. These kind of studies, which are quite frequent in the wine sector (e.g., Cembalo *et al.*, 2014; Mitchell, 2016) are useful, for example, for determining the potential impact of the introduction of taxes or to predict changes in the demand due to price or income variation. In addition, such kind of analyses are useful for producers to get insights into specific markets and the demands that characterize them, thus informing when they devise their marketing strategies.

In light of these considerations, we aim to analyse the aggregated demand of sparkling wines in relation to the total expenditure for wines. The area of analysis is restricted to the EU and UK, to work in a relatively homogeneous context. However, we acknowledge that also within this area national specificities likely exist. Therefore, to consider this potential heterogeneity, a second objective of the analysis is to investigate the structure of the demand for sparkling wines in different subareas. Despite data availability hinders an analysis conducted at the national level, we split the considered area into subareas characterized by similar characteristics of the wine market.

DATA AND METHODS

The study is based on yearly country-level data, from 2007 to 2021, retrieved from the Euromonitor Passport database. The analysis of the demand for sparkling wines was performed implementing an Almost Ideal Demand System (AIDS) model. Specifically, to allow more flexibility in the modelling, we used a the quadratic AIDS (QAIDS), as developed by Banks *et al.* (1997). In line with the double objective to study the demand for sparkling wines both at an aggregated level and separately in different EU areas, we performed a model for the whole EU and one model for each considered subarea.

The QAIDS model is described by equation (1). In our context, considering a specific area and a specific year (area and time indexing is omitted in (1)) w_i is the expenditure share of type of wine i (sparkling, still red, still white, still rosé), α_i is the model intercept, p_j is the price of type of wine j and γ_{ij}

its associated parameter. Similarly, m is the total expenditure for wine and β_i and λ_i its linear and quadratic parameters, respectively. The terms $(\boldsymbol{p})$ and $b(\boldsymbol{p})$ are defined as in (2) and (3).

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln \frac{m}{a(\boldsymbol{p})} + \frac{\lambda_i}{b(\boldsymbol{p})} \left[\ln \frac{m}{a(\boldsymbol{p})} \right]^2 \tag{1}$$

$$\ln a(\boldsymbol{p}) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i}^{n} \sum_{j}^{n} \gamma_{ij} \ln p_i \ln p_j \tag{2}$$

$$b(\boldsymbol{p}) = \prod_{i=1}^{n} p_i^{\beta_i} \tag{3}$$

The identification of the subareas was performed by cluster analysis. Specifically, we considered as clustering variables the annual per-capita consumption of the four types of wines, their value share over the total value of wine, and the price of sparkling wines and still wines. Since we work with yearly observations, we decided to perform the clustering based on median values of the considered variables over the whole period. The prices of the three types of still wines showed a high correlation. Based on this, we averaged them into a single still wine price. The use of these variables is meant to identify subareas with different characteristics of the wine market.

Since all the clustering variables were continuous, Euclidean distance was used after standardizing the variables. The clustering technique consisted in a mixture of hierarchical clustering, used to define the optimal number of clusters, and k-means, used to form the actual clusters. This approach is considered one of the most robust in the clustering literature.

RESULTS

In Table 1, we report the sample summary statistics of the variables used for clustering and in the QUAIDS model, while in Table 2 the results of the cluster analysis are reported, with the identification of four homogeneous European submarkets. The names of the clusters were assigned on the basis of the average values of the clustering variables. Specifically, in the *Sparkling lovers* group (including countries such as Italy, France, Germany) the per-capita consumption of sparkling wine is relatively high, while its price is lower, on average, than in other groups. Countries in the *Red lovers* (e.g., Spain, Portugal) and *White lovers* (e.g., Greece, Cyprus) groups share similar patterns, displaying, each for the relative type of wine, high per-capita consumption values and high market shares. In the *Wine niches* there are countries without a relevant tradition of wine consumption and production (e.g., Baltic countries, Finland), as can be inferred also from the low per-capita volumes consumed. Here, sparkling wine seems to have a higher importance than in the *White lovers* and *Red lovers* group.

Table 1 – Summary statistics for the whole sample (year 2021)

Variable	Type of wine	Min-Max	Median	Mean	Standard deviation
Volume (liters)	Sparkling	0.1-4.7	1.2	1.6	1.3
	Still red	1.5-28.3	8.0	8.8	5.8

	Still rosé	0.1-7.6	1.1	1.6	1.6
	Still white	1.3-21.2	7.2	8.2	4.8
Value share (%)	Sparkling	0.0-0.4	0.1	0.1	0.1
	Still red	0.3-0.7	0.4	0.4	0.1
	Still rosé	0.0-0.1	0.1	0.1	0.0
	Still white	0.1-0.7	0.4	0.4	0.1
Price (euro/liter)	Sparkling	8.0-108.7	31.0	36.5	22.3
	Still red	5.1-20.7	10.9	11.5	5.0
	Still rosé	4.6-21.2	9.8	10.7	4.8
	Still white	0.1-20.8	10.4	11.1	5.2
	Still (average)	4.8-19.5	11.0	11.1	4.8
Total wine expenditure (billion euros)		0.1-26.9	1.3	4.1	6.5

Table 2 - Means of the clustering variables in each cluster

Variable	Type of wine	Cluster 1 *White lovers*	2 *Sparkling lovers*	3 *Red lovers*	4 *Wine niches*
Annual per-capita volume (liters)	Sparkling	1.07	3.86	0.77	1.46
	Still red	7.33	13.19	14.42	3.45
	Still rosé	1.12	3.85	2.08	0.37
	Still white	12.13	9.24	7.55	3.69
Value share (%)	Sparkling	0.08	0.26	0.08	0.19
	Still red	0.34	0.38	0.56	0.39
	Still rosé	0.06	0.09	0.08	0.04
	Still white	0.52	0.26	0.29	0.38
Price (euro/liter)	Sparkling	36.50	25.30	34.25	45.29
	Still	13.47	8.47	8.93	11.69

In Tables 3 and 4 the estimated elasticities of the aggregated and subareas models are reported. In the former, the values of the expenditure elasticities suggest that an increase in wine expenditures in the EU market has similar effects for all kinds of wines. Sparkling wine, however, appears to be more elastic to its own price than the other types of wine are.

Table 3 – Elasticities of the aggregated model computed at the mean values

	Sparkling	Red	Rosé	White
Price (Marshallian)				
Sparkling	**-1.33****	0.07**	0.60**	-0.08**
Red	0.31	**-0.60****	-0.95**	-0.34**
Rosé	0.37**	-0.12**	**-0.70****	0.00
White	-0.38	-0.36**	-0.04	**-0.57****
Price (Hicksian)				

Sparkling	**-1.24****	0.16**	0.70**	0.01
Red	0.75**	**-0.18***	-0.49**	0.08
Rosé	0.43**	-0.07	**-0.64****	0.06
White	0.07	0.08	0.43**	**-0.14**
Expenditure	1.03**	1.00**	1.09**	0.99**

Significance levels: ** $p < 0.05$; * $p < 0.10$
Own-price elasticities in bold.

With respect to the analysis in the different subareas, the demand of the different types of wine appears to have different structures in the four markets. Red and white wines are usually perceived necessary categories within the wine market in almost all areas. Conversely, sparkling wine is usually considered a luxury category.

Focusing specifically on sparkling wines, the smallest own-price elasticities are observed in *Sparkling lovers* and *Red lovers*, country, while it is the highest in *White lovers* countries. As was also the case for the aggregate model, few substitution or complementarity relationships are observed between sparkling wines and other wine categories.

Table 4 – Uncompensated price elasticities and income elasticities of the group models computed at the mean values

	White lovers				*Sparkling lovers*			
	SP	RD	RS	WH	SP	RD	RS	WH
Price								
Sparkling (SP)	**-1.54****	0.10**	0.53**	-0.05**	**-0.62***	0.54**	-2.52**	-0.68**
Red (RD)	0.53	**-0.42****	-1.11**	-0.32**	0.98	**-0.95****	3.23**	-1.41**
Rosé (RS)	0.44**	-0.14**	**-0.26**	-0.02	-0.56	0.40**	**-5.22****	0.57**
White (WH)	-0.62	-0.51**	-0.33	**-0.60****	-0.94*	-0.91**	3.09**	**0.58**
Expenditure	1.19**	0.97**	1.16**	0.98**	1.14*	0.92**	1.42**	0.94*
	Red lovers				*Wine niches*			
	SP	RD	RS	WH	SP	RD	RS	WH
Price								
Sparkling (SP)	**-0.65****	-0.12	0.17	0.07	**-0.90****	-0.07**	0.94**	-0.06*
Red (RD)	-0.93	**0.65****	-2.46**	-2.21*	-0.04	**-0.79****	-4.43**	0.14
Rosé (RS)	0.14	-0.29**	**-0.02**	0.26*	0.13	-0.34**	**0.47****	0.15**
White (WH)	0.14	-1.20**	1.03	**0.95***	0.00	0.16*	1.97**	**-1.30****
Expenditure	1.30**	0.96**	1.28**	0.93**	0.81**	1.03**	1.05	1.07**

Significance levels: ** $p < 0.05$; * $p < 0.10$
For expenditure elasticities, significance levels are referred to the hypothesis of equality to 1.
Own-price elasticities in bold.

DISCUSSION AND CONCLUSIONS

Sparkling wines is the category of wines that presents the higher elasticity to its own price, especially when we compare it to red and white wines. This result is not surprising, since the latter categories appear to be considered necessary goods within the wine market, as also our model suggests. Moreover, the demand for sparkling wine seems to be not affected by the price of red and white wines, while some substitution relation is found with rosé wines. Also the latter can in fact be considered a luxury category within the EU market.

The analysis of the demand at the subareas level, however, provides more insights. Specifically, it allows to identify different types of EU submarkets, whose knowledge might be useful for wine exporters to tailor their strategies. This evidence suggests that a geographically-narrow approach is probably more suitable to identify relevant trends and dynamics in the wine market, despite in this study data limitations prevented the adoption of a narrower scale (e.g., national).

Among the four identified submarkets, the *Sparkling lovers* includes two traditional wine producers, (France and Italy), and three central European countries (Germany, Belgium, and Luxembourg). In this group a high level of per-capita consumption of all types of wine is observed, and especially for sparkling wines. Here, sparkling wines cannot be considered, according to our results, a luxury category, and their demand is highly inelastic to price. This evidence suggests the presence of a large market for sparkling wines, whose consumption is well-established and whose consumers have quite consolidated preferences. In such a market, a entry producer likely faces a relatively low risk, but it might find a quite fierce price competition, as suggested by the low price levels observed in this area.

In the *Red lovers*, wine consumption is strongly related to still red wine. Here, sparkling wine presents the features of a luxury good, whose consumption is particularly moderate. However, in these countries, the demand for sparkling wines seems slightly affected by variations in prices, suggesting them as a potential market for premium wines.

While many characteristics of the sparkling wine market are similar to the ones observed for *Red lovers*, in *White lovers* countries, sparkling wines exhibit a high own-price elasticity. This suggests that, in addition of being considered a luxury category, consumers are ready to dramatically change their choices in response to price strategies. The lower consumers' loyalty to sparkling wines in this area is highlighted also by the substitutability relationship with rosé wines, which is observed also within this submarket. All these features might suggest a potential exporter to pay particular attention to the price strategies when trying to enter such a market.

Finally, *Wine niches* seem to offer good opportunities for the marketing of sparkling wines. Despite their limited size, in these countries, the price of sparkling wines is usually very high. In addition, the almost unitary expenditure elasticity estimated in this submarket suggests that it is not considered a luxury good. Moreover, the rather inelastic demand might suggest quite stable preferences that might compensate for the smaller size of the market.

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FREEDOM OF CHOICE – ITALIAN CONSUMERS' PREFERENCES FOR LABELLED NEW GENOMIC TECHNIQUES IN TOMATO PASTE

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KEYWORDS
New plant breeding techniques (NPBTs), NGTs, organic food, consumers' acceptance, discrete choice experiment, willingness to pay.

INTRODUCTION
New genomic techniques (NGTs), also known as New Plant Breeding Techniques (NPBTs), identify various methods (e.g. cisgenesis, genome editing (GE), transgenesis, mutagenesis, CRISPR/Cas9 system, etc.) that are used to develop new plant varieties with the desired traits through the rapid modification of the DNA of seeds and cells (Beghin and Gustafson, 2021). Although initially this set of methods was identified as NPBTs, the term was considered not neutral and misleading, as it implies similarity with traditional breeding techniques (IFOAM EU, 2015). Indeed, semantics may play an important role in consumer acceptance or rejection of food (Giboreau, 2017), which applies especially to novel food (Stolzenbach *et al.*, 2013).

A considerable debate exists on how these techniques should be regulated (Vindigni *et al.*, 2022). Those favouring implementing these techniques in the European Union (EU) advocate that NGTs might generate plants more resistant to diseases and climate change effects, improved agronomic or nutritional traits and reduced use of agricultural inputs (Laaninen, 2020). On the other hand, those against their implementation – NGOs, the organic and the GMO-free premium market sector – believe that NGTs represent a risk to human health and the environment (IFOAM, 2020; IFOAM EU, 2015). Moreover, the organic sector believes that using NGTs might threaten and severe their value chain, as implementing traceability and labelling requirements might be difficult, risking consumers' trust in the sector (Laaninen, 2020).

In 2018, the Grand Chamber of the Court of Justice of the European Union (EU) ruled that any organism obtained through NGTs using mutagenesis will be classified as a Genetically Modified Organisms (GMO) (European Parliament and Council of the European Union, 2018), thus forbidding their use in farming in the EU. Then, in 2021, the European Commission highlighted that while plants obtained from NGTs have the potential, there are still concerns linked to the potential safety and environmental impacts, the coexistence with organic and GM-free agriculture and the concern on labelling and information transparency towards the consumers (European Commission, 2021).

In fact, among the EU Member States' views, the concerns mentioned most relate to public acceptance. In particular, there is a debate on labelling products obtained from NGTs. While the organic sector and consumer organisations recognise the importance of product labelling to ensure consumers' right to information and freedom of choice, a group of stakeholders believe that introducing a new NGT-specific labelling scheme would generate confusion among the existing labels. Specifically, they highlight that even if consumers are assumed to understand the labels, their choices should be based on the products' final characteristics and not the technology used to produce them (Laaninen, 2020). Nevertheless, consumer acceptance is critical for implementing new technologies in food production processes (Lusk *et al.*, 2014).

While previous studies have investigated Italian consumer acceptance and willingness to pay (WTP) for cisgenic and GE techniques in conventional food products (Borrello *et al.*, 2021; De Marchi *et al.*, 2021, 2022), there are no studies in the Italian organic market. Moreover, most studies focus on specific NGT methods (e.g. cisgenic, GE), not on the NGT as an umbrella term for several biotechnological techniques (Beghin and Gustafson, 2021). Only Vindigni et al. (2022) have studied Italian consumers' attitudes towards food products derived from NGTs in more general terms. However, the study does not include consumers' WTP.

The current study investigates Italian consumers' preferences and acceptance of NGTs seeds in organic food production, specifically in tomato paste, using a hypothetical discrete choice experiment (DCE). While European conventional consumers might not perceive all GMOs in the same way (Delwaide *et al.*, 2015a), organic food consumers clearly reject using these methods (Mandolesi *et al.*, 2022a). The implementation of NGTs with no traceability requirements, even only in conventional food production, would jeopardise the development of the GMO-free premium sector and the organic market, triggering technical complications, problems in traceability and increased economic costs for their operators in order to address (when possible) the risk of contamination (IFOAM EU, 2015).

METHODOLOGY

The DCE included four attributes based on previous literature (Bernard *et al.*, 2009; Edenbrandt, 2018; Mandolesi *et al.*, 2022b): seeds type (3 levels: non-hybrid, hybrid and NPBTs); natural vitamin C content (2 levels: claim present/no claim); origin (3 levels: National, EU, Out of EU); and price (4 levels: -50%/-25%/+25%/+50% of average market price). Although hybrid seeds can be obtained according to different genetic or non-genetic mechanisms (Kumar and Singh, 2008), the present study focused only on non-genetic hybrid seeds to isolate the effects on consumer preferences of non-reusable seeds from GE seeds. Moreover, the term NPBT was preferred over NGT in presenting the choice sets, to avoid linking the NGTs immediately to GMOs, which would bias consumers' response.

In September 2020, 392 Italian organic consumers (51% females, mean age 43 year old, S.D. = 12.4), selected through quota sampling, participated in an online questionnaire that included 12 choice sets of two alternatives and an opt-out. The choice tasks and options were shown randomly to avoid any ordering effects. Before the DCE, the participants saw an example of the choice task, the labels definitions and a "cheap talk" to reduce the hypothetical bias (Cummings and Taylor, 1999).

The data were analysed using a mixed multinomial logit (MMNL) model with random and independent parameters. The random parameters for national origin, EU origin, non-hybrid seeds, hybrid seeds and vitamin C were assumed to be normally distributed. The price parameter was assumed to be fixed. Two models were estimated, one in the preference space and the other in the WTP space, using the APOLLO package (Hess and Palma, 2019). The log-likelihood was obtained by Monte-Carlo simulation-based integration using Halton draws with 1000 replications.

RESULTS

Results in the preference space show that the price coefficient was significant and negative. The national and EU-origin coefficients were statistically significant and positive, which indicated a clear preference for national over EU-origin and non-EU products. The coefficient for non-hybrid seeds was significant and positive, showing that the respondents gained higher utility from non-hybrid seeds than NBT seeds. The consumers considered both hybrid and NBT seeds at the same level of non-acceptance. The coefficient for the natural presence of vitamin C was significant and positive. The analysis from the WTP space confirms these results. Consumers were willing to pay more for Italian, non-hybrid-seeds tomatoes with a natural vitamin C content.

The obtained results align with previous studies on European consumers' preferences for GM products (Delwaide *et al.*, 2015b). Generally, European consumers do not accept GM food well, which might extend to NGT products (Eriksson and Chatzopoulou, 2018). European consumers prefer food that does not have biotech-derived traits and are less willing to pay for biotech-derived food (Palmgren *et al.*, 2015). The same applies to Italian consumers.

Moreover, Italian consumers' preference for non-hybrid seeds over seeds from NGTs might indicate that they perceive NGTs as incompatible with organic farming. Previous studies have shown that organic consumers are generally against GE products and are less willing to purchase GM products than other consumer segments (Edenbrandt, 2018). Part of the consumers' hostility to GM food is based on the perception of Nature and naturalness as "sacred" (Siegrist *et al.*, 2016). In this view, if Nature is minimally altered, it is seen to be polluted or contaminated. For these consumers, "organic" is linked to the idea of "natural" and "not manipulated" products (Zanoli and Naspetti, 2002), which means that the use of NGTs in organic farming is seen as a threat and as a violation of the organic *Ecology* principle. The organic label should guarantee "GMO-free" products (Wickson *et al.*, 2016).

CONCLUSIONS AND IMPLICATIONS

According to the current results, organic farmers and processors who want to meet consumer demand should act precautionary and transparently concerning seeds' origin and quality. Specifically, planting non-hybrid, farm-saved seeds may result in competitive advantages for organic farmers. Processors and retailers may successfully differentiate their offer by clearly labelling food products from locally sourced vegetable ingredients from non-hybrid seeds. Transparency in labels appears of paramount importance for the Italian organic consumer. Such results contribute to the current EU food policy debate on traceability and labelling as preconditions for freedom of choice for consumers (IFOAM EU, 2015). If food products from NGT seeds were allowed in the market, traceability and a clear and transparent labelling scheme should be mandatory to preserve consumers' freedom of informed food choices.

It is essential to highlight that the present study focuses on one specific lightly-processed product, which means that these results might vary if other products are considered (e.g., fresh products or highly processed products). Moreover, additional consumer characteristics such as attitudes towards NGTs, neophobia and consumer knowledge of organic products could be included in further explaining choices. Future research should explore these directions.

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Water scarcity and consumer behaviour: how to alleviate the Water Footprint of the current Italian food consumption.

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PAROLE CHIAVE
Food consumption, Water scarcity, Water Footprint, Sustainable food consumption, Mediterranean Diet

INTRODUCTION

Global freshwater resources are limited, and the 70% of them are employed for agricultural purposes (FAO, 2017). At worldwide level, over 2 billion people are already experiencing high water stress conditions and projections about population growth, urbanisation, changes in eating habits will increase the need for water (UN, 2018). In this perspective, adopting sustainable diets with lower environmental impact would help reducing the stress on water resources.

So far, a line of research in the recent economic literature analyses the environmental impacts of diets, especially by means of the carbon footprint (CF) and ecological footprint (EF) indictors (Notarnicola *et al.*, 2017). However, the environmental externalities of diets are not only about greenhouse gases (GHGs) emissions, land use and pollution, they also regard water consumption (Ritchie and Roser, 2020). Concerning this, literature demonstrates that animal products have a higher water footprint (WF) compared to crop products (Hoekstra, 2014). As a consequence, reducing the consumption of animal-based foods, especially red meat, would contribute to decrease the diet-related environmental in terms of water consumption (Ridoutt *et al.*, 2017).

In light of the above, the adoption of sustainable diets could significantly contribute to achieve an improvement in terms of environmental sustainability, meanwhile preserving nutritional adequacy (Cavaliere *et al.*, 2018). The Mediterranean Diet (MD) is an example of sustainable diet (FAO, 2015);

however, even in Mediterranean Basin countries, the population is shifting away from the MD with consequent higher environmental impacts (FAO, 2015).

Moreover, projections on climate show that the Mediterranean area will be subject to extreme climatic events such as droughts (Ali *et al.*, 2022), which might lead to a reduction in agricultural production (Senapati *et al.*, 2018). Because of these, the Mediterranean basin is considered a hotspot of increasing interest for mitigation and adaptation policies in the near future. Among Mediterranean countries, Italy has been proven to have high diet-related environmental impact, especially due to an excessive consumption of meat products (Cavaliere *et al.*, 2023). As mentioned above, animal products are high-water intensive foods. Moreover, Italy has been recently affected by severe drought as a consequence of lack of precipitation during the winter period (Toreti *et al.*, 2022) and on the other side, Italian population has one of the highest per capita water consumption and waste of water rates at worldwide level (The European House – Ambrosetti, 2021). Considering all the above, Italy needs to find adequate policies to reduce water consumption.

The aim of the study is to assess the water consumption of the current Italian diet using the WF indicator and explore if the adoption of alternatives diets can reduce the WF related to food consumption. By answering this question, the study contributes to expand the existing literature in the field of WF of diets and give some important clue to policy makers to adopt measures fostering eating policies to protect the fundamental natural resource which is water.

METHODS

Data

To assess the current Italian diet, we used the most recent available data from the Italian National Institute of Statistics (ISTAT, 2021). The data collection involves a representative sample of the Italian population (N= 45,597). Consumption data are referred to fourteen food categories, namely bread, pasta and rice; potatoes; fruits; leaf vegetables; vegetables; red meat; white meat; fish; pulses; milk; cheese; cured meat; sweets; salted snacks.

We subsequently calculated the WF of the current Italian diet and the Recommended MD; we use WF data from the CWASI database[1].

Research design

Then, we developed a Sustainable Diet Model (SDM) to obtain alternative diets such that the WF is minimized.

$$\arg \min_{\substack{m_i \le x_i \le M_i, \\ \sum_{i=1}^{14} k_i x_i = K}} \quad \omega_w \sum_{i=1}^{14} \frac{w_i x_i}{1 \left[\frac{\text{liter}}{\text{pers}\cdot\text{day}}\right]} + \beta \sum_{i=1}^{14} \left(\frac{x_i - p_i}{p_i}\right)^2 \quad (1)$$

In (1), xi represents the weekly intake of each food category. The quantities mi and Mi are the minimum and maximum of the range of the intake (in grams) of each i-th food. These parameters change depending on the model of diet that we are considering. The parameter K represents the weekly calorie intake of each diet and ki represents the calorie contribution of each i-th food. wi corresponds to the WF associated to the weekly intake of the i-th food.

[1] https://www.watertofood.org/download/ (Accessed on 10 November 2022)

The second term in (1) considers people resistance to change their dietary habits. When we assume high values for β, it means people has a high resistance to change their eating habits, while it is the opposite with low values of β.

To summarize, the solution to (1) corresponds to the optimal diet where the sum of the total WF and the relative change from the current Italian diet are minimized at the same time.

RESULTS

The WF of the Italian diet is 95.96% higher than that of the MD (Table 1).Red meat is the major contributor (WF equals to 1228.95 L person-1 day-1), followed by sweets (686.06 L person^{-1} day^{-1}), cheese, (284.63 L person^{-1} day^{-1}), fish (138.07 L person^{-1} day^{-1}), cured meat (130.85 L person^{-1} day^{-1}) and white meat (116.11 L person^{-1} day^{-1}). The high WF value of these food categories depends on the combination of two factors: the unit WF (uWF) and quantity consumed.

On the opposite, some food categories have low uWF and lower weekly consumption than that of the Recommended MD. As a consequence, the WF of these food categories is lower than it would be in the MD. This is the case of bread, pasta and rice (143.30 L person^{-1} day^{-1}), fruits (102.76 L person^{-1} day^{-1}), pulses (98.79 L person^{-1} day^{-1}), milk (57.09 L person^{-1} day^{-1}), vegetables (49.82 L person^{-1} day^{-1}) and leaf vegetables (10.54 L person^{-1} day^{-1}).

Table 1 –WF by food categories respectively for the Italian diet and the Mediterranean Diet (MD).

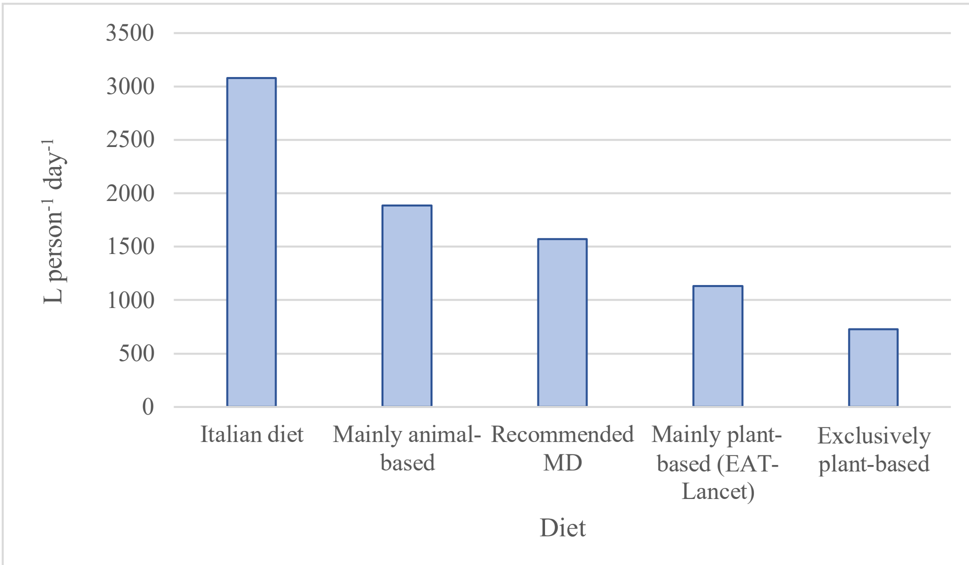
FOOD	uWF l/g	WF Italian diet 2021 (L person^{-1} day^{-1})	WF MD (L person^{-1} day^{-1})	Δ
Bread, pasta and rice	0.98	143.30	230.87	-37.93
Potatoes	0.12	9.72	5.58	74.19
Fruits	0.49	102.76	209.60	-50.97
Leaf vegetables	0.15	10.54	24.03	-56.15
Vegetables	0.31	49.82	122.09	-59.19
Red meat	18.65	1228.95	213.13	476.61
White meat	2.36	116.11	53.91	115.36
Fish	1.81	138.07	72.32	90.92
Pulses	1.49	98.79	102.10	-3.24
Milk	0.69	57.09	207.54	-72.49
Cheese	3.38	284.63	173.81	63.76
Cured meat	6.59	130.85	23.36	460.24
Sweets	18.12	686.06	128.37	434.46
Snacks	2.11	20.05	3.36	496.42
Total		**3076.76**	**1570.07**	**95.96**

By solving the SDM, we obtained the WF values for a mainly animal-based, a mainly plant-based and an exclusively plant-based diet (Figure 1). The mainly and exclusively plant-based diets have a substantial reduced WF with respect to both the current Italian diet and the MD.

The WF of the mainly plant-based diet is equal to 1131.38 L person^{-1} day^{-1}, -63.21% with respect to the WF of the current Italian and -27.91% with respect to the MD. The exclusively plant-based diet is the least impactful diet with a WF of 729.34 L person^{-1} day^{-1}.

The mainly animal-based diet, which includes a moderate amount of meat products, improves the impact of the Italian diet (-38.70%), but is +21.12% higher than the one of the MD. This diet has been selected since it does not imply significant changes in eating habits, meanwhile leading to an overall significant benefit for the environment.

Figure 1 – Bar charts of the WF of all dietary patterns



CONCLUSIONS

The results of this paper demonstrate that some changes in consumers' dietary habits can reduce the diet/related WF. In line with previous studies, we found out that meat and other animal-based products are the most water-consuming foods and even moderately reducing their consumption can improve the WF of diets.

The findings of the study are useful to provide guidance for supporting policy makers in fostering sustainable food consumption in line with the objectives of the 2030 Agenda. Increasing consumers' awareness regarding the WF of food through information campaigns and the development of WF/specific labels might represent effective instruments in guiding consumers' choices towards more sustainable products.

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Millennial consumer analysis of novel food purchasing attitudes: an application of the Means-End Chain (MEC)

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Keyword: Food consumption analysis, novel food, millennials, means ends-chain (MEC), food globalization

INTRODUCTION TO THE TOPIC

The phenomenon of globalization has transformed the eating habits of consumers together with theirgreater awareness and attention to food safety, quality, sustainability of supply chains etc. This event process marks a starting point for a real change in consumer choices that seeks the quality of the experience. It affirms a supranational model of food in which tradition and innovation are founded; those expectations mature for an exploratory search for goods and services preferably exclusive, non-standard, recognizable. [Branzato A., 2020]

This consumption model has led agri-food companies to direct production according to the needs expressed by groups of consumers, developing products with heterogeneous and detailed attributes: not only in function of sensory and nutritional aspects but also with respect to the so-called "*credence*" attributes, in an attempt to address an increasingly informed, trained, aware and demanding consumer profile; For this reason, companies tend in their strategies to focus not only on the product as it is, butto favour the criteria that guide consumer choices from time to time.

Studies on the increase in the consumption of organic food and the willingness of consumers to pay are numerous [Gracia et De Magistris, 2008; Pellegrini et Farinello, 2009, Bellini, 2011, Ceccacci, 2013]. As the literature confirms, novel food products respond on the one hand to the needs of modern consumers who are increasingly attentive to food with a high content of services and sustainable lifestyles, and on the other hand to the UN Sustainable Development Goals, referring to the ability that innovative production processes, the use of renewable and less impactful energy and protein sources, are more sustainable and enable, to those who choose them, greater participation in reducingthe effects of food choices on the environment.

In the light of the changes that the food market is going through, the research object aims to identify what is, today, the need for "food innovation" and which can be considered new foods by the Millennials.

To identify this need, the logical chains, the criteria, which determine the purchasing behavior of a particular group of consumers, the Millennials, with regard to new innovative food products have been highlighted.

The choice of this group comes from the great interest that the research has towards future consumers whose food demand shows evident differences with respect to the accumulated demand especially because they see in food not only a means of functional satisfaction, but a direct expression of innovative lifestyles characterized by hedonism, sociality, heterogeneity, respect for the environment, economic sustainability.

The attitude analysis of this group of consumers is based on the methodology of the means-ends chains (MEC) applied to the responses to a structured questionnaire administered to a convenience sample of Millennials. The respondents, after having chosen in the questionnaire a certain category of new food from:

- organic products, light, gluten-free, wholemeal,
- laboratory products (in vitro meat),
- products not available in Italy but only abroad,
- IV and V range products,
- any food not consumed in Europe before 1997 (e.g. insects).

As shown from the list suggested by the Milan Map, a new food product can be both a food not consumed in europe before 1997 and a food characterized by a process or product innovation (organic food, gluten-free, IV and V range products ecc.)

The surveyed people choose the attributes, consequences and values among those proposed and built logical decision chains that determine the purchase. From the data processing of the questionnaire, using the excel spreadsheet, we traced the profile of the collected sample, identified the categories of novel foods most chosen by Millennials and critically analyzed the most frequent logical-decision chains.

DATA DESCRIPTION AND RESEARCH METHODOLOGY

The MEC is a theoretical model aimed at understanding the decision-making processes that lead the consumer to the choice of a given product. Market researchers use this approach to understand consumers' choices and design advertising and communication messages to induce them to choose their product or brand. A recent study [Barrena R. et Sanchez M.,2013,], applied MEC to analyse consumer Neophobia towards novel foods. It demonstrates that the variation in complexity and associated benefits and values in the novel food choice structure can be linked to the degree of consumer phobia towards novel foods.

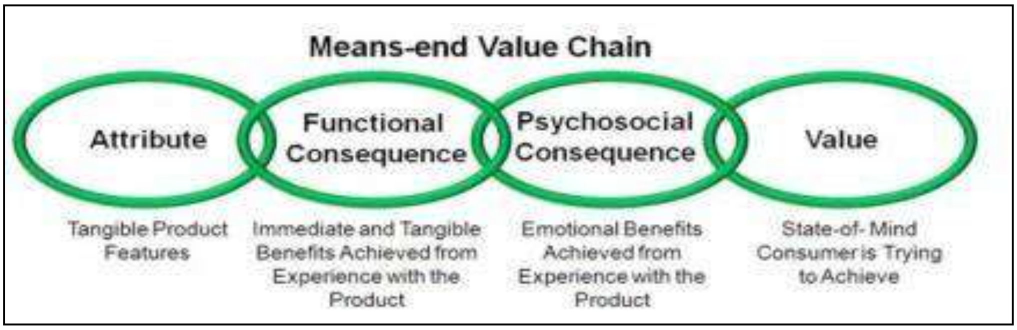
The first versions of MEC were introduced by advertising professionals who developed guidelines for the creative process and took as their starting point to investigate what degree of involvement and what type of information processing are typical for marketed products. The first application of the MEC on food consumption dates back to Gutman (1982) who developed this concept, suggesting that consumers use benefits, which in turn contribute to satisfying personal values.

The MEC methodology is a qualitative model which can be conducted with two different approaches. In the first (hard laddering interview) the interviewee can choose some characteristics or attributes and values to connect according to his own logic. The second approach (soft laddering interview) favors free discussion in an unstructured way in order to deepen the choices made. We used hard laddering interview. In order to define a list of attributes, consequences and values to be presented to the respondents in the questionnaire, a focus group with stakeholder's experts in the agri-food sector (researchers, entrepreneurs, traders, social media managers) has be conducted.

The consumer, therefore, will start from the choice of a *concrete* or *abstract attribute*. He will link the first choice with one or more *personal consequences* and with one or more *personal values*. Afterthis first round the interviewee can choose another attribute and build other chains in the same way (figure n.1). The product is therefore not chosen and purchased for itself, but rather for the meaning that it assumes for the consumer. The main output of the MEC analysis is a Hierarchy-Value-Map (HVM) revealingthe most common decision paths that explain consumer behavior.

HVM is a tree diagram in which the frequency of linkage is represented by the dimension of the arrows that connect attributes, consequences and values.

Fig.1: Means-end chain (MEC) from Rockbridge Associates



The questionnaire was administered via social networks (due to Covid-19 restrictions).

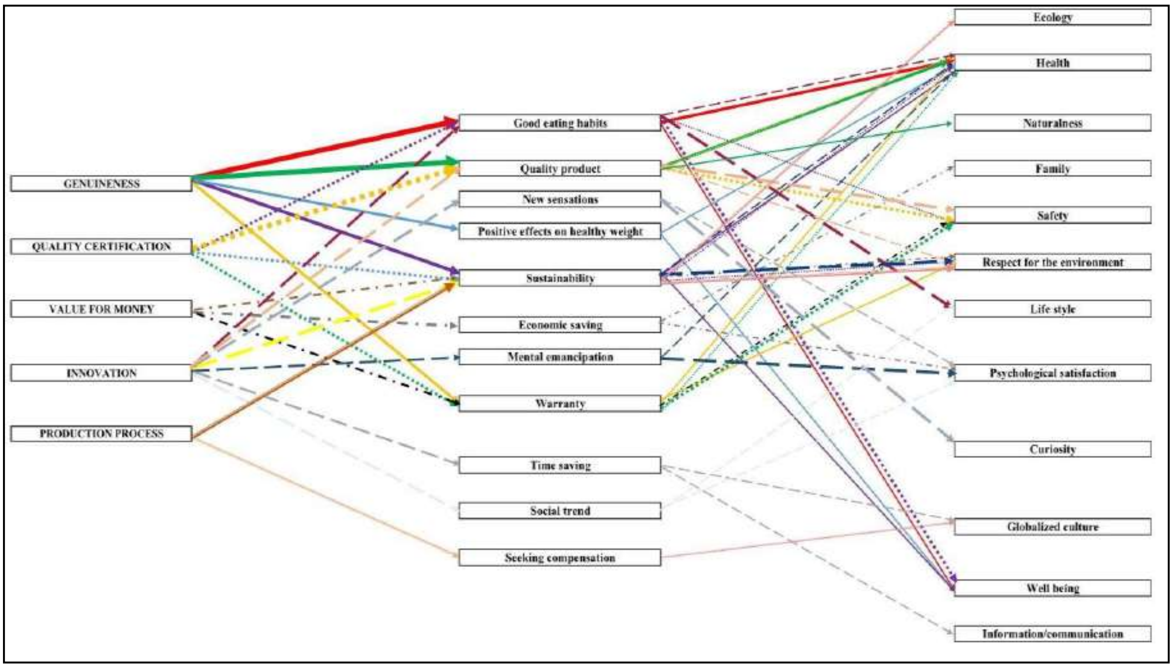
RESULTS AND DISCUSSION

The questionaire was submitted from 26/10/2020 to 02/11/2020 and we obtained 267 responses. The descriptive analysis draw a socio-demographic profile of Millennial consumers based on their level of knowledge and sensitivity towards sustainable innovation in the food supply chain.

The results showed that, a new food product is an organic, light, gluten-free or technologically innovative product for 78.7% of interviewee.

Each arrow is characterized by a thickness, a typology and a colour: the thickness indicates the frequency of choice, the typology indicates the starting attribute and the color helps the reading of the chains that connect the attributes to the consequences and these to the values.

Fig.2: Hierarchical map of values (HVM)



As the HVM diagram shows (fig.2), the most chosen attributes for novel food in general are genunity, quality certification, value for money, innovation and the production process.

It emerges that the genuineness of a product (16.5%) is appreciated by Millennials, as a feature "threatened" by the spread of intensive production models and the massive use of chemistry in agriculture. Improving the quality of life is an important objective of the modern consumer, whose consumption patterns have become the expression of their own life style.

The main consequences of those who have chosen genuineness are “good eating habits” (15.9%), “quality products” (18.8%); the values are, "health" (21%) and "safety" (8.7%). In fact, a sort of psychological "palliative" to a more sedentary lifestyle than in the past, caused mainly by the study and the office work that today, also because of the pandemic, is always more "smart", and therefore substantially static.

Another appreciated attribute that drives millennials to buy new food is the certification of quality (11.8%).

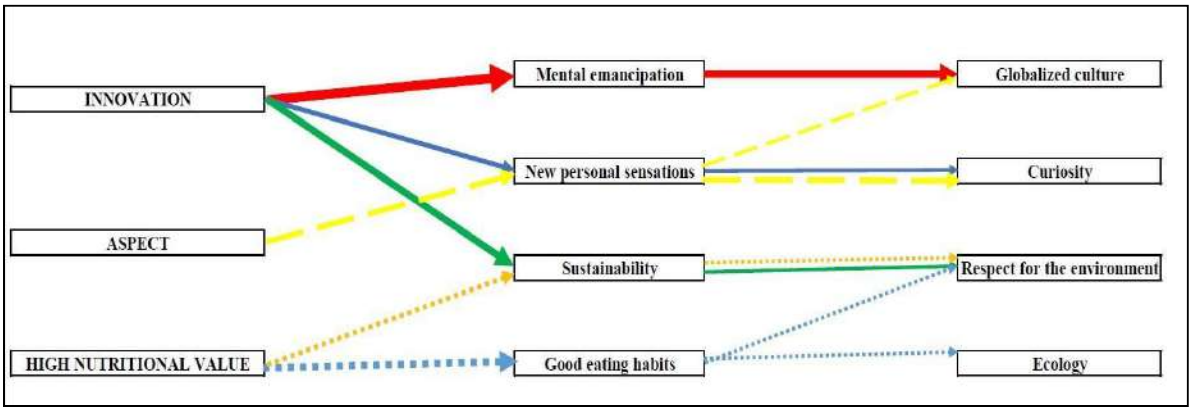
The modern consumer has broader parameters than the only typical characteristics of food. This attitude is caused by a greater awareness of the indispensable relationship between health and food, reinforced by the many food scandals of recent years (the Bse case, the dioxin crisis, avian influenza, etc.). The main consequences of those who have chosen certification quality are “quality product” (18.8%) and sustainabiliy (17,6%); the values are, "health" (21%) and "safety" (8.7%). A certified product results in the mind of the consumer in safe, traceable product.

Then we observed the chains of two innovative products: novel food based on insects and burgers invitro

As for insect-based foods, an appreciated attribute was the high nutritional value (12%): in fact, they represent a good source of energy, amino acids and fatty acids essential for health. Eating insects isa good food habit, as well as an ecological and environmentally friendly choice [Caporale A., 2022,]

Many millennials have appreciated entomophagy by associating it with an innovative food (16.1%) that leads to a status of mental emancipation (13.5%) and globalized culture (17.6%)

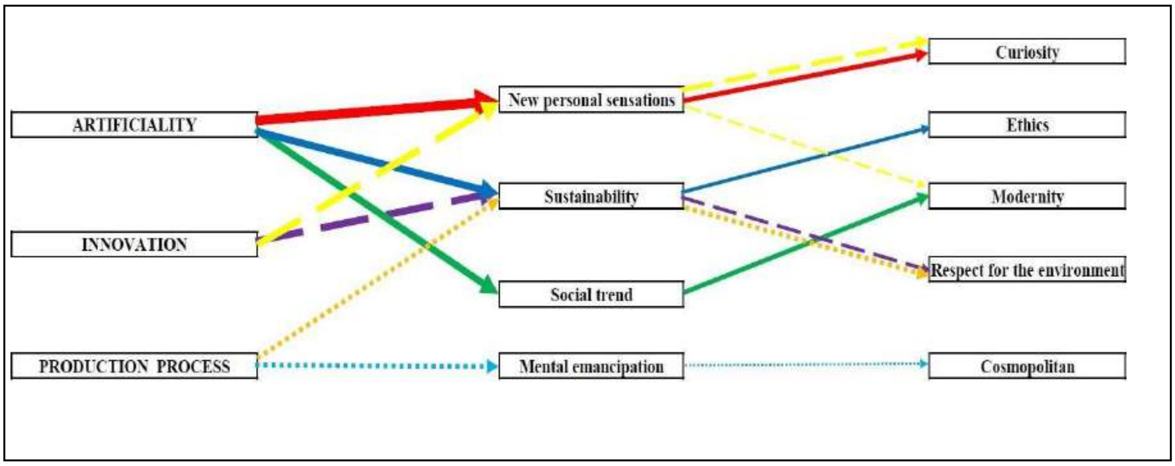
Fig.3: HVM insect food products



Also in vitro meat is considered a novel food whose production technique is based on the ability of stem cells to differentiate and give life to different organic tissues.

The attribute "high nutritional value" in this caseis onlyabout 1%, being the nutritional values still little known. Artificiality (28.8%) and innovation (27%) are the most frequent attributes, chosen in order to achieve new personal sensations (21.7%) and high levels of environmental sustainability (17.2%). The artificiality is linked to values such as curiosity (13.5%), ethics (7%) and modernity (13,1%).

Fig.4: HVM synthetic meat



CONCLUSIONS

The results obtained from the HMV hierarchical map of values allow us to highlight how novel food(insects and synthetic meat), are still seen by the Millenials as distant and dystopian realities. Furthermore, these are considered only as elements of curiosity, source of new sensations and emotions.

As emerged from the chains related to "foods of the future", our sample appreciate the attribute "innovation", coherent with their "emancipated" and "globalized" lifestyle.

Policy commitment should be the reduction of the information asymmetry between producers and consumers with the aim of avoidingmisunderstandings. Moreover, innovation should be introduced by government tools, respecting the uniqueness and centrality of the agrifood system, in the protection of the multifunctionality of agriculture.

This qualitative study conducted through the Means-End Chain could be useful both as a guide for carrying out quantitative studies aimed at assessing the propensity and interest of Millennials towards novel foods and as a guide for designing ad hoc advertising marketing campaigns.

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ECONOMIC OUTPUTS OF ORGANIC AND CONVENTIONAL FARMS: THE CASE OF PERMANENT CROPS

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KEYWORDS: organic farms, size company, permanent crops, farms input, green policies

1. INTRODUCTION

Organic production is encouraged by policies for the positive environmental outcomes (Boncinelli et al., 2016) and health benefits. At European level, in 2004, the Commission adopted the first European Action Plan for Organic Food and Farming, with the aim to promote and strengthen the organic sector (EC-COM, 2004); with this Plan the creation of the new organic production logo of the European Union has been achieved. The main goals of the Action Plan were concentrate on various goals, some of these were: increasing consumer awareness of organic products providing more information and promotion to consumers and operators; encouraging Member States to make a more coherent and greater use of the different rural development measures to support organic farming; improving and reinforcing of the Community's organic farming standards; establishing an independent committee for scientific and technical advice; increasing the efficiency and transparency of the inspection system. In 2017, a negotiation by EU Institutions reviewed organic regulation with some changes to the rules on production, controls, and imports (Willer et al., 2018).

For more than two decades, the organic sector revealed a constant global increase. The strategic relevance of organic agriculture in Italy has been recognized in 2004 by the National Action Plan for Organic Food and Farming for promoting organic products (Gamboni and Moscatelli, 2015). It includes the standardisation of the application methods of the support measures for organic farming contained in the Rural Development Programs of the different Regions and the encouragement of the aggregation among producers (Amato et al., 2019).

Besides the policy support, producers need to consider the economic perspectives and implications of organic conversion (Greer and Hunt, 2011) for a sustainable market strategy. In fact, organic agriculture will primarily be determined by its economic performances compared with conventional agriculture (De Ponti et al, 2012) and policies should carefully take into account this issue (Offermann and Nieberg, 2000; Casolani et al., 2021). Two main policy tools European policies developed to support organic agriculture: payments for conversion of farming into organic practices and methods (as defined by European standards) and payments for the maintenance of organic farming practices and methods (Casolani et al., 2021).

Overall, EU policies involving measures for organic agriculture have been implemented differently through member states and this had an impact on the relative economic attractiveness of organic farming (e.g. Offermann et al., 2009; Stolze and Lampkin, 2009; Läpple, 2010; Sanders et al., 2011). In order to offer new insight to policy makers, several studies have been conducted in order to analyse the economic sustainability of organic farms compared to conventional ones and the main factors influencing the economic success of organic farming. The financial status of organic farming was analysed in the Czech

Republic by Vlašicová and Náglová (2015) and Krause and Machek (2018): Czech organic agricultural companies outperform conventional companies in terms of profitability. Conversely, Rattanasuteerakul and Thapa (2012) in Thailand analysed the financial performance of organic vegetables farming, demonstrating that it was much less financially attractive than conventional farming due to low yields which usually are not accompanied by a premium price for the products; consequently, farmers are growing organic vegetables on a small scale primarily for household consumption.

Jouzi et al. (2017) investigated the main opportunities and challenges of the organic production system of small-scale farmers in developing countries with an emphasis on their livelihoods, revealing that the most significant socio-economic advantages are the increase of farmers' income and the reduction of external input costs, the enhancement of social capacity and the increase of employment opportunities. Khanal et al. (2018), using an unconditional quantile regression approach, found that the US organic farms financial performances, measured by the total value of farm sales and the net cash farm income, vary across the different economic dimensions of the farms.

Rattanasuteerakul and Thapa (2012) and Schifferstein and Oude Ophuis (1998) highlighted the attractiveness of organic farming in a saturated market, especially for small farmers who cannot benefit from the scale effects of technologically advanced agricultural production. Binta and Barbier (2015) suggested that the organic farming system would be economically more attractive for farmers in the Niayes region in Senegal compared with the conventional farming system only when a premium price is applied to organic crops, in accordance with Crowder and Reganold (2015). Uematsu and Mishra (2012) suggested that the lack of economic incentives could be a barrier to organic farming: contrary to expectations, certified organic farmers do not earn significantly higher income than conventional ones and spend significantly more for labour, insurance and marketing charges.

In Italy, few studies compared organic with conventional farms considering economics issues (e.g. Sartori et al., 2005; Cisilino and Madau, 2007; Salvioni et al., 2012; Testa et al., 2015).

However, in the previous studies, the analysis of the role of farm size in affecting the results is absent or not sufficiently considered, even if farm size can have an impact on the economic and environmental performances of agricultural production (Ren et al., 2019). The aim of this study is thus to investigate the main economic performances of Italian organic *versus* conventional permanent crop farms, a sector that is very important for Italian agriculture, by considering the different classes of farm size in terms of Utilised Agricultural Area (UAA), in order to offer new insight for policy makers.

2. MATERIAL AND METHODS

Data related to organic and conventional farms for the year 2021 were extracted from the Italian Farm Accountancy Data Network (FADN), which constitutes a source of microdata harmonised at European level that is representative of commercial and market-oriented farms (i.e. farms with a Standard Output higher than 8,000€).

Data were analysed through SPSS 26.0 statistical program. To compare organic and conventional farms for the different classes of UAA t tests were used (significant values ≤ 0.05). Only farms classified as permanent crops specialists were selected. A synthetic index of the organic/conventional ratio of the various economic indicators was calculated. The sample characteristics are reported in Table 1. The South and islands areas are the most represented in both typologies of farms (organic farms=61.5%; conventional farms=37.5%). The class 2 of UAA (5-15 hectares) comprehends 50.2% of organic farms and 48.2% of conventional farms.

The average economic dimension (25,000-100,000€) is the most represented (organic farms=50.5%; conventional farms=51.0%).

The economic outcomes calculated for both organic and conventional farms were the following: company total revenues, gross salable production, value added, farm net value added, company net product, gross operating profit, operating income and net income. In addition, the following costs were analysed: fertilisers, pesticides/herbicides, variable inputs, fixed inputs, salaries and social charges.

Table 1 - Italian sample of organic and conventional farms of permanent crops for the year 2021

		Organic farms (n=1112)	Conventional farms (2445)
		%	%
Area	North-west	6.1	18.1
	North-east	13.7	32.5
	Center	18.7	11.9
	South and islands	61.5	37.5
Class of utilised agricultural area (UAA)	Class 1 (UAA< 5 hectare)	16.0	31.8
	Class 2 (UAA 5-15 hectare)	50.2	48.2
	Class 3 (UAA 15 - 40 hectare)	23.1	15.4
	Class 4 (UAA> 40 hectare)	10.7	4.6
Economic dimension	Large (>100,000€)	28.4	26.3
	Medium (25,000-100,000€)	50.5	51.0
	Small (<25,000€)	21.0	22.7

3. RESULTS AND DISCUSSIONS

In Table 2 the comparisons between organic and conventional farms in relation to the mean values of some economic indicators are reported (values for hectare). The class 2 of UAA presents statistically different values for all the analysed variables except for farm net value added. T tests were applied to compare organic with conventional farms within each class of UAA.

The total revenues of conventional farms present higher values than organic ones in all classes of UAA, even if statistically significant only for class 2 of UAA. In Table 3, costs per hectare for organic and conventional farms are compared. On average, both variable and fixed costs are lower for organic farms except in the smallest ones, while salaries and social contribution are higher for the organic farms. Costs for pesticides/herbicides and for fertilisers are lower in organic farms than in conventional ones. The cost for pesticides/herbicides is the only variable that presents statistically significant differences in all classes of UAA, while the cost for fertilisers is significantly lower for classes 2 and 3 of organic farms.

Lower average costs in organic farming seem not sufficient to create comparative advantages over conventional farms, as the other indicators such as value added, farm net value added, company net product, gross operating profit, operating income and net income perform better for conventional farms.

Cisilino and Madau (2007) revealed a difference in efficiency and productivity through a comparative analysis of the organic and conventional farming in Italy; their study concluded that conventional farms' gross production, net margin, net product and costs were significantly higher than the organic ones.

The higher attractiveness of conventional production compared to organic one has been pointed out by several authors in international literature (e.g. Rattanasuteerakul and Thapa, 2012; Kramol et al., 2013; Tiedemann and Latacz-Lohmann, 2013; Alkahtani and Elhendy, 2012). Conversely, other researchers found a higher attractiveness of organic farming (e.g. Crowder and Reganold, 2015; Vlašicová and Náglová, 2015;

Krause and Machek, 2018). This controversial point on economic output is not the only one for evaluating the organic or conventional economic convenience, because in some cases organic products represent a useful way to acquire different markets than conventional ones.

Table 2 - Economic performances of organic and conventional farms (per hectare) per class of utilised agricultural area

		Class 1 (UAA< 5 hectares)			Class 2 (UAA 5-15 hectares)			Class 3 (UAA 15 - 40 hectares)			Class 4 (UAA> 40 hectares)		
		Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)
Company Total Revenues	Organic farms	11029.7	13540.34	n.s.	7467.0	8691.24	**	6154.7	9053.75	n.s.	5518.3	8337.71	n.s.
	Conventional farms	11839.5	11858.25		8799.1	10206.73		6876.0	10674.99		7149.1	14874.47	
Gross salable production	Organic farms	10026.5	11422.78	n.s.	7009.9	8426.33	**	5829.5	8767.38	n.s.	5430.4	8207.76	n.s.
	Conventional farms	11226.6	10323.35		8462.6	9911.25		6756.4	10547.92		7075.9	14845.08	
Value added	Organic farms	7511.7	10398.43	n.s.	5323.9	6478.28	*	4117.4	5773.76	n.s.	3798.9	5734.65	n.s.
	Conventional farms	8163.3	8872.58		6258.7	7756.87		4507.2	6275.57		5175.0	12791.06	
Farm Net Value Added	Organic farms	7205.0	9716.26	n.s.	5341.2	6260.01	n.s.	4218.1	5553.40	n.s.	4000.2	5791.12	n.s.
	Conventional farms	7447.5	8515.06		5894.3	7588.90		4336.3	6025.51		5091.7	12620.44	
Company Net Product	Organic farms	6161.9	9378.27	n.s.	4659.5	6089.23	*	3685.5	5436.76	n.s.	3511.2	5533.34	n.s.
	Conventional farms	6823.7	8144.53		5472.7	7307.57		4040.0	5901.47		4792.1	12573.86	
Gross Operating Profit	Organic farms	5461.4	8581.81	*	3999.3	5508.28	**	3039.4	4931.65	n.s.	2770.7	5023.59	n.s.
	Conventiona l farms	6708.2	7262.30		5021.6	6904.01		3466.8	5387.69		3886.3	10798.07	
Operating income	Organic farms	3983.9	7776.04	*	3165.6	5046.63	**	2502.6	4520.06	n.s.	2370.6	4796.15	n.s.
	Conventional farms	5194.8	6468.29		4088.5	6455.91		2841.8	4728.96		3346.2	10340.65	
Net income	Organic farms	4798.5	8359.21	n.s.	3809.6	5820.36	*	2942.5	4842.53	n.s.	2739.2	5327.17	n.s.
	Conventiona l farms	5509.8	14985.60		4531.1	7698.31		3080.1	5173.11		3578.4	10387.26	

*p≤ 0.05; **p≤0.01; n.s.= not significant.

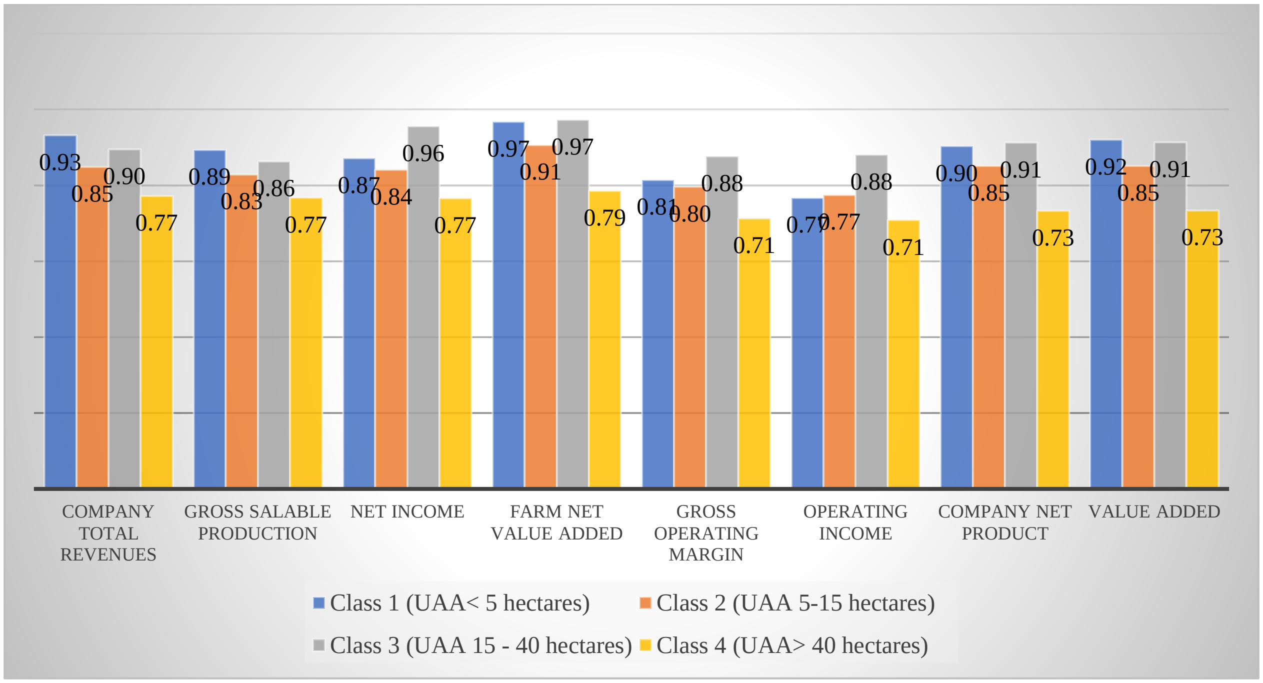
Table 3 - Costs for organic and conventional farms (per hectare) per class of utilised agricultural area

		Class 1 (UAA< 5 hectares)			Class 2 (UAA 5-15 hectares)			Class 3 (UAA 15 - 40 hectares)			Class 4 (UAA> 40 hectares)		
		Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)	Mean	St. dev.	t test (sig.)
Cost for fertilisers	Organic farms	367	652.18	n.s.	251.5	494.08	**	189.1	253.12	**	204.7	347.69	n.s.
	Conventional farms	427.6	602.31		313.2	336.81		278.4	312.79		213.7	216.78	
Cost for pesticides/herbicides	Organic farms	300.5	467.16	**	199.3	369.60	**	150.2	273.36	**	142.8	275.28	*
	Conventional farms	531.8	480.67		425.8	465.14		311.2	336.98		234.1	268.94	
Variable Costs	Organic farms	4633.8	6054.74	n.s.	2960.1	3878.44	n.s.	2804.7	4505.75	n.s.	2469.2	4978.71	n.s.
	Conventional farms	4293.3	5072.13		3270.8	3989.87		3044.8	5251.91		2658.5	3527.24	
Fixed costs	Organic farms	2284.3	2687.37	n.s.	1172.1	1524.27	n.s.	742.6	1072.50	n.s.	563.3	735.74	n.s.
	Conventional farms	2177.3	4571.20		1291.8	1307.94		831.6	1336.79		987.1	2259.90	
Salaries and Social duties	Organic farms	2050.3	2895.43	n.s.	1324.7	1782.06	n.s.	1078	1463.70	n.s.	1028.1	1312.63	n.s.
	Conventional farms	1455.1	4162.17		1237.1	1585.01		1040.4	1490.39		1288.6	2230.87	

*p≤ 0.05; **p≤0.01; n.s.= not significant.

Figure 1 shows the ratio of the various economic indicators of organic farms compared to conventional ones per each class of UAA. The classes of UAA influence economic indicators. The variables associated with positive economic outcomes (company total revenues, gross salable production, net income, farm net value added, gross operating margin, operating income, company net product and value added) present values below 1.0 for all classes of UAA. The values are lower for the biggest farms (UAA > 40 hectares), revealing higher values for conventional farms economic indicators.

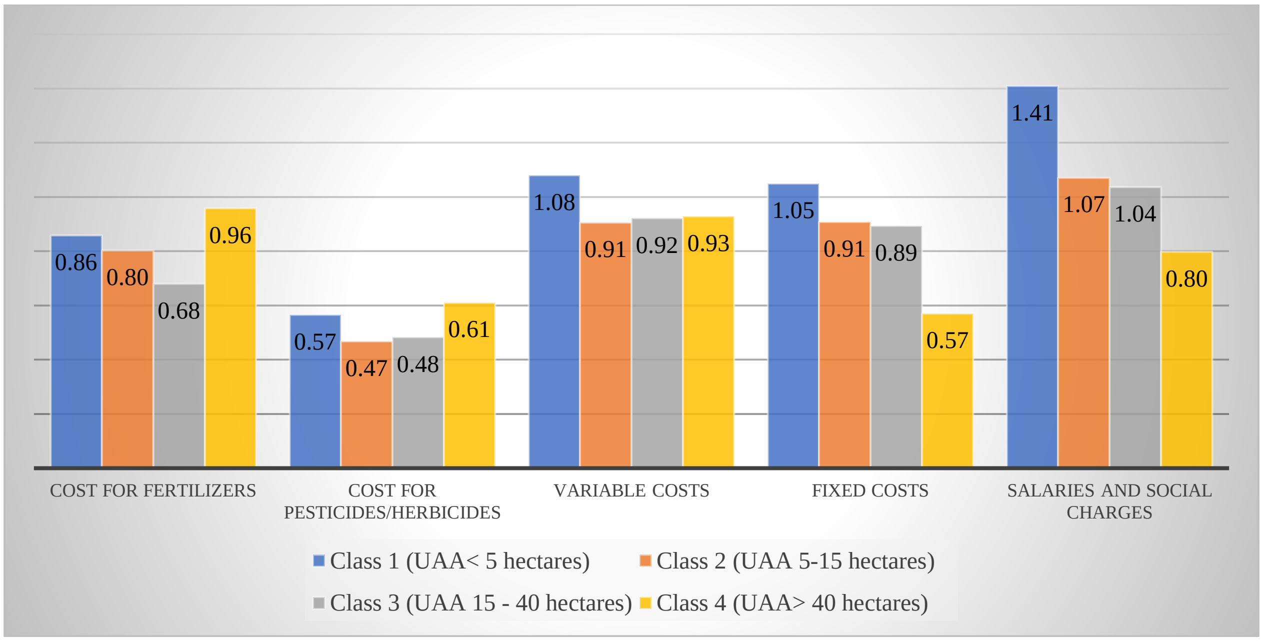
Figure 1 - Ratio of economic indicators of organic/conventional farms (average values per hectare)



The costs present values that differ for classes of UAA (Figure 2). The ratio of organic/conventional fixed costs decreases at the growth of UAA and, in the same way, the salaries and social charges. The ratio of cost for fertilisers and for pesticides/herbicides reveal higher values in class 4, indicating a lower difference between organic and conventional farms.

In general, it should be considered that the use of average values per hectare might have an impact on results, as more extensive organic farms could be penalised by this approach. Thus, further analysis would be needed to corroborate these findings.

Figure 2 - Ratio of costs of organic/conventional farms (on average values per hectare)



Figures 3 and 4 show the farm net value added (per hectare) respectively of organic and conventional farms (for class of UAA) in different Italian geographical areas. Organic farms located in North-west and North-east areas present similar values within the class 1 of UAA (μ>11,900 euro), with values higher than farms located in Centre (μ=3,581 euro) and South and island areas (μ=4,382 euro). The Northern areas perform better than Centre and South and island ones also in conventional farms. Farms with UAA > 40 hectares located in the North-west perform the best in the class 4.

Figure 3 - Farm net value added (average values per hectare) of organic farms on class of UAA in different geographical areas

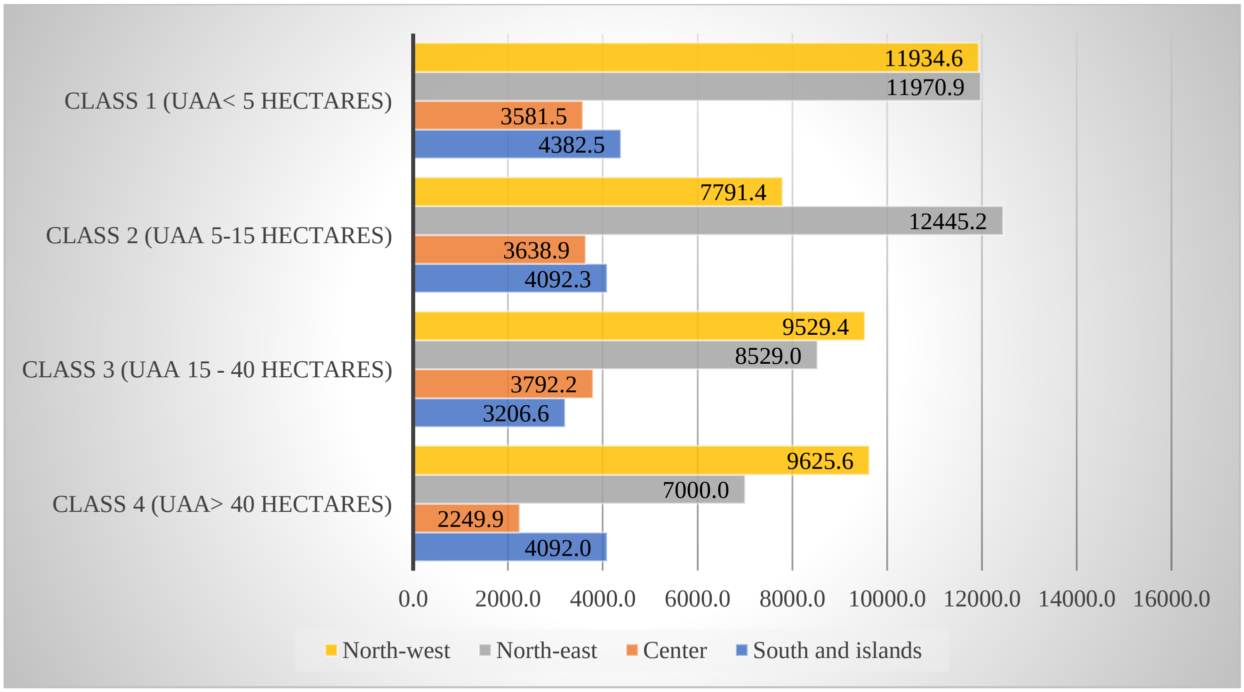
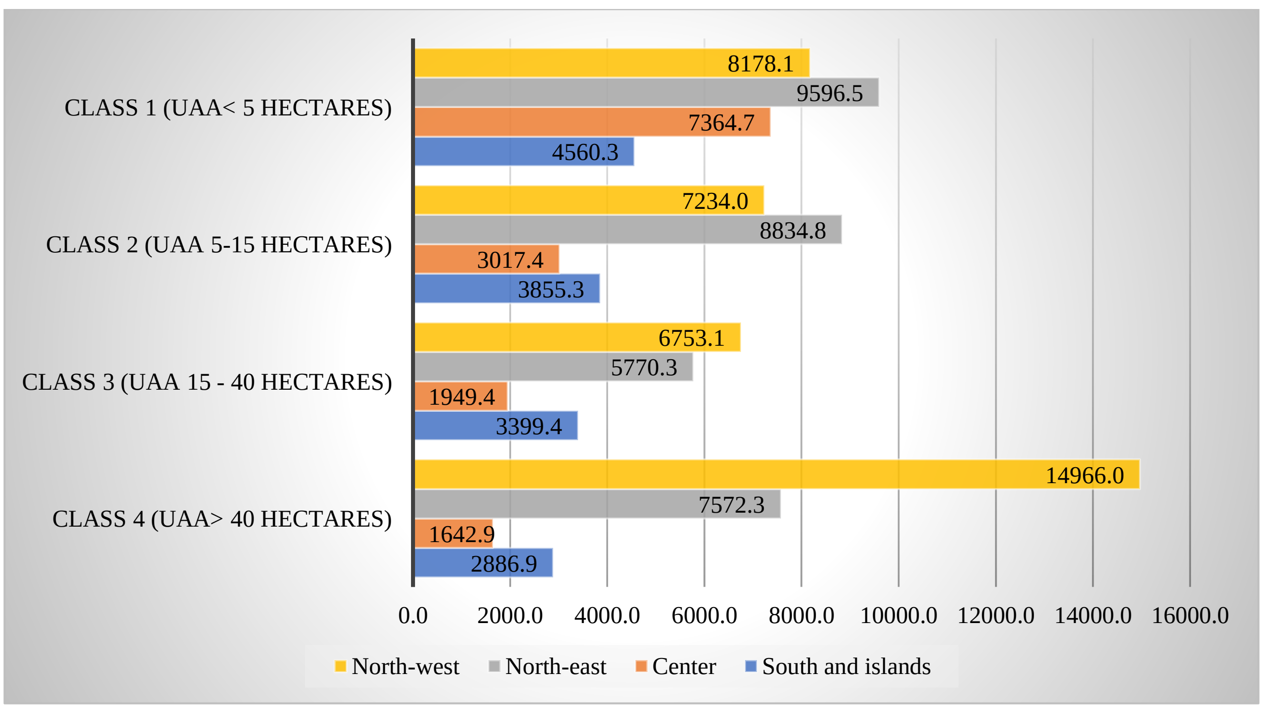


Figure 4 - Farm net value added (average values per hectare) of conventional farms on class of utilised agricultural area in different geographical areas



4. CONCLUSIONS

This study has performed a comparison between organic and conventional permanent crops farms by taking into account different farms' dimensions (in terms of UAA).

As regards the cost analysis, a significant difference is found for the pesticides expenditure, which is higher for conventional farms in all the size classes, as expected, and for the fertilisers in medium size farms. As regards the economic performances, conventional farms seem to perform better than organic ones. In this case, the class of UAA seems to matter as the only significant comparisons are found for the smallest classes of UAA.

The approach used in this study, which relies on values per hectare, might have penalised the results for a more extensive type of farming, like organic production. However, if confirmed by broader studies, the results here highlighted would suggest that the policies perspective for organic subsidies should adequately consider the role of farms' dimensions and maybe focusing support to smallest farms that seem to behave worse than biggest ones.

Limitations of the study include, among others, the time horizon of the analysis, too short to appreciate long term trends and potentially affected by short term shocks; the lack of distinction between different types of cultivation among permanent crops, which, of course, might have different economic performances and cost shares and the representativeness of the sample, that is not ensured for the Italian organic farms. Lastly, in this paper, the analysis is limited to the economic aspects while, in the light of the green transition of the sector, a future research direction should consider the integration between the economic outcomes and the use of resources, for a proper technical-economic evaluation of organic farms in comparison with conventional ones following the so called Sustainable Value Approach (see Pacini et al., 2015).

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Would consumers buy upcycled foods? Evidence from a Discrete Choice Experiment in Italy.

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Keywords: sustainable food, upcycled food, food choices, Discrete Choice Experiments, Medicinal Mushrooms

Introduction

It is estimated that about one-third of the total food globally produced for human consumption goes lost or wasted every year along the supply chains (FAO, 2015). Food losses (happening in the production stages) and food waste (occurring at the consumption stages, at the end of the supply chain), have negative consequences in terms of environmental impact and food security. The importance of limiting food losses and waste, improving resource distribution and increasing the sustainability of the food system has been stressed also in the recent EU food policies proposed in the Farm-to-fork strategy.
Many of the by -products of the agricultural practices and food industry are lost/wasted even though they are still suitable for human consumption (i.e., do not pose risks for human health) and they still retain nutritional value (Lau et al., 2021).
In this context, a circular management and use of available food resources would positively contribute to reduce the negative impact of food losses and waste. One way of applying circularity in food production consists in the utilization of food by-products as ingredients to produce new food preparations (i.e., upcycled foods) (Spratt et al., 2020).
However, consumer acceptance of innovations in food is a non-trivial issue. It is known that, especially in Italy where there is a deep-rooted culinary tradition, consumers tend to be reluctant in accepting novel products. There is concern that innovation may damage the cultural heritage or affect the high quality of Italian food products. Furthermore, consumers are always sensitive regarding food, as eating behaviors have a strong link with health outcomes. Additionally, with specific regard to upcycled ingredients, there is the risk that consumers perceive by-products as waste, which is often expected to be disgusting and/or contaminated with compounds potentially harmful to health (Baxter et al., 2017; Aschemann-Witzel and Peschel; Sharma and Deutsch, 2023). In this frame, innovations such as the use of upcycled ingredients is likely to encounter significant barriers.
This study aims at extending evidence regarding consumer choice behaviors for food with upcycled ingredients, exploring which could be the main determinants of consumer acceptance/rejection of such foods (e.g., food neophobia, knowledge). Furthermore, acceptance effect of potential health-enhancing properties of the upcycled ingredients will be tested. The study uses a hypothetical Discrete Choice Experiment based on breadsticks produced using by-products of the cereal industry as an upcycled ingredient and containing Medicinal Mushrooms (MMs). MMs are edible mushrooms with possible beneficial properties on human health.
The results provide novel insights to inform future food policies geared towards promoting sustainable food consumption and limiting diet-related environmental impact.

Methods

Data have been collected through a nationwide online survey distributed by a survey panel provider to 920 Italian respondents. Only consumers older than 18 years old, not allergic to mushrooms, who bought breadsticks in the month before the survey and are responsible for their/their household grocery shopping were considered eligible.

The survey included a Discrete Choice Experiment (DCE) on breadsticks, a section aimed at eliciting respondents' prior knowledge about circular economy and upcycled foods, their level of food neophobia, as well as their socio-demographic and economic characteristics. The order of presentation of the different sections of the questionnaire as well as the order of questions within each section is randomized across respondents to avoid ordering bias.

The attributes selected to characterize the breadsticks in the DCE are illustrated in Table 1. The allocation of attributes across the choice task is based on a D-efficient design, resulting in 30 choice tasks divided in 5 blocks. Each choice task is composed by two buying alternatives and opt-out option, so that respondents always had the possibility not to buy the proposed alternatives.

Table 1. DCE Attributes and levels

Attribute	**Levels**
Price (€for a pack of 250g)	1.95, 2.35, 2.75, 3.15, 3.55
Upcycled	Present/ Absent
Fiber	Rich in fiber / Absent
Medicinal mushrooms	Contains Medicinal Mushrooms / Absent
Tested	Tested by the researchers of the University of Milan / Absent

The data have been analyzed using a MXL model with Error Component (MXL-EC), as described in the utility function in (2):

$$U_{njt} = \beta_0 * \text{opt-out}_{njt} + \beta_1 * \text{price}_{njt} + \beta_2 * \text{upcycled}_{njt} + \beta_3 * \text{fiber}_{njt} + \beta_4 * \text{mushroom}_{njt} + \beta_5 * \text{tested}_{njt} + \eta_{it} + \varepsilon_{njt} \quad (2)$$

where η_{it} represents the individual-specific EC associated with the purchasing alternatives in each choice set, and not with the opt-out (Model 1). Interaction terms have been included in the model to explore whether preferences for the upcycled attribute are influenced by respectively (i) information provision about upcycled ingredients (Model 2), (ii) respondents' familiarity with the concepts of circular economy and upcycled foods (Model 3).

Model 2 can be described by the following equation:

$$U_{njt} = \beta_0\text{*opt-out}_{njt} + \beta_1\text{*price}_{njt} + \beta_2\text{*upcycled}_{njt} + \beta_3\text{*fiber}_{njt} + \beta_4\text{*mushroom}_{njt} + \beta_5\text{*tested}_{njt} + \beta_6\text{*int1}_{njt} + \eta_{it} + \varepsilon_{njt} \quad (3)$$

Where int1 represents the interaction term between the upcycled attribute and the information treatment (i.e., brief explanation of the meaning of upcycled food).

Finally, Model 3, assumes the following form:

$$U_{njt} = \beta_0\text{*opt-out}_{njt} + \beta_1\text{*price}_{njt} + \beta_2\text{*upcycled}_{njt} + \beta_3\text{*fiber}_{njt} + \beta_4\text{*mushroom}_{njt} + \beta_5\text{*tested}_{njt} + \beta_6\text{*int2}_{njt} + \beta_7\text{*int3}_{njt} + \eta_{it} + \varepsilon_{njt} \quad (4)$$

where int2 represents the interaction between the upcycled attribute and a dummy variable corresponding to respondents' familiarity with the concept of circular economy and int3 is the interaction of upcycled with the dummy variable referred to respondents' familiarity with upcycled ingredients.

Results

The preliminary results of Model 1 showed that respondents overall preferred conventional breadsticks compared to alternatives that contain upcycled ingredients and/or the medicinal mushroom. This is coherent with previous literature showing that consumers are generally reluctant to buy foods that carry unusual and unknown ingredients.

As for the upcycled attribute, the positive and significant interaction term between the upcycled attribute and the information treatment (i.e., int1) indicated that providing consumers with a synthetic explanation of what upcycled ingredients are, increased preferences for such attribute (Table 1).

Table 1. Model 2: MXL-EC results

CHOICE	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Random parameters in utility functions					
PRICE	-2.06795***	.07460	-27.72	.0000	-2.21416	-1.92175
UPCYCLED	-.80101***	.12158	-6.59	.0000	-1.03930	-.56271

FIBER	.65905***	.08850	7.45	.0000	.48559	.83251
MUSHROOM	-1.38099***	.12271	-11.25	.0000	-1.62148	-1.14049
TESTED	.56026***	.08727	6.42	.0000	.38922	.73130
	Nonrandom parameters in utility functions					
INT1	.32581**	.16131	2.02	.0434	.00965	.64198
OPT-OUT	-7.08799***	.25795	-27.48	.0000	-7.59357	-6.58240
	Distns. of RPs. Std.Devs or limits of triangular					
CsBPRICE	0.0	.....(Fixed Parameter).....				
NsBUPCYC	1.57543***	.11396	13.82	.0000	1.35208	1.79879
NsBFIBER	1.03035***	.13317	7.74	.0000	.76935	1.29135
NsMUSHRO	2.90178***	.15176	19.12	.0000	2.60434	3.19922
NsTESTED	1.79513***	.10658	16.84	.0000	1.58624	2.00403
	Standard deviations of latent random effects					
EC	2.56021***	.15273	16.76	.0000	2.26087	2.85954

***, **, * ==> Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or had a nonpositive st.error because of an earlier problem.
Model was estimated on Aug 22, 2023 at 04:41:06 PM

Furthermore, in line with previous studies of this type, our results confirmed that respondent's prior knowledge regarding circular economy and upcycled ingredients respectively, increased preferences for the upcycled attribute, as indicated by the positive and significant interaction terms (int2 and int3 in Model 3) (Table 2).

Table 2. Model 3: MXL-EC results

CHOICE	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
	Random parameters in utility functions					
PRICE	-2.05346***	.07510	-27.34	.0000	-2.20065	-1.90627
UPCYCLED	-1.26211***	.14892	-8.48	.0000	-1.55398	-.97023
FIBER	.66693***	.08842	7.54	.0000	.49364	.84022
MUSHROOM	-1.32106***	.11810	-11.19	.0000	-1.55252	-1.08959
TESTED	.56711***	.08820	6.43	.0000	.39424	.73998
	Nonrandom parameters in utility functions					
INT2	.68690***	.16893	4.07	.0000	.35580	1.01799
INT3	.48336***	.17285	2.80	.0052	.14458	.82215
OPT-OUT	-7.04538***	.25933	-27.17	.0000	-7.55366	-6.53710
	Distns. of RPs. Std.Devs or limits of triangular					
CsPRICE	0.0	.....(Fixed Parameter).....				
NsUPCYCL	1.50639***	.10896	13.83	.0000	1.29283	1.71994
NsMUSHRO	1.10608***	.13281	8.33	.0000	.84578	1.36637
NsBFUNGO	2.82687***	.14991	18.86	.0000	2.53304	3.12069
NsTESTED	1.80261***	.10744	16.78	.0000	1.59202	2.01319
	Standard deviations of latent random effects					
EC	2.54611***	.15388	16.55	.0000	2.24451	2.84771

***, **, * ==> Significance at 1%, 5%, 10% level.
Fixed parameter ... is constrained to equal the value or had a nonpositive st.error because of an earlier problem.

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Model was estimated on Aug 22, 2023 at 04:41:06 PM
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The average preferences for breadsticks that carry the upcycled attribute or contain the medicinal mushroom increased if the product is “tested by the researchers of the University”. This contradicts previous findings indicating that the presence of a third-party certification can reduce risk perception, therefore having a positive effect on consumer preferences.

Overall, the results suggest that providing consumers with adequate information regarding innovative product attributes would make consumers less adverse towards buying such foods. Nowadays, innovation in food production is becoming more and more important for providing consumers with nutritious food, while reducing the environmental impact. Therefore, designing adequate strategies and food policies for promoting the consumption of such products is a key future challenge.

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Exploring participation in eco-schemes on Italian farms: a qualitative analysis.

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Farmers' participation, European Union, Common agricultural policy, Eco-scheme

INTRODUCTION

Agriculture plays a pivotal role in land use, and its management practices exert a substantial impact on the environment. The demand for a sustainable agricultural sector is intensifying; hence, policymakers are making strides to diminish detrimental impacts and amplify positive ones via environmental regulation. Optimal agricultural practices are fundamental to enhancing environmental performance and establishing a sustainable production model within this sector. Empirical evidence indicates that safeguarding natural resources and biodiversity is essential to ensure long-term food production (Gliessman,2016; Agroecology Europe 2021).While curtailing certain inputs might reduce yields in the short term, it will be advantageous to soil health over an extended period. Agri-environmental policies and programs bear upon a myriad of farms, involve significant taxpayer funds, and hold the potential to effect considerable environmental improvements (Clark et al., 2020). Determinations concerning farmers' participation in agro-environmental programs are made within each economic, social, environmental, and political context (e.g., Schlüter et al., 2017). In this landscape, farmers' participation hinges on their perceptions, resources, and available alternatives (e.g., Falk et al., 2021; Schlüter et al., 2017), which are influenced by behavioral factors.

The environmental challenges delineated by the European Green Deal, the Farm to Fork Strategy, the European Biodiversity Strategy for 2030, and the European Climate Framework have been acknowledged and addressed by a succession of decisions formulated in the Strategic Plan of the CAP 2023-2027 (PSP).

One of the key and strategic objectives of the 2023-2027 PSP, through which the CAP reform strives to 'ensure the ecological transition of the agri-food and forestry sector,' precisely involves the implementation of climate-environmental measures. These aim to support businesses in adopting agroecological practices which, whether directly or indirectly, facilitate the ecological transition. Such practices include eco-regimes, agro-environmental-climate interventions (ACA), organic production, animal welfare, forestry measures, investments for environmental sustainability, Natura 2000 quotas, and the Water Directive.

By allocating about a third of the PSP resources, across Pillars I and II, for the 2023-2027 period, eco-schemes, which are recipients of 25% of the resources assigned to Direct Aid, become a new instrument to 'reward' farmers who voluntarily undertake additional commitments beyond cross-compliance, with a focus on environmental and climate sustainability. Consequently, eco-schemes evolve into a new element of Pillar I, aligning with the specific objectives (OS) of the CAP in the realms of climate, environment, animal welfare, and combating antimicrobial resistance.

With eco-schemes, the European Commission has introduced a new policy tool, conceptually akin to the agri-environmental and climate schemes of the CAP's second pillar. The primary intention of eco-schemes was to maintain a broad base of farmer participation; thus, they have been classified as entry-level. Within the Italian National Strategic Plan, five eco-schemes have been identified. However, our research has focused on only four, excluding the eco-scheme related to animal husbandry.

This study represents a first phase of research aimed at exploring the behavior of Italian farmers towards the eco-schemes of the CAP, which encourage environmentally friendly practices. In this preliminary analysis, we conducted qualitative interviews with key-informants in order to identify the environmental and economic benefits, production costs and bureaucracy. Also analyzing the context and the institutional environment in which farmer that decides to join the eco-schemes is inserted.

We chose to investigate these behaviors because in a policy context where voluntary action is favored over government regulation, deepening our comprehension of human decision-making, and improving the prediction of farmer behavior has emerged as a primary research objective (Dessart et al., 2019; Thomas et al., 2019; Streletskaja et al., 2020).

ECO-SCHEMES IMPLEMENTED IN ITALY

Eco-schemes are a novel instrument of the CAP that pursue climate-environmental sustainability objectives to facilitate the ecological transition of the agricultural sector as showed in Table 1. They manifest as annual payments per hectare or eligible adult livestock unit, taking the form of supplemental payments to basic income support, or payments that wholly or partially compensate for additional costs incurred and income foregone. Eco-schemes account for 25% of the resources for direct payments, equivalent to roughly 874 million euros per annum.

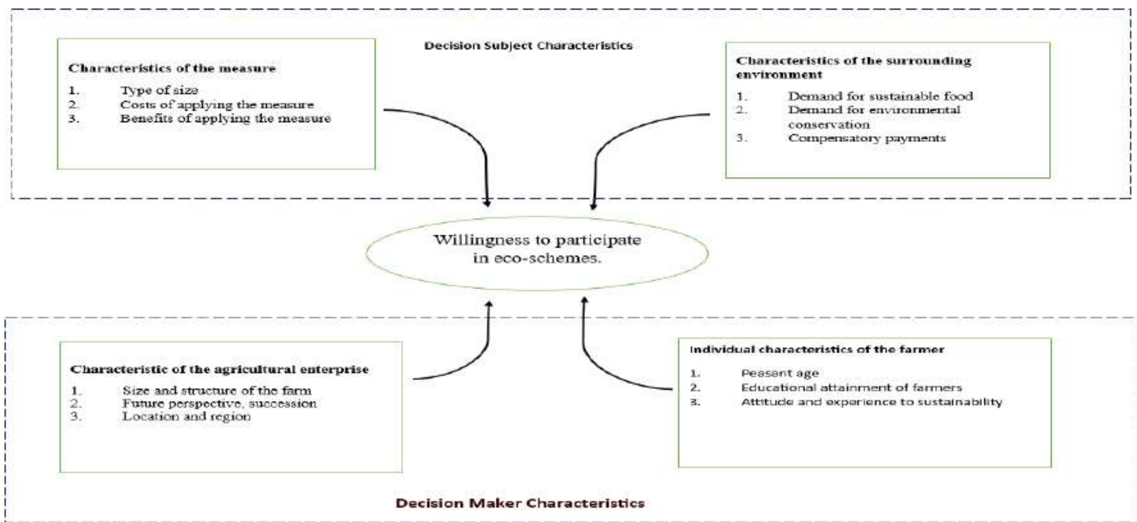
Table 1. Eco-Schemes Adopted by Italy. Source: Author's Own Compilation.

ECO 1 ZOOTECHNICAL	ECO 2 TREE CROPS	ECO 3 OLIVE GROVES OF HIGH LANDSCAPE VALUE	ECO 4 EXTENSIVE FORAGE SYSTEMS	ECO 5 SPECIAL MEASURES FOR POLLINATORS
• Its ultimate goal is to get livestock companies to join a virtuous path of reducing the use of drugs, based on the implementation of commitments directly linked to the improvement of animal welfare.	• has the objective of guaranteeing the coverage of the land in arboreal plants, such as vineyards, olive groves and orchards.	• It is specifically intended for olive growing.However, the olive grower must undertake to: Ensure biennial pruning of the foliage, with the aim of improving productivity. Do not burn pruning clippings on site. Keeping the olive grove in its status quo. It is therefore forbidden to increase the number of plants or cut them down.	• Its objective is to preserve soil fertility and biodiversity, but also to combat weeds and pathogenic organisms.	• It was chosen to support the populations of bees and other pollinating insects, the legislator decided to reward those farmers who allocate a part of the company area to the sowing of essences of beekeeping interest

METHODS

In order to identify influencing factors, a conceptual model for analysis The decision-making process of farmers regarding eco-schemes is presented. This conceptual model incorporates multiple influencing factors willingness of farmers to participate in such schemes (Figure 1).

Figure 1. Conceptual model



The willingness of individual farmers to participate is influenced by both characteristics of the object of the decision (in this case the schemes available) and characteristics of the decision maker (farmers).

The characteristics of the decision subject are further divided into characteristics product and market related. The characteristics that influence the participation of a farmer can be, for example, the required changes in practices and their effects on costs and benefits. When we talk about the market, the characteristics refer to the demand for consumers of sustainable agricultural products (e.g. through social pressure). The compensatory payment for a scheme is considered a parameter reflecting this demand. The characteristics of the decision maker we have further divided them into characteristics of the company (location, size, etc.) and characteristics of the farmer (such as age, education, environmental attitude, etc.).

We utilized a qualitative approach for this study. Initially, a comprehensive review of the relevant literature was conducted to prepare a semi-structured questionnaire, which was then used to interview key informants. Subsequently, to explore the various facets related to eco-schemes, we interviewed the following key informants: representatives of producers, agronomists, and a researcher. The interviews were conducted using a semi-structured questionnaire, allowing for more flexibility in the responses. The questionnaire was designed to identify the following factors influencing farmers' adoption of eco-schemes: environmental and economic benefits, economic and bureaucratic costs, farm characteristics, farmers' skills and characteristics, and policy context.

RESULTS

The results of the key-informant interviews are summarized in Table 2. With regard to the environmental advantages, the individuals interviewed corroborate what has previously been discovered in scholarly works, pinpointing biodiversity conservation as one of the primary benefits associated with the implementation of eco-schemes. This particular benefit, in conjunction with the reduction of emissions, was consistently highlighted throughout the discussions. Agronomists emphasized the significance of the ecological scheme 3, specifically focused on "high landscape value olive groves", for enhancing the environmental and landscape aesthetics of olive groves. From a wealth of interviews, it was revealed that certain commitments prescribed by the eco-schemes cater to the augmentation of organic matter content. Turning to the economic benefits, the interview responses primarily centered around the premium attached to the measure. However, the exact premium is speculative at this point since it will hinge on the volume of applications that will be received. In several instances, the interviewees asserted that the long-term impact of the obligations imposed by these measures will yield economic benefits by increasing the productivity of the soil.

When it comes to the costs that farmers must bear to implement eco-schemes, several interviewees pointed out that in order to meet the obligations imposed by these measures, farmers will have to contend with substantial pruning costs, not to mention a scarcity of skilled pruners in certain regions.

Another recurring theme from the interviews was the considerable cost of the mix that must be planted for eco-scheme 5. However, the costs are not purely production-based. Interviewees also brought attention to the so-called bureaucratic costs, which encompass the expenses linked to administrative obligations that come with adhering to the eco-schemes. The characteristics of farms and farmers play a significant role in participation in eco-schemes. In fact, from the interviews, it was repeatedly revealed that the traits of the farmers also affect the agricultural-environmental responses. Age is frequently identified as a pivotal factor in numerous studies, suggesting that younger farmers are more likely to take risks and therefore more inclined to engage with eco-schemes. The size of the farm has repeatedly been highlighted as one of the most significant determinants, a finding that is also corroborated by numerous academic studies. Although less emphatically, it was also noted that the type of production and the mode of production play an important role in adherence to eco-schemes. The institutional environment encompasses elements relating to the interface between farmers and policy, including the extent of information received and the participation of neighboring actors. Furthermore, some interviewees mentioned an issue of demarcation between Pillars I and II, which will certainly have to be investigated further. Also, the more the eco-schemes are tailored to the specifics of a given farm, the higher the likelihood of participation becomes. In conclusion, initial analyses affirm that elements such as farm characteristics, structural aspects, farmer attributes, attitudes, and situational factors cumulatively influence the farm's response to environmental considerations, as is well-established in literature (Beedell and Rehman, 2000). Nevertheless, gaps still persist. Modeling the motivations behind the adoption of eco-schemes remains an open question and a significant research challenge, especially in Italy.

Table 2. Results of interviews with key informants.

BENEFITS		COST		FARM AND FARMER CHARACTERISTIC	INSTITUTIONALE EVIRONMENT (policy, extension, and advisory services, etc.)
ENVIROMENTAL	ECONOMIC	OF PRODUCTION	OF BUREAUCRACY		
• Reduction of emissions. • Improvement of the environmental and landscape character of the olive groves. • Improvement of organic matter content. • Improvement of biodiversity	• The effects on soil and land productivity. • Measure award.	• High costs for pruning. • High costs for the mixtures envisaged by eco-scheme 5.	• Costs of joining the measures.	• Farm size. • Production system((e.g., organic) • Type of production. • Farmer's age. • Proactive attitude towards sustainability.	• Demarcation I and II Pillar • Diversified policies and measures by region. • Context in which farms produce. • The amount of information

CONCLUSIONS

The preliminary results would suggest some interesting policy implications. Firstly, many farmers are unclear about some commitments foreseen by eco-schemes, on crop rotation and soil and chemical products management, because many regulations require continuous refinements and clarifications. Secondly, the fundamental message that the European Union seeks to convey to farmers through the CAP is to change their mentality in the management of the territory and its products, and to improve knowledge and professionalism. It is not said openly but it must be deduced that the real revolution lies precisely in this concept, little accepted by the peasants, still strongly influenced by tradition.

Finally, even if we still don't have a certain result of farmers joining eco-schemes, we could find ourselves facing a significant risk, that of having a boomerang effect, in which farmers give up funding and proceed as they wish. This could lead to a regression in the commitment to environmental sustainability.

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Consumers' preferences and acceptance towards traditional thistle-curdled cheeses

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KEYWORDS

Consumer behaviour, sensory evaluation, vegetable rennet, sheep and goat cheese, willingness to pay

INTRODUCTION AND OBJECTIVES OF THE STUDY

Nowadays, the increased demand for cheese, the most consumed dairy product after milk, combined with increasing animal welfare constraints and reduced availability of animal rennet, has led the dairy industry to invest in research to develop alternative coagulants optimised for the cheesemaking process.

Rennet, essential for processing the milk into cheese, is obtained using a specific mixture of enzymes that promote the protein coagulation. Animal rennet, extracted from the inner mucosa of the fourth stomach of calves, represents the most widely used coagulant to act on milk proteins (Nicosia et al., 2022).

Nevertheless, among the most promising alternatives are the coagulants of vegetable origin or vegetable rennet (VR), like those derived from the cardoon flower (Zenobi et al., 2021). The present study aims to investigate consumers acceptance of the use of herbaceous perennial plants, known as "thistles", as an alternative to the animal coagulant in the manufacture of traditional cheeses. This choice could support the development of sustainable solutions for dairy farmers, climate and society.

THEORETICAL FRAMEWORK

VR is used in a wide variety of artisanal goat and ewe cheese, especially among Western and Southern Mediterranean areas. Few studies investigated consumers' preferences and acceptance of vegetable rennet cheeses (Galán et al., 2008; Roseiro et al., 2003). VR cheeses are appreciated for the uniqueness of their flavour – perceived as "slightly piquant" (Galán et al., 2008). Conversely, VR can affect the original cheese taste and exhibit an undesirable bitter taste compared to the traditional calf rennet, representing a potential barrier to the spread of this coagulant (Almeida and Simões, 2018; García-Gómez et al., 2021; Tejada et al., 2006). Nevertheless, no studies investigated consumers' willingness to pay for traditional and local cheeses with VR.

METHODOLOGY

The qualitative approach of focus groups (two FGs and 21 participants in total) was used to explore general consumer interest and knowledge of local traditional cheeses manufactured with vegetable rennet (Morgan, 1997). Then, consumers' liking and WTP were assessed on 100 Italian consumers. In line with previous literature, the consumer experiment was split into two subsequent days (Table 1). The experimental design of the acceptance test consisted of 3 sequential tests (Napolitano et al., 2010): 1) a blind assessment of experimental (thistle-cuddled, VR) and control (commercial animal rennet, AR) cheeses; 2) an expectation test based on an information stimulus; 3) an informed tasting of experimental and control cheeses. Two traditional kinds of cheese were used: Feta and Queso de Murcia cheeses. Consumers rated their liking on a 9-point hedonic scale, from "extremely unpleasant" to "extremely pleasant".

Participants' WTP (only for Feta) was measured through experimental auctions with actual monetary transactions (Canavari et al., 2019). Two English auctions were applied: one for each type of Feta cheese sample (VR/AR). After two training sessions with different products (candies), in the first auction participants were asked how much they would pay for a sample of 100 g of VR Feta cheese. A second auction (with similar rules) was then conducted for the AR Feta cheese. Participants knew that only one of the two actions was binding, and winners actually bought the randomly extracted bid. Bids were expressed in euros per 100 grams (hg). Subjects were voluntarily selected according to quota sampling. Participants ranged between 20 and 76 years, averaging 46 years; 41% were male. The majority of participants were active workers (67%). 60% of participants had a bachelor, master or a PhD. Focus groups and liking assessments were conducted in 2022 in Ancona. All participants received monetary incentives for their participation.

Table 1 Experimental design.

Test	Day	Stimulus presentation	Type of evaluation	Type of rating
1	1	AR+VR Cheese	Tasting without information	Blind liking
2	1	Information	Expectation	Expected Liking
3	2	AR+VR Cheese + information	Experiment auction	WTP (Feta AR/VR)
4	2	VR Cheese + information	Tasting with information	Actual Liking

RESULTS

FG results showed that participants had limited knowledge about cheesemaking and rennet types. However, all participants were interested in receiving more information and purchasing VR cheeses. The taste was indicated as one of the most relevant drivers of the purchase. The majority was concerned about organoleptic alterations of the original taste/smell of the cheese following the use of VR. After taste, participants were also curious whether VR could positively affect health by changing the proteins or fat content of the cheese. Concerning price, although the majority had never purchased VR cheeses, they perceived them to be more expensive than the others. Lastly, availability was considered a barrier to the spread of VR cheeses.

Liking assessment showed that consumers rated Feta and Queso de Murcia samples (both AR/VR) at scores well above the central point ("5" = "Neither pleasant nor unpleasant") for perceived liking. Overall, blind liking of VR samples (Feta and Queso) was lower than AR samples. A significant difference was found only for the Queso (p<0.0001). Results showed that the expected liking of VR samples was significantly higher than AR samples (Feta, p<0.01; Queso de Murcia, p<0.05). When performed, the comparison between blind and actual liking results showed that actual liking was significantly higher than blind liking (Feta, p<0.01; Queso de Murcia, p<0.0001). The actual liking was significantly higher and turned above the "7" ("Pleasant") or closer in both cases.

Concerning the WTP, the maximum bid for the VR Feta amounted to € 7/hg, with an average of € 2.03/hg and a standard deviation of 1.24. For the AR Feta, the maximum bid amounted to € 6/hg, with an average of € 1.84/hg and a standard deviation of 1.18. The WTP was significantly higher for the VR Feta than the AR with p<0.01. The result was mostly influenced by the females' bids, while men did not show a statistically significant difference in WTP. Also, active workers were willing to pay more for VR Feta than AR Feta (with p<0.01). Bids were used to plot the empirical demand curves for both VR and AR Feta. Unsurprisingly, regression results indicated that the WTP increased with expected liking. WTP increased by 0.29 euro/gram when pleasantness increased by one point scale of 1-9 (with p<0.01).

CONCLUSIONS AND IMPLICATIONS

The results showed a positive perception of vegetable rennet. Intrinsic (i.e., taste) and extrinsic (i.e., price, labels, origin) cues were mentioned as essential attributes influencing the decision-making process. The original taste is perceived as the primary driver when purchasing traditional and local cheeses (Ryffel et al., 2008). For this reason, thistle rennet's capacity to alter the cheese's original taste should be limited by a proper set of technological parameters (Almeida and Simões, 2018; Nicosia et al., 2022; Tejada et al., 2006). Despite their lack of knowledge, participants prefer VR cheese. Also, ethical concern related to animal welfare was another motivation to purchase VR cheeses (Allen et al., 2018).

The present study revealed positive evaluations of both VR cheeses (Feta and Queso), which aligns with previous studies (above "6" = "Slightly pleasant") (Galán et al., 2008; Roseiro et al., 2003). However, results did not show any statistically significant sensory acceptance effect of VR Feta over the AR type in blind conditions, similar to Vioque et al. (2000). In the case of the Queso, the liking was significantly higher for the AR samples (García-Gómez et al., 2021; Roseiro et al., 2003). As expected, the sensory acceptance analysis revealed significantly higher preferences for cheese samples with information (actual liking) than those without information (blind liking) (Napolitano et al., 2010).

Experimental auction results showed that participants were, on average, willing to pay significantly higher prices for VR Feta than the AR, meaning that VR traditional cheese can be considered a speciality food, where the price is a quality indicator (Stefani et al., 2006). This implies that high-quality traditional cheese made using VR (i.e., Cynara humlilis) has good margins of appreciation. Asa consequence, even without specific marketing efforts, the use of VR should not influence feta cheese sales, and indeed there are already organic feta cheeses made with VR. The findings showed that the effect of information on the rennet would significantly improve the attitude (i.e., actual liking) of cheeses made with VR. Therefore, clear labels and advertising higher-quality properties (i.e., on ingredients, production methods and health benefits) of VR cheeses should be encouraged to promote consumption (not only vegetarians or those more sensitive to ethical aspects) and maximise revenues, especially for small local farmers (Almeida and Simões, 2018; Napolitano et al., 2010). As with other speciality foods, the appreciation for culinary heritage, local origin and traditions can improve communication around local vegetable rennet cheese (Stefani et al., 2006). Furthermore, the perceived "different" taste of vegetable rennet cheese can contribute to diversifying the variety of cheeses on the market (Tejada et al., 2006). Further studies could be conducted to assess the effect of different communication strategies or labels and to evaluate other sensory characteristics of VR cheeses for which consumers are willing to purchase.

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TERRITORIAL INNOVATION AND PROXIMITY ECONOMY FOR THE REGENERATION OF INNER AREAS

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KEYWORDS
Territorial innovation, proximity economy, short food supplì chain, value creation.

INTRODUCTION

The social demands emerged in the last decades led citizens-consumers to express new instances concerning the environment, the relationship between food and well-being, the socialization and, in general, the quality of life (Marotta and Nazzaro, 2020; Thilmany et al., 2021). Agriculture, through its new forms, created the conditions for addressing the current citizen-consumers' instances.

Such evolution also affected inner areas, which are rural depopulated areas characterized by their distance from the main service centers of education, health, and mobility (Barca et al., 2012).In fact, several transformations occurred in inner areas concerned agriculture, following three lines of structural and organizational evolution (i.e. diversification, product differentiation and multifunctionality), approaching, through the short food supply chain (SFSC) (Nazzaro et al., 2016), citizen-consumers to rurality and traditions. In this context, rurality has taken on an identity dimension and reflected a better quality of life, recognized and appreciated more and more by citizens-consumers. Agriculture, in such renewed interpretation of rurality, through different forms of SFSC, has added new dimensions, to its productive function, such as relationship, creating new connections and contaminations between the citizen-consumer/community and producers, generating shared value (Nazzaro et al., 2017).In this respect, the new model of territorial innovation involves in a single experiential space production and consumption in order to create shared value.

In this perspective, the resilience of vulnerable territories, such as inner areas, can arise from the reconstruction of relations between local resources and local community (Quaranta et al., 2016). Local resources (including local products, landscapes, etc.), in fact, are the symbols of the history and evolutionary processes of a local community over time. For this reason, the experiential engagement linked to the use of the symbols of a fragile territory, can be a valid path to rebuild the relationships between resources and communities, creating transformative economies generating shared value.

The study aims to the analysis, definition, mapping, experimentation and evaluation of research methods and policy implications for value creation in inner areas through models of territorial innovation and proximity economy based on SFSCs. Specifically, the research aims to adapt the current models (e.g. *Territorial Staging System - TSS*) in order to define a theoretical-methodological framework of territorial innovation, and its multilevel governance mechanism, functional to the experiential engagement of market and nonmarket resources through the SFSC, and the enhancement of a specific territorial portfolio of values (Marotta and Nazzaro, 2020). It also aims to analyze the enabling factors and policies useful for the functioning of the model, as a real prospect of territorial innovation able to regenerate inner areas.

THE THEORETICAL FRAMEWORK

As stated in the Cork Declaration (2016) and resumed by the European Green Deal, social innovation and evolution of inner areas is a national test to explore solutions and policies of economic regeneration, or models of transformative economy, as well as to mobilize useful resources for the community. The potential for innovation in inner areas is high and fuelled by a strong base of natural resources and community spirit, an intelligent use of tacit knowledge and the use of cooperation to overcome barriers, such as weaker infrastructure and services (Moralli and Allegrini, 2021). There is unanimous recognition about inner areas in playing a crucial role in the responsible management of natural resources, in the mitigation of the effects of climate change, in urban decongestion, as well as allowing the transition to green and sustainable development. The pandemic highlighted the vulnerabilities and interdependencies between rural and urban communities: there are in fact many cases of citizens returning to inner areas and appreciate more and more living spaces and a cleaner environment.

Literature offers different analytical approaches to the territorial development. In the agri-food sector, Marotta, Nazzaro and De Rosa (2022) proposed the “territorial portfolio of values” (TPV), which interprets the SFSC as an experiential involvement of producers and citizens in the fruition of the values (material and intangible) of rurality. The authors define the TPV as “a set of chains of tangible and intangible values, representative of territorial identity, that local actors organize and make accessible to citizens-consumers through experiential involvement that creates shared value”.

In the economic-territorial literature, Jeannerat-Crevoisier (2010) propose a model called “Territorial Stage Setting” (TSS) as “Organizational model of actors, objectives and activities that contribute to transforming productive resources into a particular representation/configuration of experiential activities and consumption resources in an experiential involvement that generates value”.

In both models, reference is made to the concept of the experiential market, as a method of purchase and/or consumption conceived as an experience lived in the production places of goods and/or services (Pine and Gilmore, 2013; Troisi, 2020). In other words, the conceptualization of the experiential market theorizes territorial development not only through the local organization of production, but also through the contextual local organization of purchase/consumption.

Proximity economy is inspired by the models just mentioned and, in particular, the concept of territory as a contextual space of production and purchase/consumption. Proximity economy, in fact, means an organization of production aimed at selling its products and services to the citizens of its territory and the nearest one and at the same time a demand for these products expressed by the local community and by the nearest one (Masson and Bubendorff, 2022).Producers organize themselves to sell in the same production territories and in the nearest ones and local communities buy and consume food from their own territory and/or the nearest one. This concept is often expressed as re-territorialization of food.

On the supply side, the producers organize themselves in an individual form, practicing sales formulas through farm outlets, and/or in collective form, participating in the so-called farmers’ markets. Nowadays, it is possible to propose new formula based on models of social innovation, such as the creation of collective entities by local producers for the management of permanent and exclusive outlets of local food, a kind of “Small Organized Distribution of Local Food” (SOD). Through these new models of social innovation it is possible to generate also territorial innovation: it is a regenerative economy of inner areas, based on new models of value creation realized through a bottom-up approach and the enhancement of SFSCs. Such models allow to activate new occupation and permanence in the territory, leading the citizens-consumers to consume on the spot as attracted by the traditions, identities and beauties of local landscapes.

In fact, the citizen-consumer of a given area, in the SOD can find all the products expression of agriculture and the smaller supply chains of the reference territory.

Valorization processes through the stage setting have been explored in literature of territorial development, which have looked beyond the traditional territorial innovation models (Moulaert and Sekia, 2003). Nonetheless, studies are still scarce about the reconfiguration of rural resources through stage setting approaches, the role of citizen-consumers, producers and other stakeholders belonging to inner areas.

TSS can thus be adapted to interpret the models of experiential engagement determined by the different forms of SFSCs (e.g. direct selling, farmers' market, agritourism, SPG, etc.) in inner areas. It also helps in shed lights on the enabling factors and policies most suitable for the economic development, as a real prospect of territorial innovation able to regenerate inner areas.

According to such theoretical framework, the study attempts to provide an original contribution, adapting the territorial staging system to interpret the models of experiential involvement determined by the different forms of SFSCs in the inner areas. It also aims to analyze the enabling factors and policies most suitable for the development, as a real prospect of territorial innovation able to regenerate inner areas. From this perspective, the study fills literature gap, endogenizing a broader set of variables to give sound basis to the stage setting in inner areas. On this line, the study aims to analyze and define a theoretical-methodological framework of territorial innovation, functional to the experiential involvement of market and non market resources through the SFSC, and the enhancement of a specific TPV.

In particular, the analysis aims to investigate case studies of value creation managed by multilevel governance mechanisms in inner areas, validating the conceptualized theoretical-methodological model and identifying targeted policies for its implementation.

In this perspective, the research questions of the study are:

RQ1: How can the short food supply chain, in its various forms, be interpreted as a stage setting creating value through experiential involvement?

RQ2: Through which models of territorial innovation and stakeholder involvement can the stage setting be implemented?

RQ3: What are the enabling factors and policies for an effective implementation of short food supply chains able to create shared value through the stage setting?

METHODOLOGY

Adopting a case study approach, the study aims to investigate value creation managed by multilevel governance mechanisms in inner areas, validating the conceptualized theoretical-methodological model and identifying targeted policies for its implementation (Eisenhardt, 1989).

The research explores, in three inner areas, representative of different local dynamics and trends, territorial innovation models, based on SFSCs, aimed at developing transformative economies. The main characteristic of these models of SFSCs is that all actors co-participate in a new model of value creation that is inclusive (i.e. employing vulnerable workers in production processes), sustainable (i.e. creating multifunctional, regenerative production processes of territorial ecosystem services) and resilient (i.e. contributing to the rural socio-ecological resilience).

The study, relying on a combination of qualitative and quantitative methods, allows the analysis, definition, mapping, experimentation and evaluation of adapted Territorial Staging Systems based on SFSCs and their policy implications. In particular, the research consists of three phases. The first one concerns the analysis of the transformative dynamics in inner areas and of the SFSCs models. It address the following activities: a) analysis of the main transformative dynamics and the factors contributing to the development of inner areas; b) analysis of the different models of SFSCs contributing at the regeneration of local economies; c) analysis of the theoretical debate in terms of experiential engagement for the economic regeneration of inner areas functional to the definition of a theoretical-methodological framework. The second phase focuses on the definition of the theoretical-methodological model and its multilevel governance mechanisms. The following activities are included: a) definition of a theoretical-methodological framework adapting the territorial staging system in inner areas, in order to depict models of experiential engagement tacit in the different models of SFSCs. b) definition of the theoretical-methodological model's enabling factors; c) definition of the multilevel governance mechanisms able to support the implementation of the theoretical-methodological framework and the sharing of value generated. The last step concerns the validation of the model through: a) identification of the three pilot areas to be investigated by the project partners; b) analysis of the endogenous resources in the pilot areas selected; c) identification of the case studies to validate the theoretical-methodological model; d) assessment of the territorial innovations, based on SFSCs, put into place by the case studies selected; e) assessment of the theoretical model's enabling factors and assessment of the multilevel governance mechanisms; f) identification of policy needs to facilitate the implementation of the theoretical-methodological model.

RESULTS AND CONCLUSIONS

The study developed new knowledge related to regenerative economies and territorial capacity in inner areas. Moreover, it tests interpretative hypotheses related to the adaptation of the model of the Territorial Staging System to the SFSC in inner areas, functional to the identification of a territorial portfolio of values. The first results of the study, still in progress, enable the identification of more coherent and effective policies capable of triggering regenerative processes and rebalancing local ecosystems. Moreover, the study defines best practices that can be extended to other inner and vulnerable areas, enabling an effective orientation of the territorial value creation capabilities.

Specifically, through the definition of a small-organized distribution organizational model, local and proximity food becomes the center of a territorial organization, where the generative and transformative social innovation builds upon and involves producers, citizens-consumers, local institutions and citizens-tourists. This innovative "engine" allows to efficiently exploit products that do not have the competitive strength to face the challenges on global markets, products obtained with extensive production techniques, sustainable and inclusive, thanks to smaller chains that resist in their activities, presiding and representing fragile territories.

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Global Antibiotic Use in Animal Farming: An Estimation for Cattle, Chickens, and Pigs

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Background and objectives

Antimicrobial resistance (AMR) is a property of microorganisms achieving the capacity to resist the effects of the medicines created to neutralize them or prevent their development. Because of AMR, antibiotic and other antimicrobial active substances lose efficacy against the infections they are expected to treat. AMR can occur naturally, but it is also induced by antibiotic treatments on both humans and animals and is accelerated by the misuse and overuse of such substances (World Health Organization, 2020). The rapid increase of urban population worldwide boosts the global demand for food of animal origin and the animal farming industry (Mulchandani et al., 2023; Tiseo et al., 2020), which relies on massive use of antimicrobials for both therapeutic and non-therapeutic purposes, such as prophylaxis, metaphylaxis, and to promote animal weight growth. It is estimated that, at the global level, antimicrobial use (AMU) in farming largely overcomes the use for human healthcare (Patel et al., 2020; Van et al., 2020). Estimating AMU in animal farming is challenging because most countrieseither do not collect or do not release data on veterinary antimicrobials (Boeckel et al., 2015; Malijan et al., 2022). Moreover, there is no global surveillance system to monitor and regulate AMU in animalfarming (Price et al., 2015). Despite these limitations, Boeckel et al. (2015) estimated a global antibiotic consumption of 63,151 tonnes of active substances for cattle, chickens, and pigs in 2010.
For these species, Tiseo et al. (2020) estimated a global consumption of 93,309 tonnes of antibiotic active substances in 2017 and Mulchandani et al. (2023) attributed to the same animal groups, along with sheep, a consumption 99,502 tonnes of antibiotics in 2020. These studies are based on estimations on the average global annual use of antibiotics for each farmed species, in terms of mg of active substance per kg of animal biomass at treatment: one kg of animal biomass at treatment corresponds to one Population Correction Unit, or PCU (European Medicines Agency - EMA, 2022). Then they estimated, for each farmed species, the global PCU in the year, to calculate the global AMU, but without considering that for a given species (e.g., cattle), the different zootechnic categories(e.g., calves, heifers, cows, bulls, etc.) have different weight at treatment. The objective of our study isto produce a more accurate estimate of the global AMU that considers the different weight at treatmentof animal categories in the main farmed species.

Theoretical-methodological Approach

Our analysis is based on two principal data sources: the FAO statistics of the global stocks of farm animals and the global data from the Production, Supply, and Distribution (PSD) (PSD Online, 2023) The FAO database provides data on the total stocks (in animal heads) of the different farmed species covering all the world countries, but without distinguishing the livestock categories within the species (e.g. for cattle, there is no distinction between calves, heifers, cows, bulls, etc., but only the total heads). On the other hand, the PSD database covers the annual supply (i.e., beginning stocks + production) and distribution (i.e., ending stocks + slaughtering) of cattle and pigs of the most producing countries worldwide (44 countries for cattle and 38 for pigs) over 63 years, providing data on the stocks and flows of the different zootechnic categories. The two databases allowed us to estimate the distribution of the global heads of cattle and pigs in the different zootechnic categories of the two species. We set four categories for cattle, i.e., calves, heifers, cows, and bulls, and two categories for pigs, i.e., fattening pigs and sows. For these categories, the European Medicines Agency(EMA) has defined the standard average weights of animals at treatment (AWT) with antibiotics (EMA, 2022): 140 kg for calves, 425 kg for cows, 200 kg for heifers, 425 kg for bulls, 65 kg for fattening pigs, and 240 kg for sows. This is a critical piece of information to calibrate the global PCU calculation and the farm AMU assessment. Based on the PSD data, we found that in terms of heads of cattle, on average, the ratio between the annual supply and the annual stock in the 44 countries covered was 1.31 over the 2015-2019 period. For pigs this ratio was 2.72. These data allowed us to estimate the supply and the number of heads in the different livestock categories at the global level from the FAO data on global stocks. The following step was to calculate the global PCU by multiplying the number of heads in each category by the corresponding standard AWT. For chickens, the AWT is 1 kg, then we assumed that the FAO global production statistics (in heads) correspond to the global PCU. Finally, to calculate the global use of antibiotics from the estimated PCU, we made use of the average global dosages of antibiotics administrated to animals estimated by Mulchandani et al (2023) for the year 2020: i.e., 59.6 mg per PCU for cattle, 35.4 mg per PCU for chickens, and 173.1mg per PCU for pigs. Formulas 1 and 2 formally describe the above explanations.

$$\boldsymbol{PCU_{ij} \cong \sum_1^n TS_i \times P_{ij}\, W_{ij} = \sum_1^n (EN_i \times R_i) \times P_{ij}\, W_{ij}} \tag{1}$$

$$\boldsymbol{AMU \cong \sum_1^n PCU_i \times mg.PCU_i^{-1}} \tag{2}$$

where i is animal type, j is animal category, n is the number of categories, TS_i is the total annual supply of the animal, P_{ij} is the proportions of each weight category in the total supply, and W_{ij} is theAWT by animal category. EN_i is the ending stock of the animal each year. Factor R_i reflects the ratiobetween ending stock to the total supply of a certain animal type.

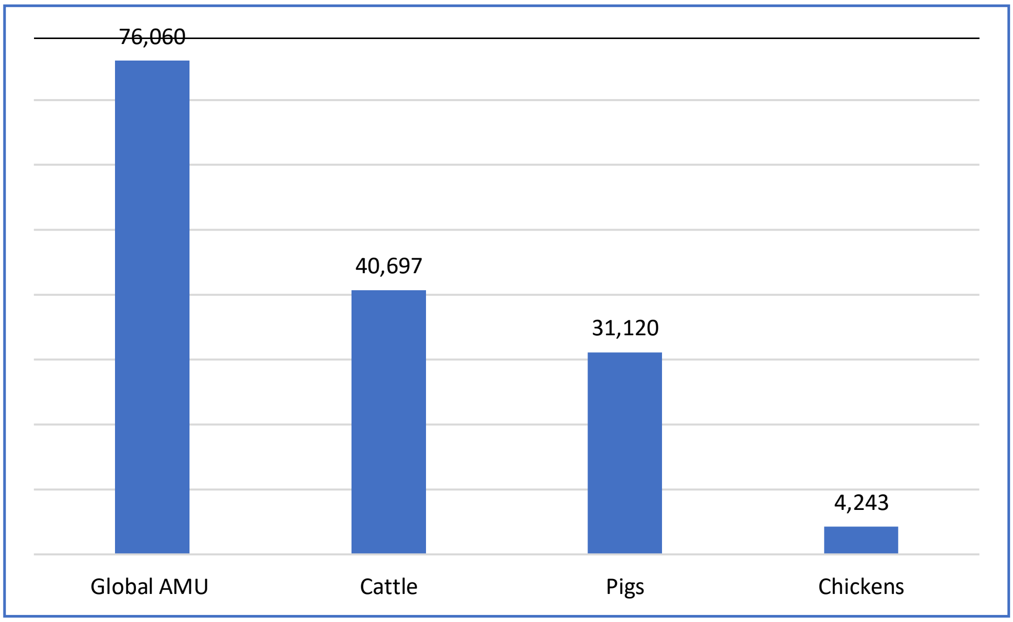
Results

We collected data on global heads of cattle and pigs from FAO for the last three years (data on stocks from 2019 to 2021) and converted them to the total supply. The total production of chickens gathered from FAO from 2019 to 2021 has been considered as its total supply (FAOSTAT, 2023). Based on our analysis, in terms of cattle heads, 41% of the global supply are cows, 29% are bulls, 26% are calves, and 4% are heifers. In pigs, 96% of the total heads in the global supply are pigs, and 4% are sows (Table 1). Figure 1 shows that, between 2019 and 2021, the average annual global AMU administered to the selected livestock species was 76,060 tonnes, of which 40,697 tonnes or 53.5% on cattle, 31,120tonnes or 40.9% on pigs, and 4,243 tonnes, or 5.6% on chickens. Our estimations are lower than those of Mulchandani et al. (2023), who reported a total of 99,502 tonnes of antibiotics used by the same animal groups plus sheep in 2020. Since we used the same mg per PCU for cattle, chickens, and pigs; this discrepancy is due to the different methods of calculating the PCU, which we adjusted for weight variations among the animals. To further explore this issue, we computed the PCU for cattle, chickens, and pigs in 2017 using the same methodology. By using the same coefficients of mg per PCU for cattle, chickens, and pigs in 2017, we estimated the global AMU at 73,291 tonnes, which is significantly lower than the 93,309 tonnes reported by Tiseo et al. (2020) in 2017 for the same animal species.

Table 1 – Quantities of AWT, P, and R; Source: (European Medicines Agency, 2022), and our elaboration from PSD (PSD Online, 2023)

Zootechnic categories	AWT (kg)	P (%)	R (ratio between global supply and global stock)
Cattle:	-	-	1.31
Calves	140	26	-
Cows	425	41	-
Heifers	200	4	-
Bulls	425	29	-
Chickens:	-	-	1
Broilers	1	100	-
Pigs:	-	-	2.72
Pigs	65	96	-
Sows	240	4	-

Figure 1 – Global AMU (tonnes) quantified in cattle, chicken, and pig farming; Source: own calculation.



Conclusions

AMR is a serious concern that increases the healthcare costs of treating infections. It is estimated that the global cost of resistant infections could reach up to 3.5 billion USD, annually (Hofer, 2019). Thus, precise monitoring of AMU in both humans and animals is essential for developing effective regulations and policies to prevent antibiotic-resistant infections. PCU is a widely used indicator for measuring and comparing AMU in animal farming across different countries. However, calculating PCU requires data on the number of animals by age or weight group, which is often not available at different levels of aggregation (global, national, etc.). In this study, we estimated the PCU of cattle and pigs using the PSD online database, which provides data on world supply and distribution for these animals. We derived a formula for PCU estimation that can be applied to any level of aggregation without the need for age-specific animal numbers. We used this method to estimate the global AMU for cattle and pigs. We compared our estimate with previous studies. According to our findings, the global AMU resulted significantly lower than the previous estimates, which may be related to the different method we used to attribute AWT to livestock categories in PCU calculation, since we used the same mg per PCU for each animal species. This demonstrates the importance of a more accurate consideration of AWT in estimating AMU on farms at the aggregate level.

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Consumer Preferences for Circular Economy Products: A Case Study in Italy

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PAROLE CHIAVE
Food choices, circular economy, consumer preferences, Discrete Choice Experiment

INTRODUCTION

The new Circular Economy Action Plan aims to foster sustainable growth by favoring those production models that preserve natural resources and, at the same time, generate new jobs (European Commission, 2020). Compared to the traditional linear economy models, circular economy minimizes waste while creating value-added products (Tunn, 2019). Agri-food supply chains, including the consumption stage, contribute to exploiting the environment with significant use of natural resources and waste production (Ritchie and Roser, 2020). Implementing sustainable production and consumption practices is necessary to reduce the burden of food production on the environment. Circular economy processes can be applied to the agri-food system by recovering and reusing materials otherwise wasted along the supply chain (Coderoni and Perito, 2020).

A transition from a linear economy to a circular economy should aim to involve all the stakeholders, including producers, researchers, and consumers, who might have an interest and a responsibility in the value creation system (Naziri *et al.,* 2014; Hamam *et al.,* 2021).

Recent is the literature on consumer preferences for circular economy food products, as most previous studies focused on electronic products (Parajuly *et al.,* 2020) or on fashion (Henninger *et al.,* 2020).

Aschemann-Witzel and Peschel (2019) Danish consumers' preferences of cocoa drinks which included protein obtained from potato starch production. They found that consumers did not perceive the potato protein-based cocoa drink more positively (nor better in quality) than the conventional alternative. Coderoni and Perito (2020) evaluated Italian consumers' purchasing intentions for value-added foods (waste to value (WTV)) deriving from olive oil production. Through interviews, they found that environmental sustainability, the origin, and the nutritional values of the products were driving the choices. In addition, they found that food neophobia and food technology neophobia negatively influenced the preferences for these products.

Grasso and Asioli (2020) explored UK consumers' preferences for biscuits made with upcycled ingredients using a hypothetical ranking experiment. Results indicated that most consumers were not familiar with upcycled ingredients, however, they would have considered buying foods with upcycled ingredients.

In this paper, consumer preferences for eggs obtained from a circular supply chain were explored. Laying hens are usually fed with calcium carbonate-based supplements of synthetic origin to improve their well-being and egg quality. In this case, supplements were obtained from sea urchins' waste, reducing the environmental impact.

A first hypothesis was that consumers characterized by higher food neophobia levels might be reluctant to consume food from circular supply chains as they consider it unconventional and unsafe. In addition, it was hypothesized that consumers who have a higher pro-environmental behavior might be more interested in buying circular economy products.

For this purpose, a Discrete Choice Experiment (DCE) was applied to study consumers' choice behavior.

METHODS

Data collection started in June 2023 through a nationwide online survey. A Bayesian optimal design was chosen for this study. For this reason, a pilot survey has been first distributed to 420 respondents, in order to obtain the priors for the second experimental design. The second experimental design is expected to be distributed by a survey panel provider to 1015 respondents in September.

Bayesian designs are used to obtain priors (i.e., estimates of betas), which provide information on how an attribute's parameter affects choice when all the other attributes' parameters are held constant (Jaeger and Rose, 2008). When the prior is positive, it means that the attribute increases choice probability, whereas when the prior is negative, the attribute decreases choice probability (Jaeger and Rose, 2008). The aim of Bayesian design is to add power to the performance of a model, by obtaining more behaviorally accurate distributions of WTP (Hensher *et al.,* 2005).

Only consumers older than 18 years old, not allergic to eggs, who bought eggs in the month before the survey were considered eligible. A final sample of 244 respondents was obtained.

The survey included a measure of Food Technology Neophobia (FTN) (Cox and Evans, 2008) and of Ethically Minded Consumer Behaviour (EMCB) addressing sustainability issues (Sudbury-Riley and Kohlbacher, 2016) to explore whether individual levels of FTN and EMCB affect choice behavior and the evaluation of circular economy product attributes. FTN might represent a barrier to the consumption of circular economy products. On the contrary, the EMCB scale evaluates consumers' behaviors that take into account environmental and social sustainability. These behaviors might instead be possible drivers of consumption of circular economy products.

The survey was made of a section with the FTN questionnaire (Cox and Evans, 2008), a section with a treatment informing consumers on the circular economy (visible only to half of the sample), a DCE on eggs, a section aimed at eliciting the main socio-demographic and economic characteristics of the respondents, and lastly, a section with the EMCB questionnaire (Sudbury-Riley and Kohlbacher, 2016). The presentation order of the questions within each section was randomized across respondents to avoid ordering bias.

The FTN questionnaire is a 13-item scale aimed at identifying segments of the population who might be unwilling to consume foods made using new technologies. Answers consist of a 7-point scale anchored ranging from disagree to agree.

The EMCB scale was developed to assess consumption choices concerning environmental issues. It is made of 10 items whose scoring method goes from (1) never true to (5) always true.

In the DCE section, respondents chose among a set of choice questions (choice tasks), each including two experimentally designed egg alternatives (buying options) and a no-purchase option (status quo). An information treatment was shown to on half of the sample in order to evaluate whether knowledge of circular economy could foster a preference for the circular economy attribute.

According to the literature, the most common attributes characterizing eggs are price, farming method, origin, size, eggshell colour, and yolk colour. Additional attributes might be nutritional or health claims or environmental attributes. The design included some of the most common attributes of eggs (price, farming method). In addition, a common nutrition claim for eggs was included, concerning omega-3 fatty acids, as well as two environmental attributes, namely the origin from a circular economy process and the production area. The attributes and levels used for this DCE design are illustrated in Table 1.

Data was analyzed by estimating a random parameter logit with an error component (RPL + EC) model with panel structure, as reported in Scarpa *et al.* (2005), and Scarpa *et al.* (2008).

Table 1. Attributes and levels

Attributes	Levels
Price (€ for a 6-egg box)	1.85-2.15-2.45-2.75-3.05
Circular economy	Circular supply chain / None
Farming method	Organic/Free-range/Cage-free
Omega-3	Rich in Omega-3 / None
Production area	Zero kilometers / None

PRELIMINARY RESULTS

The preliminary results show that considering the whole sample, all the attributes' coefficients are significant. The price attribute is negative, as expected, meaning that an increase in price leads to a lower choice probability. Surprisingly, the farming method also has a negative coefficient, meaning that cage-free eggs are associated with higher choice probabilities compared to organic eggs. In the same way, negative is the coefficient associated with the Omega-3 claim. Positive are the coefficients of the remaining attributes, namely circular economy and production area, with the latter coefficient higher than the former.

In addition, respondents with different EMCB scores are characterized by different socio-demographic and economic conditions. Considering gender, women seem to have an overall higher EMCB than men, consistent with previous literature. Furthermore, statistically significant differences could not be found associated with education; instead, considering previous literature, higher education levels were expected to correspond to higher EMCB levels.

Analyzing FTN, it was found that there is a statistically significant association with women, as seen in previous literature. In addition, FTN seems to increase with age. In past literature, evidence of this association is mixed.

The DCE results show that levels affect consumer evaluation of all three sustainability-related attributes (i.e., farming system, circular economy, and production area), especially regarding circular economy, which is more positively evaluated by consumers with higher levels of EMCB compared to those with lower levels. In addition, the preliminary results demonstrate that consumers express different choice behaviors depending on their level of EMCB. More specifically, consumers with lower levels of EMCB seem to attach more importance to the free-range and organic farming systems, followed by the production area, whereas the circular economy process is not significant. Consumers with higher levels of EMCB instead seem to have higher preferences for products that originate from a circular supply.

From the preliminary results, FTN seems to have a lower influence on consumer evaluation of the circular economy attribute. Indeed, both consumers with higher and lower FTN levels seem to appreciate more the farming system attribute, indicating that food neophobia does not seem to be associated with a rejection of food coming from circular supply chains.

More relevant is the impact of the circular economy treatment: consumers who were shown the treatment exhibited a higher preference for circular economy products compared to the control group whose survey did not include the circular economy treatment. The coefficient of the circular economy attribute was positive in both groups, but significant only for the group with the treatment.

CONCLUSIONS

The preliminary results show that EMCB has a key role in affecting sustainable food choices. For this reason, consumer segments with higher levels of EMCB (for example, those with a vegan or vegetarian diet) are more likely to consume circular economy products. Public policies should be aimed at developing a more profound EMCB in consumers in order to favour sustainable food choices among the population.

Furthermore, considering the results regarding the information treatment, campaigns aimed at increasing the level of knowledge of consumers might be effective in promoting not only the consumption of circular economy products but also more sustainable food consumption patterns overall.

It is important to consider that, being a pilot study, these results might not be confirmed when considering a larger sample. In addition, the identification of FTM and EMCB levels might not be accurate, as they are both evaluated through validated scales that assess stated behaviors. Indeed, consumers might incorrectly evaluate their behaviors.

Future studies might evaluate consumers' preferences for other categories of circular economy products or compare preferences for more than one product category in order to identify whether consumers' preferences for circular economy products vary depending on the food category considered.

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Measuring sustainability performances of Mediterranean olive ecosystems with Life Cycle approaches for SUSTAINOLIVE project

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KEYWORDS
Olive growing, Mediterranean countries, Ecosystem services, Life Cycle Methodologies, Environmental impacts, Socio-economic impacts.

INTRODUCTION
Mediterranean olive growing is an excellent model of the multifunctionality of agriculture in rural areas. It characterizes, identifies, and can sustain the socio-economic viability of rural areas, not only through the production of primary products, but also through the management of renewable natural resources, and the conservation of landscape and biodiversity. However, high levels of mechanization, monocultures, intensive farming techniques, and the use of synthetic pesticides and fertilizers are threatening the environment and affecting rural communities in turn. In the last years, the agroecological discourse emerged and evolved from a purely environmental and social concern to a transdisciplinary science merging agronomy, ecology, and socio-economic sciences.

This study presents some results provided by the international research project “SUSTAINOLIVE” (funded by the PRIMA programme and co-funded by Horizon 2020) and based on the implementation of Life Cycle Sustainability Assessment (LCSA) approaches to evaluate environmental and socio-economic performances of different olive farms (in Spain, Italy, Greece, Portugal, Tunisia, and Morocco) - by comparing “agro-ecological” (i.e., Sustainable Technological Solutions - STSs) and “ordinary” (i.e., non-STSs) management principles. SUSTAINOLIVE project aimed to find strategies for Mediterranean olive groves by integrating ecological, territorial, and socioeconomic knowledge, designing, and evaluating agricultural practices based on agro-ecological concepts, to devise more efficient and site-specific solutions, namely STSs. Based on the scientific knowledge about agroecology, the STSs tested on experimental olive farms have been co-defined with the farmers and are based on the use of natural resources and on closing biological cycles at the farm or local level, entailing the reduction of external inputs and the improvement in the quality and efficiency of use of internal inputs.

The project’s activities wanted to test if and how this improvement may be achieved through a combination of management and strategic actions in olive farming systems, through the implementation of LCSA methodologies (De Luca et al., 2017) - Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Social Life Cycle Assessment (SLCA) - to assess the sustainability impacts of the Mediterranean olive growing from the “cradle” (the planning phase) to the “grave” (the disposal phase). For the purpose of this study, the ISO (2021) standards are used as a reference to describe four different and iterative steps to conduct the different life cycle analysis as an umbrella procedure to homogenize the evaluations: 1. Goal and scope, for the definition of the system boundaries, the foreground and background systems, the choice of cut-off and allocation criteria and Functional Unit (FU), the measuring unit to which refer all impact to compare different scenarios; 2. Life Cycle Inventory, the collection of quantitative and qualitative data, inbound and outbound flows of energy, materials and emissions; 3. Impact assessment, the environmental characterization models that allow estimating midpoint and endpoint impact such as ReCiPe2016, LC-Impact and Impact World+; 4. Interpretation of results, identifying, checking, and comparing information from the results obtained to draw conclusions and recommendations in an exhaustive and comprehensive way.

MATERIALS AND METHODS

Farms were selected as study cases of the project according to their suitability to respond to the SUSTAINOLIVE experimental design, and therefore the selection included olive farms as business as usual, and others that were similar (comparable in terms of surfaces, plant age and density, yields, pedoclimatic conditions), but using agroecological practices (STSs). Therefore, similar STS and non-STS olive farms from Greece, Italy, Morocco, Portugal, Spain, and Tunisia, were selected choosing typical ordinary olive groves (business as usual), and comparable olive farms with combinations of specific agroecological management practices implemented during at least the past 8 years. By applying LCSA methodologies, the sustainability performances of contrasted models of olive cultivation, representative of business as usual (nSTS) and agroecological models (STS) have been delineated. The following criteria have been focused on: a) the choice of an epistemological perspective, framed within the paradigms of post-positivism, i.e., in the search for causal relationships between olive growing systems and possible impacts on society, the economy and the environment through quantitative methodologies, i.e., Life Cycle approaches; b) the delimitation and sizing of the survey, context, and spatial-temporal scope. Data gathered were referred to the last 5 years of production (from 2017 to 2021 included), to retrieve average data and overcome eventual fluctuations due to external constraints (weather, productive cycles, market fluctuations); b) the definition of the analytical method to be applied, i.e., the choice of the data to be collected and the most suitable tools for collecting, processing, and summarising the information. The survey instrument chosen is the semi-structured questionnaire, to collect quantitative and qualitative data, organised in thematic sections according to a logical sequence, to guide the respondents in their compilation.

For the survey on olive farms, 59 qualified technicians from olive farms involved in the SUSTAINOLIVE project were selected, i.e., 6 Portuguese farms, 16 Spanish farms, 7 Moroccan farms, 11 Tunisian farms, 9 Italian farms, 10 Greek farms; direct interviews were carried out during 2022, by interviewers appropriately instructed and trained to collect data qualitatively in a univocal manner in all the countries involved and to ensure a high level of quality data. The STSs under study for the Life Cycle analysis have been selected according to results of other SUSTAINOLIVE activities by which a characterization of the diversity of conditions under which olive groves are cultivated, in terms of diversity of agronomic management practices, the pedo-climatic conditions, ecological landscapes have been provided (Table 1, Figure 1). To test agroecological practices to improve the sustainability of Mediterranean olive groves, the previously described STSs have been implemented in the study cases (in real farms involved in the partnership) and LCSA has been set up to assess their performances, the same methodologies have been chosen to be combined (Table 2) because of their ability to grasp the bridge between natural and social sciences providing appropriate knowledge about the sustainability of agroecosystems and information for monitoring and policy making.

Table 1 - Sustainable Technological Solutions (STSs) in SUSTAINOLIVE project

Agroecological practices	Sustainable Technological Solutions
Cover crops (spontaneous or seeded)	*Temporal spontaneous or seeded cover crops* provide synergistic advantages including: i) decrease in soil loss, and subsequent decrease of nutrient and organic matter, and water runoff, ii) intra-cycle nutrient retention and N inputs being promoted, iii) habitats for the control of pests and diseases and improved winter quarters and breeding range for birds, iv) improved rates of chemical and physical parent material weathering, v) improved soil water infiltration and (if adequately managed) soil water availability, vi) improved soil fertility, organic matter and C sequestration, among others. In addition, seeding cover crops can also help reinforce the following ecosystem services: i) fix atmospheric N (legumes), ii) cover the soils with their residues or serve as fodder for sheep (wild grasses), and iii) indirectly perform pest control (cruciferous).
Livestock integration	*The integration of olive farming and livestock production* is environmentally beneficial because it includes effective weed control with a low risk of erosion, fertilisation without external inputs, and the maintenance of important biodiversity and landscape values.
Tree pruning and residues management	An adequate pruning regime (intensity and frequency) is key to guarantee a high level of stable olive production and to prevent pests and diseases. Chipping and soil incorporation of the tree pruning residues as mulch is an environmental management practice which promotes N and C retention and recirculation and provides habitats for microflora, and micro, macro and mesofauna, increasing olive farming biodiversity.
Locally available organic fertilization	Positive effects are widely acknowledged of using organic fertilization (manure and other locally available processed by-products of the olive mill industry, such as composted olive mill pomace) on improving some ecosystems services such as i) nutrient retention and synchronization between nutrient supply and demand, reduction in nutrient loss and, consequently, in environmental pollution (e.g. nitrate leaching), ii) biodiversity protection, and iii) closing the loop of nutrient cycles at landscape scale.
No chemical treatments	STSs include combinations of spontaneous and seeded cover crops, green manuring, composting and reduced tillage practices, among others. The expectation is that the combination of this management will significantly contribute to an effective reduction of chemical fertilisation, compensated by an increase in nutrient retention, a decrease in nutrient loss via soil erosion, and increased levels of N inputs from either wild or planted legumes in the cover crops or by other locally recycled nutrients from composted OM pomaces and struvite. Also, by using mechanical or livestock-based alternatives for weed control, the use of herbicides shall be reduced.

Source: authors' elaboration.

Figure 1 - Combinations of management practices in SUSTAINOLIVE experimental farms.

Source: authors' elaboration.

Table 2 - LCSA Methodological framework for sustainability assessment.

Methodological step	LCSA		
	LCA	LCC	SLCA
Goal and scope	Evaluating environmental loads generated from specific STSs scenarios by characterising and quantifying the impacts in a mid-term and long-term perspective. Allocation procedure: economic allocation.	Evaluating the economic performances of STSs and comparable non-STSs to identify bottlenecks in the adoption of sustainable strategies. It will identify and quantify the main cost items, but also financial indicators of investment, throughout the life cycle stages	Assessing the social performances of olive farms, in terms of well-being, with and without STSs in terms of psychosocial risk factors (PRF) i.e., the hours of potential exposure to working conditions that can lead to health problems.
Inventory data from primary and secondary sources	Secondary data: Eco-invent V. 3.5, Agri-footprint, and World Food LCA databases IPCC (2019) for the estimate of N_2O, Brentrup et al. (2000) for the estimate of nitrate leaching, etc. Primary data for background processes, about fuel, lubricant, energy, fertilisers, pesticides, and capital goods production, as well as wastes process.	Main cost items, financial data of investment, classified as initial costs, periodical maintenance costs, operational costs and end-of-life disposal costs or residual value.	Working hours needs per each farming operation, characteristics of the tasks, postures, and exposures of workers.
Impact assessment	ReCiPe (Huijbregts et al., 2017) assessment method using SimaPro software.	Internal costs: specific economic and physical parameters. Investment analysis: Discounted life cycle cost (DLCC), Net Present Value (NPV), Internal Rate of Return (IRR), Gross Margin (GM) and Payback Period (PBP).	Psychosocial Risk Factors impact pathway (SLCA type II). Impact categories: Cancers, cardiovascular diseases, deficiencies, metabolic disorders, musculoskeletal disorders, neurological diseases, psychological problems, respiratory diseases.

Source: authors' elaboration.

RESULTS

Scenarios were analysed for all countries and farms involved in SUSTAINOLIVE, in terms of impact per kilogram of olives produced. In Tables 3 and 4 the main structural, technical, and agronomic characteristics of the sampled farms are provided in terms of average values for STS and nSTS groups for each country. Subsequently, the impact results were normalized and compared across all scenarios both in terms of normalized impact per ha per year and in terms of normalized impact per kg of olives produced. Finally, for the most impactful nSTS scenario and the most impactful STS scenario, a contribution analysis of the impacts with respect to the full production phase was performed.

Table 3 - Main characteristics of SUSTAINOLIVE farms.

Country		**Greece**		**Italy**		**Marocco**		**Tunisia**		**Portugal**		**Spain**	
		nSTS	*STS*	*nSTS*	*STS*	*nSTS*	*STS*	*nSTS*	*STS*	*nSTS*	*STS*	*nSTS*	*STS*
No. of Farms (59)		5	5	4	5	3	4	5	6	3	3	5	11
Farm size (ha)		225.0	225.0	32.5	40.5	4.0	12.5	84.0	140.0	470.0	359.3	155,0	582,
Olive grove size (ha)		2.3	1.8	24.3	24.7	2.6	8.9	45.2	74.7	94.2	80.7	54,0	503,
Olive plot size (ha)		1.3	5.0	6.4	3.9	2.6	8.9	15.3	17.3	47.2	10.1	7,7	18,9
Slope	*Plain*	40%	40%	50%	40%	75%	25%	100%	100%	100%	100%	50%	33%
	Hill	60%	60%	50%	60%	25%	75%	-	-	-	-	50%	45%
	Mountain	-	-		-	-	-	-	-	-	-	-	22%
No. trees/ha		155	147	174	198	100	105	82	157	1,067	658	199	142
Plantation system	*Trad*	80%	80%	100%	80%	100%	75%	100%	83%	33%	66%	50%	55%
	Int	20%	20%	-	20%	-	25%	-	17%	-	-	50%	45%
	SuperInt	-	-	-	-	-	-	-	-	66%	33%	-	-
Production mode	*Conv*	100%	100%	75%	-	100%	50%	20%	-	66%	-	25%	-
	Integ	-	-	25%	20%	-	25%	-	-	33%	33%	75%	55%
	Organ	-	-	-	80%	-	25%	10%	100%	-	66%	-	45%
	Biodyn	-	-	-	-	-		-	-	-	-	-	-
Irrigation		90%	100%	25%	20%	-	75%	40%	83%	66%	33%	50%	77%
Subsidy (€ ha^{-1})		400	533	520.5	456	-	-	-	-	116	629	375	434
Average no. of tractors/ha		0.04	0.04	0.25	0.22	rental	rental	0.08	0.16	0.002 partial rental	0.02	0.07	0.07

Source: authors' elaboration.

Table 4. Main characteristics of SUSTAINOLIVE farms.

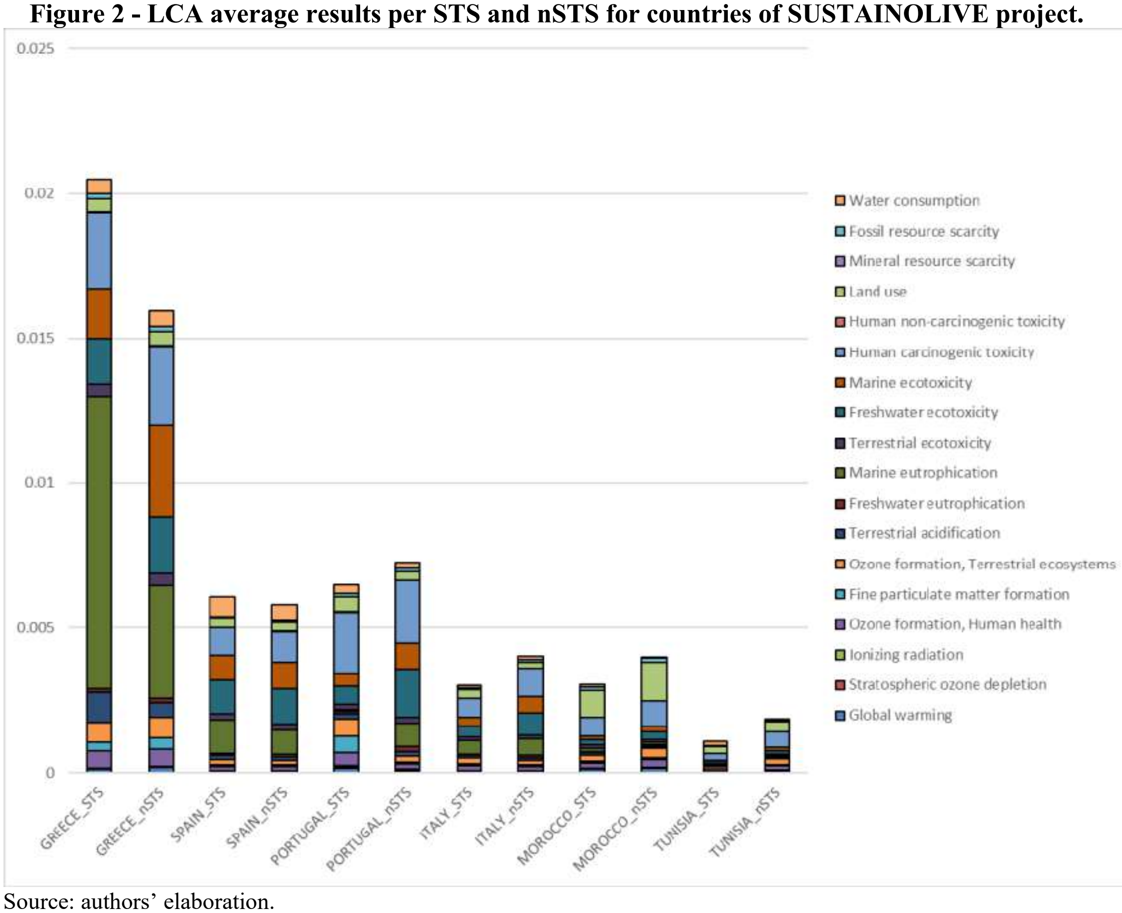
Agricultural operations		**Greece**		**Italy**		**Marocco**		**Tunisia**		**Portugal**		**Spain**	
		nSTS	STS	nSTS	STS	nSTS	STS	nSTS	STS	nSTS	STS	nSTS	STS
No. of Farms (59)		5	5	4	5	3	4	5	6	3	3	5	11
Weed control	*Chem*	-	-	50%	-	-	-	-	-	66%	-	-	17%
	Mech	100%	100%	25%	100%	100%	100%	100%	100%	33%	100%	25%	55%
	Chem + Mech	-	-	25%		-	-	-	-	-	-	75%	33%
Shredding	*average presence*	100%	100%	50%	100%	-	-	-	-	-	100%	25%	77%
	no. per year	1,25	1	2	2	-	-	-	-	-	3	-	2
Tillage	*average presence*	-	-	50%	-	100	100	100%	100	-	33%	75%	
	no. per year	-	-	2	-	1	1	3,6	3,6	-	1	2	-
Grazing	*average presence*	-	-	-	20%	-	-	-	17%	33%	33%	-	22%
	no. per year	-	-	-	1	-	-	-	-	-	continuos	-	1
Chemical weed control	*no. per year*			3						3		1	1
	product			Glyphosate						Fluroxipir, Glyphosate		Glyphosate, Flazasulfuro	Diflufenican, Glyphosate, Flazasulfuron
	average presence	100%	100%	100%	80%	66%	100%	-	17%	66%	100%	100%	100%
Fertilization	*chemical*	100%	-	75%	-	-	-	-	-		33%	100%	50%
	product	Ternary		Organic-mineral		-	-	-	-	Ternary	Phosforo	Ternary, Ammonium nitrate, Potassium nitrate	Ternary
	organic		100%	25%	80%	66%	100%		17%	100%	77%	-	50%
	product	-	Chiken manure Olive mill leaves residues/compost Compost	Manure	Compost, Cow manure	Manure	Manure, Cover crops (50%)	-	Cover crops	Cover crops (33%)	Sheep manure, Compost	25% Manure	Fresh olive pomace, Equine manure, Olive leaves, Compost
Phytosanitary control pest		100%	60%	100%	60%					66%	66%	75%	75%
Product		Pyrethroid 2.5%, Acetamiprid 20	Natural pyrethrin 5%	Acetamiprid, Deltametrina,	Spinosad	-	-	-	-	Fosmet, Deltametrine	Bacillus, Spinosad, Pheromone traps	Deltametrin, Acetamiprid	Deltametrine, Spinosad, Trap

Number of operations per year		2	2	-	5	-	-	-	-	3	1,5	1 at soil	1
Phytosanitary control for fungal diseases		100%	100%	50%	40%	-	-	-	-	100%	33%	100%	100%
Product		Copper	Copper	Copper	Copper	-	-	-	-	Copper, Dodine, Trifloxistrobina, Difenoconazolo	Copper	Copper	Copper
Number of operations per year		2	2	2	4	-	-	-	-	3	5	1,5	2,1
Pruning management	Shredding	80%	100%	100%	100%	-	-	-	33%	100%	66%	100%	100%
	Burned	20%	30%	-	40%	100%	100%	-	-	-	33%	-	-
	Other	0	0	-	-	-	-	100% Feeding of animals and charcoal	50%	-	-	-	-
	Specific use	-	-	-	-	-	-	-	17% (Animal feeding)	-	-	-	-
Harvesting		Manual (with sticks)	-	60% Mechanical, 20% Semi-mechanical, 20% Manual	-	Manual	-	Manual	-	Mechanical	-	Mechanical	-
Average production per hectare (kg ha^{-1})		3,416	2,579	6,750	5,920	2,210	3,028	4,248	6,296	5,600	4,066	5,380	5,568

Source: authors' elaboration.

Regarding LCA results, i.e., in terms of environmental loads generated from STS and nSTS farms, data show that in the case of assessments of Greek scenarios per kg of product, analyses showed better performance for STS in almost all impact categories, with the exception Ozone formation - Human health, Terrestrial acidification and above all Marine eutrophication (Figure 2). The impacts related to this last indicator cause the STS scenarios to perform worse than the nSTS scenarios. This result is related to the organic fertilisation carried out in three of the five STS farms, which due to the high amount of nitrogen units causes potential impacts due to nitrate leaching. Analyses of the Spanish scenarios show that, on average, there is no clear predominance of STS over nSTS in environmental terms using 1 kg of product as the Functional Unit. The slight advantage of nSTS scenarios is dictated by the higher yields. In all other national contexts analysed STS scenarios are always better than nSTS scenarios. It should be noted that both Tunisia and Morocco show an increase in impacts due to water depletion but, nevertheless, the STS scenarios are still better. This is because the use of irrigation water in some STS scenarios allows a significant increase in yields.

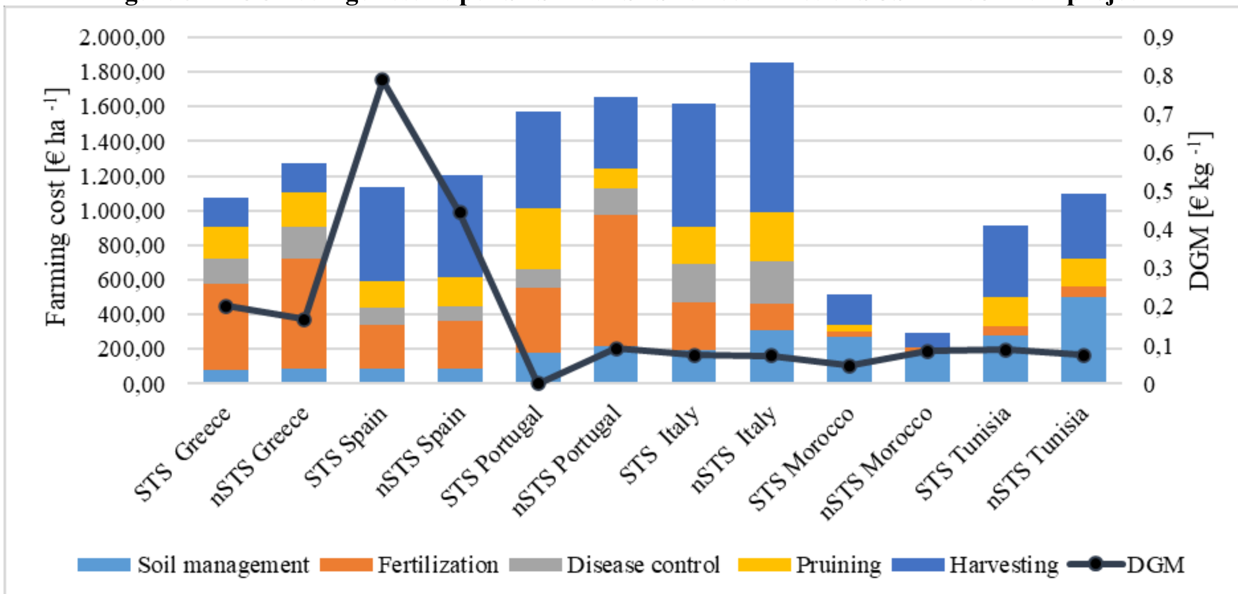
Figure 2 - LCA average results per STS and nSTS for countries of SUSTAINOLIVE project.



Source: authors' elaboration.

In terms of LCC results, i.e., economic olive grove performance, Figure 3 shows that in Greece, Spain, Portugal and Italy, STS farms have a lower cost of production due to the use of low-cost inputs (e.g., for fertilisation, use of compost, manure, and pomace) and the performance of some no-cost cultivation operations, such as soil management with grazing. Morocco and Tunisia have an overall lower cost of production than the other countries. In these two cases, however, the most expensive production processes are STS practices and the highest outputs. In terms of DGM gross margin, expressed per kg of olives, the results are very similar between STS and nSTS, for all countries except Spain and Portugal. In the former case, the best performance is obtained by STS scenarios, in the latter by nSTS.

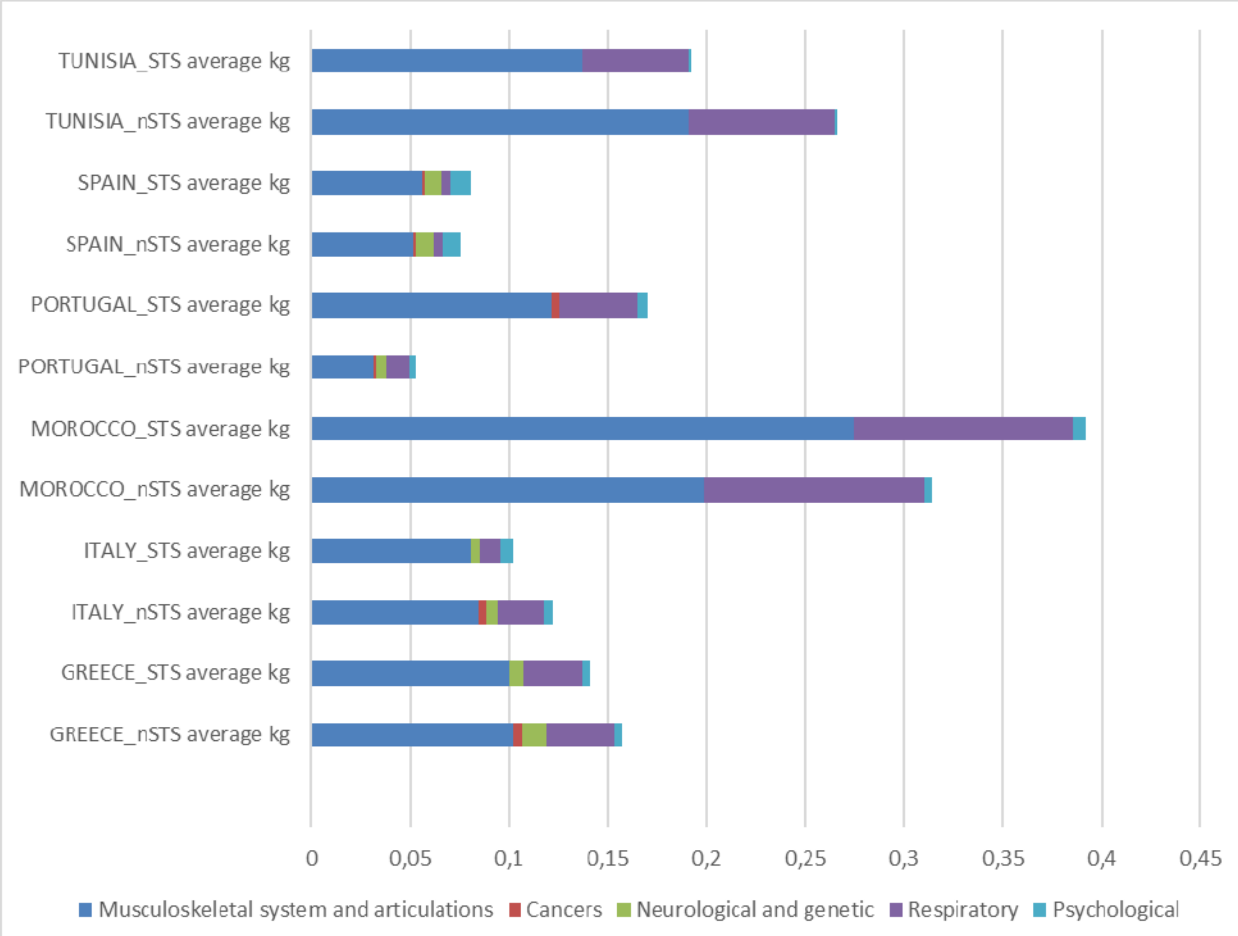
Figure 3 - LCC average results per STS and nSTS for countries of SUSTAINOLIVE project.



Source: authors' elaboration.

Concerning the evaluation of social impacts deriving from the product life cycle, the Psychosocial Risk Factors impact pathway PRF-IP (Iofrida et al., 2019), a postpositivism-oriented SLCA methodology (type II according to UNEP, 2020), is being applied, because it allows to make an objective assessment of potential impacts directly linked to inventory inputs. In absolute terms, when comparing all farms per all countries (Figure 4), the farms with the highest quantitative impacts in all categories, in hours/kg of olives are from Morocco, followed by Tunisia. This is because most of the operations are manually conducted, harvesting above all. Looking at the specific impact categories, in these countries "Musculoskeletal systems and articulations" and "Respiratory disorders" are the most evident. However, the potential risks linked to diseases with mortal course are totally absent because synthetic pesticides are not applied. Concerning the best performances, summing all the impact categories per typology, the following average scenarios are the best: i) Musculoskeletal system and articulations: Moroccan nSTS farms; ii) Oncological diseases (cancers): Moroccan and Tunisian STS and nSTS FARMS (totally absent); iii) Neurological and genetic diseases: Moroccan and Tunisian STS and nSTS FARMS, and Portuguese STS farms (totally absent); iv) Respiratory disorders: Spanish STS farms; v) Psychological disorders: Tunisian nSTS farms.

Figure 4 - Social LCA average results per STS and nSTS for countries of SUSTAINOLIVE project.



CONCLUSIONS

This study presents some results from the LCSA analysis carried out for sustainability assessment within the international project SUSTAINOLIVE, to evaluate the environmental and socio-economic performances of different Mediterranean olive farms by comparing "agroecological" and "ordinary" management principles. The assessment of multiple sustainability dimensions is as complex and intricate as the ecosystem processes that are involved. This is particularly true in olive-growing agroecosystems, which are strongly linked to economic viability and quality of life in Mediterranean rural areas. In general, environmental impacts of olive cultivation showed a great variability across the Mediterranean basin and they tended to be lower in North African (Tunisian and Moroccan) olive groves. Much higher levels of mechanization and fertilizer and plant protection products application together with more irrigation were the main factors/management of higher environmental impacts of EU oil-producing countries. Overall, the implementation of STS (e.g., cover crops, shredded tree pruning, manure or composted olive mill application, livestock integration) reduced the impacts. Indeed, the environmental impacts of the nSTS EU olive farms were on average 85 % higher than that of the STS farms when expressed per hectare. Impacts on marine and freshwater toxicity and freshwater eutrophication were reduced on average by around two times whereas impacts on mineral resources by four times under STS. This was not the case for North African countries where the impacts of the nSTS farms were like the STS farms. This was since none or very few fertilizers and/or plant protection products, no irrigation and a low level of mechanization were verified in both nSTS and STS olive farms.

Despite the environmental impact of olive cultivation in North African olive farms being significantly lower compared to EU olive oil-producing countries, the health risks were typically the highest. This was mainly due to the higher number of hours exposed to the considered health risks. This was because of the low or very low mechanization level of the Tunisian and Moroccan olive farms as most of the operations are manually conducted, especially harvesting.

Olive harvesting, along with pruning operations, is the most important practice in the management of an olive grove. This is because the quantity and quality of the product, the production costs and, consequently, the economic results of the farm depend on the harvesting method and its timeliness. Traditional olive groves, which still characterize the olive-growing areas of the country, have centuries-old trees, irregularly arranged or at least with low-density planting patterns that do not allow a high level of mechanization, as intensive and super-intensive models do. Manual harvesting is a long-lasting operation; the use of semi-manual tools or mechanical shakers can reduce the exposure of many workers to musculoskeletal disorders, shifting the problem toward other kinds of risks, but in less time. Furthermore, modern tractors have improved ergonomics that allow workers to drive more comfortably and safely.

A difficult trade-off exists between the best performances in terms of impact on climate changes, economic constraints, and dangerous exposure to risks of agricultural operations. In relative terms, however, results show that farmers should take advantage of the opportunities provided by STS agroecological practices to make their productions more resilient. LCSA approaches provided a holistic and multiperspective assessment of the sustainability of different models of olive farming, contributing to improve the effectiveness of farm processes, also by the co-construction of novel knowledge that can be useful to key actors in the olive oil sector.

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Measuring Shopping-Out for Food in Italian Remote Areas. A Natural Experiment

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KEYWORDS
Remote Areas, Food Consumer Behavior, Natural Experiment, Shopping-Out

INTRODUCTION

In many high-income countries people living in remote areas have higher proportion of total food expenditure compared to people living in urban areas. Several hypotheses have been proposed to explain this circumstance. There is a consistent literature concluding that households in remote areas with high transportation cost have some issues with food availability (including less variety and lower-quality fresh produce and meat compared to suburban and urban stores) and affordability (food prices can be higher than the average national prices) (Kaufman, 1998; Beaulac et al. 2009; Whelan et al., 2018). Several studies had measured store prices for reference food baskets and found significant differences in prices between remote areas and urban areas. This difference was defined as "remoteness premium", meaning that households pay a price premium on food for the mere fact of living in remote areas (Dawson et al. 2008; Cummins et al. 2010; Hirsch et al. 2013; Hirsch et al. 2016; Dumfries and Galloway Citizen Advice Service 2015; 2017; Hirsch et al. 2013; Tsang et al. 2007; Palermo et al. 2008; Beaulac et al. 2009; Ward et al. 2012; Pollard et al. 2014; Ferguson et al. 2016; Bardenhagen et al. 2017; Naylor et al. 2020). In particular, the lack of access in remote areas to low-price food sources like discounter is considered as one of the main drivers of the remoteness premium (Marshall et al., 2018). According to Laraia et al. (2004), residents of these same neighborhoods in the rural areas tend to consume fewer fruits and vegetables, and often have a greater BMI (Body Mass Index) than do residents of affluent areas. This may be the consequence of reduced availability of low-price healthy food in remote areas (Shanks et al, 2015). In fact, Dawson et al. (2008) pointed out that availability and affordability of healthy food is affected by the presence of medium and large stores in the area.

In remote areas, food sources are not evenly distributed; there are areas of concentration and areas where few or no large retailers or even grocery stores exist (Morton et al., 2005). In this regard, shopping-out (i.e., purchasing food from retailers located outside local municipalities) is a key strategy to attenuate the consequences of high food prices and limited availability. Travelling to other areas for food shopping, households have access to a variety of food sources and are able to combine a more efficient food basket.

Nevertheless, shopping-out practices may have a negative impact as well. They increase competitive pressure in remote areas, reducing profit margins of local business. In fact, households in remote areas face a typical arbitrage problem. If the cost of traveling is lower than the price difference between the local stores and large retailers in other areas, shopping-out is profitable. The resulting equilibrium discriminate between households with high transportation costs suffering from high-prices and reduced availability at local stores and households with low transportation costs engaging in shopping-out.

This economic process has a dynamic component. The loss of small grocery stores in remote areas due to the competitive pressure from shopping-out practices increase the distances that residents must travel to obtain food (Bardenhagen et al., 2017; Beaulac et al., 2009). This is particularly critical for low-income families who are more likely to shop less frequently due to less independent access to a vehicle and lack of public transportation. The result is a vicious circle of shopping-out leading to loss of local store and higher local prices, leading to more shopping-out (Bailey, 2010; Whelan et al., 2018).

The dynamics of the shopping-out process shows the importance of this practice for the sustainable development of rural areas. Our research contributes to the academic discussion about shopping-out in remotes areas, by providing a measure of the practice in remote areas of Italy. The objectives are i) to assess if shopping-out is an important practice to ensure access to large retailers in remote areas and ii) to describe the possible consequences of limitations in the shopping-out practices.

Our research provides important insights into the possible support measures in favor of local stores in remote areas, such as limitations of new opening of large retailers or other forms of limitation of competition in the retail sector.

METHODOLOGY

Because shopping-out practices are not observable, we estimate their intensity and effects by comparing consumer behavior in situations when shopping trips are possible and when they are not possible (or, at least, highly discouraged). Holding everything else constant, the difference can be attributed to shopping-out. In this paper we use the COVID-19 lockdown as the state of nature when shopping trips were not allowed. We compare the behavior of Italian households during the lockdown with the data from a period of free circulation to observe possible differences.

Because COVID-19 impacted on consumer behavior in many ways beyond just restriction to movement (including increased stress and anxiety, health concerns, change in eating habits) the following actions were taken in order to reduce the effects of confounders in the analysis. Firstly, a difference-in-difference analysis was performed, comparing the results from Italian remote areas (“aree interne” according to ISTAT definition) with results from other areas in Italy. Under the assumption that other factors affected households in remote and non-remote areas alike, we use households in non-remote areas as control group and households in remote areas as treatment group. Secondly, we compare data from the lockdown period (March 9 – May 3, 2020) with data from exactly the same months in 2019, in order to control for seasonality effect and for possible permanent changes in habits after COVID-19.

We applied this approach to the ISTAT dataset of “Indagine sulle spese delle famiglie” from 2017 to 2020. The dataset reports food expenditure of Italian households by product and type of outlet (from family store to hypermarket) but it does not report the location of purchase.

In order to investigate shopping-out, we test two hypotheses:

1. During the lockdown, purchase from large retailers (supermarkets, hard-discount and hypermarkets) decreased more in remote areas than elsewhere. This test allows us to assess the importance of shopping out practices in ensuring access to low-price, large assortment outlets for remote-area households.
2. During the lockdown, the consumption of healthy food (namely, fruits and vegetables, fresh fish and meat) in remote areas was relatively smaller than in non-remote areas. We use this test to infer about the role of shopping-out in determining affordability and accessibility to healthy food baskets.

RESULTS

ISTAT dataset reports the type of stores Italian households visited during the survey period using a 7-item classification: Traditional shops, Markets and peddlers, Hard discounts, Supermarkets and Hypermarkets, Malls and chain stores, On farm retail, Online stores. We compute the empirical probability (relative frequencies) that a household shop at a given store type and the empirical probability that a household did shop neither at a hard discount nor at a supermarket (No large retailers). Table 1 reports the relative frequencies. The data refer to the period from March to June of each year, so that the 2020 data cover the lockdown period and the data from previous years are comparable.

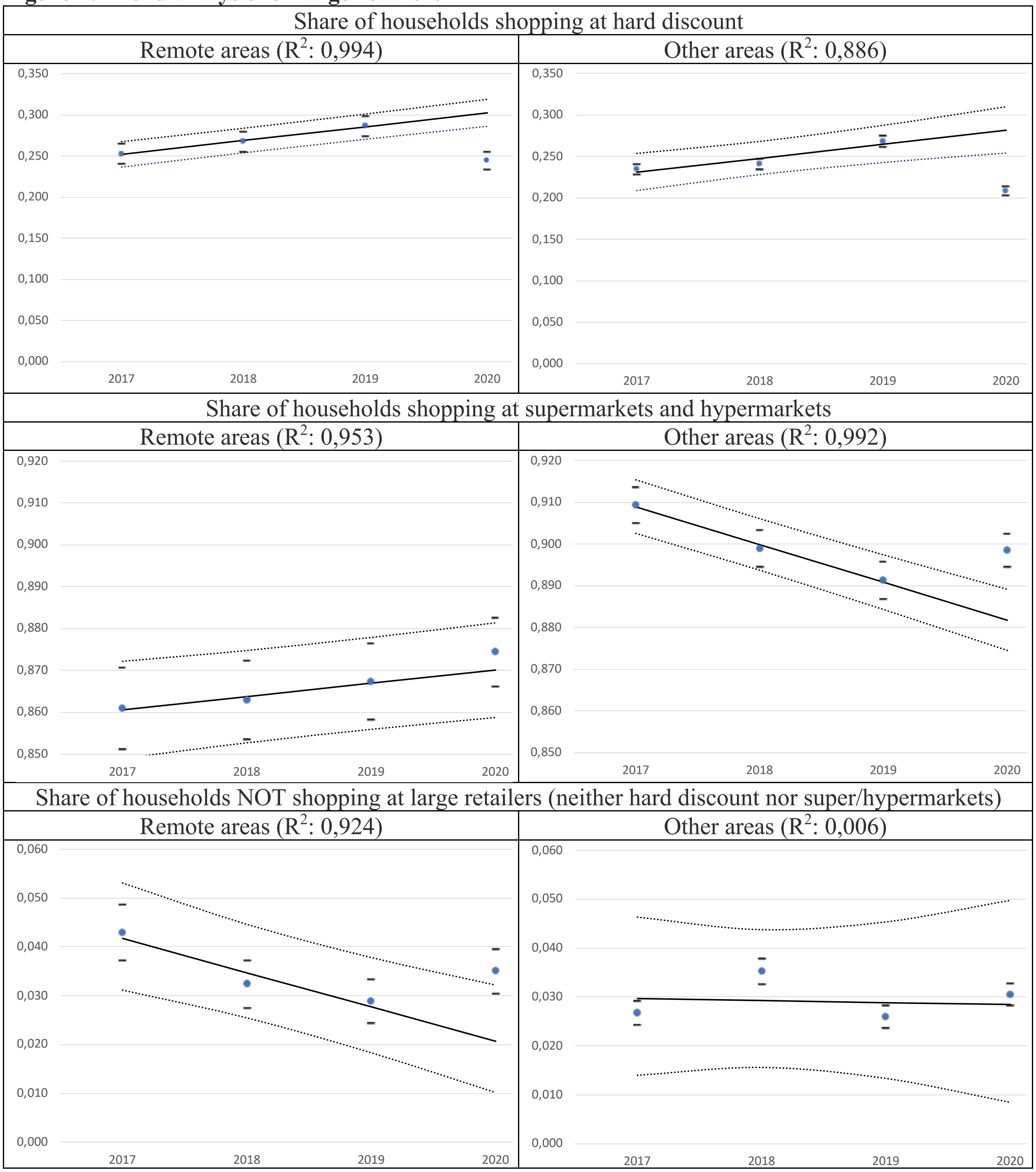
Table 1: Share of households by purchasing channel.

	Remote areas				Other areas			
Year	2017	2018	2019	2020	2017	2018	2019	2020
N. of households	1259	1328	1387	1628	4340	4744	4822	5739
Traditional shop	0,809	0,733	0,728	0,613	0,679	0,626	0,616	0,496
Markets and peddlers	0,278	0,229	0,240	0,130	0,222	0,199	0,178	0,097
Hard discount	0,253	0,267	0,286	0,244	0,234	0,241	0,268	0,208
Super & Hypermarkets	0,861	0,863	0,867	0,874	0,909	0,899	0,891	0,899
Malls & chains	0,056	0,038	0,044	0,035	0,049	0,045	0,043	0,028
On farm	0,100	0,110	0,102	0,053	0,097	0,088	0,083	0,040
Online	0,010	0,006	0,012	0,013	0,007	0,008	0,009	0,015
No large retailers	0,043	0,032	0,029	0,035	0,027	0,035	0,026	0,030

The large majority (more than 85%) of households in rural areas shops at super and hypermarkets. More than 95% of households in remote areas shopped at large retailers. Like other studies in rural Europe, our estimates confirm that the supermarket revolution reached even remotes areas of Italy (e.g., Revoredo Giha & Russo 2022).

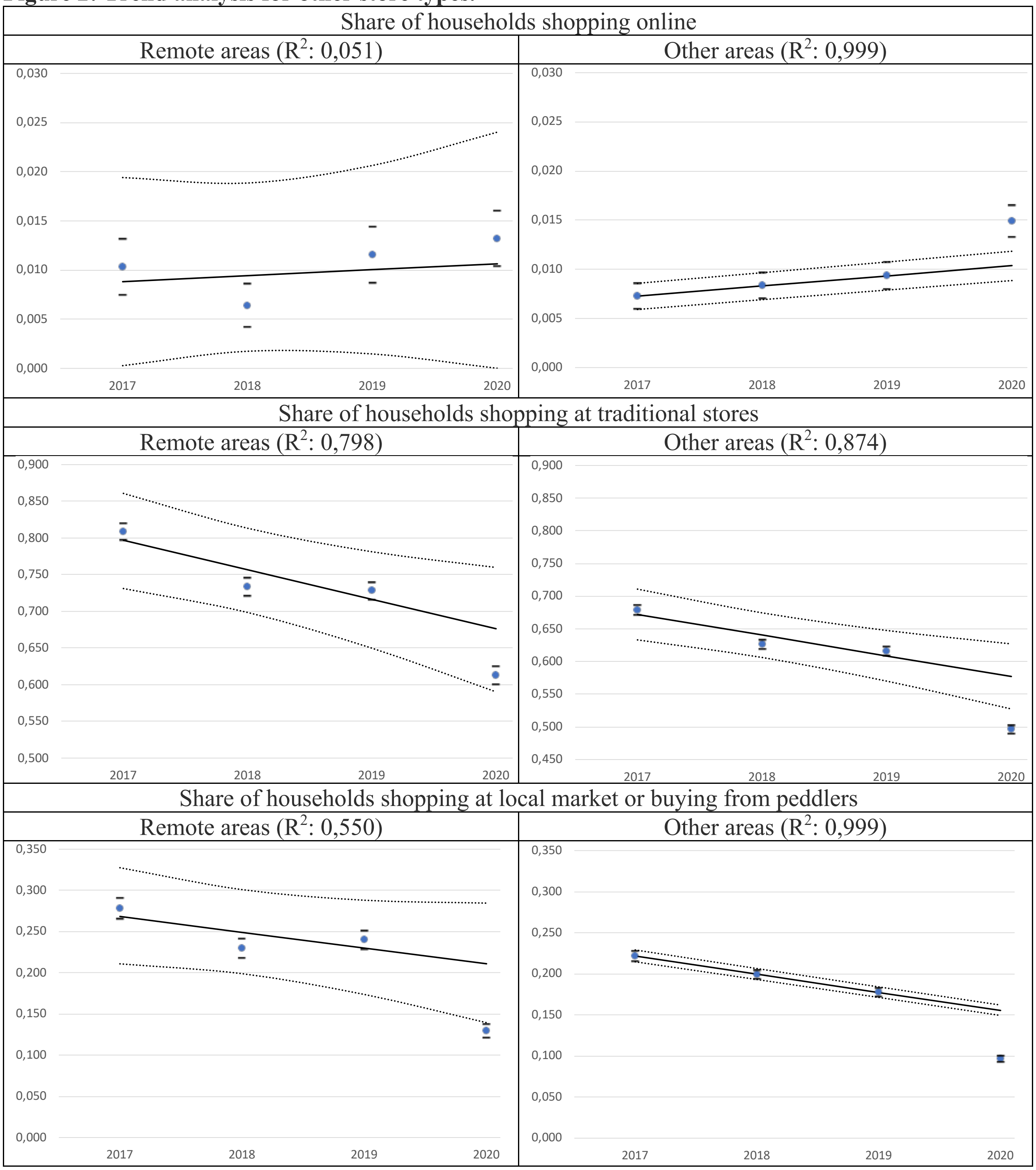
The COVID-19 lockdown can be used as a natural experiment to measure the role of shopping-out in granting access to large retailers. In fact, if shoppers in remote areas must travel far to access large retailers, a decrease in the share of households using large retailers is expected during lockdown.

Figure 1: Trend analysis for large retailers



Because data in Table 1 exhibit trends, a trend analysis was used to test for the effect of lockdown. A time trend was calculated for each variable in Table 1 using data from 2017 to 2019. Then, we observe if the confidence interval for the 2020 share lies outside the confidence interval for the prediction obtained using the trend. The prediction confidence interval is adjusted to consider that data are sample means and are subjected to sampling errors. We acknowledge that three observations may be few to build a trend but, given the data limitation and the high R^2 for the remote-area variables, we concluded that the analysis provides valuable information. Figure 1 reports the trend analysis for large retailers (hard discounts and super and hypermarkets).

Figure 2: Trend analysis for other store types.



During lockdown, there was a reduction in the access to hard discount by households in remote areas that went against the increasing trend in the previous years. The observed share was 0,244 instead of the predicted 0,302 and the difference is statistically significant at 95% confidence level. The data from non-remote (other) areas exhibit a similar result. There was no evidence that the lockdown affected the share of households in remote areas using super and hypermarkets. The observed datapoint in 2020 was consistent with the increasing trend in years 2017-2019. Overall, in 2020 the share of households that did not use large retailers increased significantly. The observed value was 0,035 instead of 0,21 as predicted by the declining trend of the previous three years.

In non-remote areas, the decline in the share of hard-discount users (-0,07 compared to predicted trend value) was compensated by a statistically significant increase in the share of supermarket users (+0,16, contrasting a declining trend in previous years). As a consequence, the share of households that did not shop at large retailers did not exhibit a statistically significant deviation from the trend.

Comparing results of remote and non-remote areas, we find that during lockdown the use of hard discount by Italian households decrease. In non-remote areas this change was fully compensated by the increased use of super and hypermarkets. Instead, in remote areas a small but statistically significant share of households (approximately 0,015) lost access to large retailers completely. It must be noted that this value might underestimate the effect of shopping-out because limited exemptions from lockdown restrictions were granted to shoppers.

The limited access to hard discount in remote areas was not compensated by online shopping. Figure 2 shows that the observed share does not deviate from the trend significantly. Access to traditional stores in remote areas during lockdown did not deviate from the declining trend. Instead, pandemic restrictions reduced access to local markets and peddlers. Non-remote areas showed a different pattern because online shopping for food increased significantly (although the share is limited: 0,015 at most) and the share of household using traditional stores decreased significantly from the already decreasing trend. These results confirm that households in remote areas may find more difficulties in adjusting their shopping behavior than those in non-remote areas due to lack of opportunities.

ISTAT dataset does not allow us to compare individual households at different points in time. Consequently, it is not possible to observe the effects of the exclusions of individual households from access to large retailers. However, it is possible to compare descriptive statistics for groups in two periods. Table 2 reports the mean of selected expenditure variables in 2020 and 2019, comparing the group of households without access to large retailers to the rest of the sample, in remote areas.

Table 2: Comparison of sample means of selected variables for households in remote areas, by type of access to large retailers.

	Household in remote areas not shopping at large retailers		Other households in remote areas	
	2019	2020	2019	2020
	$\mu_{N,19}$	$\mu_{N,20}$	$\mu_{O,19}$	$\mu_{O,20}$
Expen. on healthy food on total food expen.	***0,067±0,018***	***0,042±0,016***	***0,083±0,003***	***0,094±0,003***
Food expenditure per person	**180,32±57,9**	***84,356±28,81***	234,7±10,40	*230,4±7,35*
Non-food expenditure per person	**1051,6±338,5**	**655,3±96,8**	**885,7±36,2**	**752,4±32,0**
Age of respondents	64,6±5,963	*65,2±4,292*	60,3±0,847	*59,4±0,776*
Share of female respondents	0,325±*0,12*	*0,421±0,12*	0,309±*0,02*	*0,297±0,02*

Bold font: $\mu_{G,19} \neq \mu_{G,20}$ at 95% confidence level with G =N, O (comparing same group, different year)
Italic font: $\mu_{N,T} \neq \mu_{O,T}$ at 95% confidence level with T =2019, 2020 (comparing same year, different group)

The data indicate that lack of access to large retailers may be associated with a lower share of expenditure for healthy food (fruit and vegetables, fresh fish and meat) on total food expenditure and a lower expenditure for food on average. During the lockdown these effects were even larger. Noticeably, while the expenditure share for heathy food for households with access to large retailers increased during the lockdown, the value for households without access decreased. Similarly, while total food expenditure for households with access to large retailers did not change during the lockdown, it decreased for households with no access, reaching a much lower value than the other group.

Under the assumption that shopping-out was discouraged during the lockdown, the results suggest the possibility that shopping out may be beneficial for households in remote areas if it allows access to large retailers. However, more research is needed to reach a final assessment of this hypothesis.

CONCLUSIONS

The paper addresses the issue of shopping-out practices in Italian remote areas. The preliminary results suggests that shopping-out is critical for keeping access to large retailer for a non-negligible share of households. Consistently with other studies from other European Region (Revoredo-Giha & Russo 2023), large retail chains already reach a large share of population even in remote areas. This means the level of competition for local business is high.

The importance of shopping-out practices shows that the threat to local economies can be real. As a sizable share of consumer food expenditure is paid to firms outside the local area, there is a drain of financial resources from the local business. Yet, this process seems to favor healthy eating habits in consumers.

If public policies limiting further openings of large retailers in local areas are contemplated, regulators must consider that their impact might be limited. The extensive shopping-out practices already ensure that a large share of population in remote areas buy most of their food outside local communities. Any restriction of trade has the unintended consequence of increasing the inequalities between residents who are able to run shopping trips and those who are unable because of high transportation costs.

It must be noted that these conclusions were obtained using COVID-19 lockdown as a natural experiment to measure shopping-out. Because the pandemics affected food consumption in several ways, results must be interpreted with caution. The difference in difference approach, comparing households of interest with control groups was intended to attenuate the effect of possible confounders.

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The Cocoa Value Chain in Ghana: sustainability constraints and linkages to SDGs

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1. KEYWORDS

- Global Value Chains
- Cocoa Value Chain Ghana
- Sustainability constraints
- SDGs

2. OBJECTIVE AND METHODOLOGY

This paper discusses the main sustainability issues of the Cocoa Value Chain in Ghana, starting from the description of its position in the international market and the identification of the main stakeholders involved.
Considering the fundamental role of agriculture in providing food, income, raw materials, and resources for the poor, its sustainability represents a key factor in achieving the SDGs of the Agenda 2030. Even though Ghanaian cocoa is worldwide recognized for its quality, the value chain is still facing some major sustainability issues which are strictly linked to the wider sustainability of the agricultural sector and therefore need to be adequately addressed.
This analysis is based on the review of the most recent available literature and data sources. Figure 1 summarizes the Ghanaian cocoa value chain's main sustainability drawbacks concerning the SDGs.

Figure 1. Linkages between the sustainability constraints of the cocoa value chain in Ghana and the SDGs

Cocoa Value Chain Ghana						
Sustainability Pillar	**Economic**	**Social**		**Environmental**		
Issue	Added value and income	Child labour	Gender equality	Deforestation	Pesticides	Mining
Link to SDGs	SDG 1 SDG 8 SDG 10 SD6 16	SDG 3 SDG 4 SDG 8	SDG 5 SDG 8 SDG 10	SDG 12 SDG 13 SDG 15	SDG 3 SDG 6 SDG 14 SDG 15 SDG 8	SDG 3 SDG 6 SDG 13 SDG 14

3. THE COCOA VALUE CHAIN

According to the estimates of the International Cocoa Organization for the 2021/2022 season, world cocoa production stands at 4.9 thousand tonnes, with an expected upward trend for 2022/2023. World production is concentrated in West Africa, with Côte d'Ivoire and Ghana being the two largest cocoa-growing countries, accounting respectively for 43% and 20% of global production. The main destination markets for Ghanaian cocoa exports are the Netherlands, receiving 25% of the products, followed by the UK (10.1%), Malaysia (8.9 %), France (8.6%), and the USA (7.3%) (ICCO, 2023).
Trade relations between Europe and Ghana are regulated by an Economic Partnership Agreement (EPA). The EPA provides on one hand duty-free and quota-free access to the EU market for all imports originating in Ghana and on the other hand partially liberalizes Ghanaian imports from the EU for 20 years, mainly on goods that are not produced locally, for instance, agricultural inputs. The EPA's main objective is the economic development and inclusion of the Ghanaian economy in the global scenery and lacks, at the current state, of specific chapters dedicated to sustainable development (European Commission, 2016).

Employing approximately 850,000 family farms and generating annually more than $2 billion through export, the cocoa value chain is undoubtedly one of the main pillars of the Ghanaian economy. The cocoa industry in Ghana is completely controlled by the Cocoa Board (COCOBOD), the governmental agency which performs, through its subsidiaries, a wide range of functions starting from the farm gate level - by providing seedlings, agrochemicals, and other facilities to cocoa farmers- to marketing and exporting of the cocoa products (Martey et al., 2022). Another important role is played by the Licensed Buying Companies (LBCs), organizations that act as competitors to the state-owned Produce Buying Companies (PBC). The LBCs are authorized by COCOBOD to purchase, on its behalf, cocoa beans from the farmers, through their local purchasing clerks.

The seasonal farm gate price of cocoa is set at the beginning of each crop year by the Producer Price Review Committee on Cocoa, which includes representatives of farmers, transporters, LBCs, COCOBOD, and the Ministry of Finance and Economic Planning. The main objective of the upfront determination of the farm-gate price is to make the sector less vulnerable to the international market's price volatility (Aidenvironment and Sustainable Food Lab, 2018).
The cocoa global value chain (GVC) comprises different stages: the fermented beans are prepared for sale at the farm level and then moved to the cocoa buying centers where purchasing clerks stock the beans in bags. The cocoa beans are later moved to district depots where they undergo, under the supervision of COCOBOD, different stages of quality inspection, before their transfer to the port and shipment to international destinations.
In contrast with the first steps of the production, characterized by a large number of farmers taking care of small-sized farmlands (2 to 3 hectares on average), cocoa grinding and manufacturing are highly concentrated and mostly occur outside the Ghanaian borders. Today, three multinational grinding companies (Barry Callebaut, Cargill, and Olam) dominate the industry with over 60% of the total cocoa processing, and the same trend is followed by the manufacturing companies, with Mars Wrigley, Ferrero Group, and Mondelēz International leading the market (Grumiller et al., 2022).

4. SUSTAINABILITY CONSTRAINTS

The sustainability of the cocoa GVC has gained attention concerning social-economic as well as environmental aspects. Most of the socio-economic challenges refer to child labour, gender imbalances, living income, and poverty alleviation, while from the environmental perspective literature focuses on climate change adaptation, mitigation, production intensification, and deforestation. Hereafter, the paper reports an analysis of the main challenges the cocoa GVC faces in meeting SDGs.
For comprehension matters this document considers sustainability-related topics dividing them into three categories: economic, social, and environmental sustainability. It is however essential to underline

that the three pillars of sustainability cannot be considered other than integrated and indivisible (United Nations, 2015) to reach sustainable production models.

4.1 ECONOMIC SUSTAINABILITY

ADDED VALUE AND INCOME. Even though cocoa production contributes to overall economic prosperity and employment rate, 90% of Ghanaian cocoa farming households do not reach the level of a "living income" (van Vliet et al., 2021), intended as the income threshold which not only provides for to basic needs but also ensures decent living conditions and access to food, water, housing, education, and healthcare.

Among the reasons behind the inadequate incomes of cocoa farmers is the scarce added value of the raw cocoa beans; 60% of the Ghanaian cocoa is sold unprocessed to the international market. This implies that the cocoa beans undergo several other transformations before ending up in the retail stores, therefore most of the added value is created outside Ghana. It is estimated that 79.4% of the added value is obtained by final manufacturers and retailers, whereas only 6.6% goes to cocoa farmers (Fountain et al., 2022).

Another crucial factor is represented by the cocoa farms' low productivity, which is determined by the limited access to agricultural inputs and finance. Farm investments are consequently limited, leaving these farmers stuck in a trap of low productivity and low incomes. Exacerbating the issue, accordingly to Löwe (2017) the gradual loss of soil fertility, caused by bad agricultural practices and land overexploitation, not only reduces the yield of the cocoa trees and makes them much more susceptible to pests and diseases, but also makes it more convenient for cocoa farmers to expand into native forests rather than investing on old plantations. To address the issue, the governments of Ghana and Cote d'Ivoire, in agreement with the main global chocolate companies, introduced in 2019 the Living Income Differential (LID) policy which raises farmgate prices by roughly 20-30% by charging an extra premium of USD 400 per ton on all cocoa sales (Boysen et al., 2021). No official report has been published about the outcomes of the first year of implementation of the policy, but the existing studies determine that its gains, in terms of living income and poverty alleviation, are very low (Boysen et al., 2023).

Voluntary standards also represent an important tool. The most relevant in terms of fair income is Fairtrade, which requires buyers to pay a minimum price to producers (currently USD 2 400 / ton); the value is set based on the average cost of sustainable production. Nevertheless, Fairtrade recently lowered its standards; it is possible to label as "Fairtrade" a product containing even just one Fairtrade ingredient, breaking away from the original requirement for all the available-as-Fairtrade ingredients to be certified (EURRED, 2021). This shift not only strongly impacts the capacity of the label to sustain farmers at large, but also results in misleading communication to the final consumers.

All in all, even though important steps have been made towards economic sustainability, farm gate prices are still not sufficient to guarantee a fair income to farmers.

4.2 SOCIAL SUSTAINABILITY

CHILD LABOUR. Cocoa cultivation in Ghana is largely family-based and especially at the peak of the cocoa harvest, the demand for workforce increases resulting in a wide involvement of children in farm activities due to the impossibility of most families to afford hiring paid labour. Even though socio-cultural factors also play a role, as the participation of children in cocoa cultivation is often seen as an important part of their upbringing, restricting their education decreases their and their country's potential of escaping poverty in the future (Luckstead et al., 2019).

Several initiatives, both on the international (EU Sustainable Cocoa Initiative), national (Public-Private-Partnerships), and community level (Child Labour Monitoring Systems) are actively addressing the topic but, despite the elaborate existing legal and institutional framework, the exploitation of children remains prevalent in Ghana; 55 % of Ghanaian children living in agricultural households are exposed to hazardous work, particularly to the use of agrochemical products, with severe repercussions on their health (Busquet et al., 2021).

GENDER EQUALITY. Even though cocoa is overall considered a “male crop”, some of the most important activities which are crucial for the quality of the beans and productivity are led by women. Since the ownership of land is a prerequisite to being recognized as a cocoa farmer and women usually work on plots owned by their husbands, selling cocoa is primarily done by men, who, therefore, directly receive payments (Barrientos et al., 2016). That’s why it is extremely difficult for women to access finance and inputs as well as take part in farming collectives and cooperatives. This condition pushes them into looking for additional sources of income, adding up to their workload. This has serious implications for their well-being as well as their children’s (Ahrin, 2022).
In addition to the above-mentioned private standards, gender equality is addressed by several initiatives implemented by some of the main global chocolate companies; the Cocoa Life Project by Mondelez International, the Sustainable in a Generation Plan by Mars, and the Nestlé Cocoa Plan. However, for these private initiatives to be effective, robust participation of the government is crucial; a legal enabling framework must be set to create real change toward women’s equal treatment.

4.3 ENVIRONMENTAL SUSTAINABILITY

DEFORESTATION. Cocoa-driven deforestation in West Africa started in 1986 and reached its peak between 2000 and 2013 when the deforestation rate hit the number of 132 hectares per year. New plots were established using the ‘full sun’ method, which implied the felling of most forest trees, with a consequent high impact on the forest’s biodiversity and inducement of desertification patterns due to the constant irradiation of the land. Agroforestry practices, such as intercropping cocoa trees with food crops, can play an important role in the re-greening process by also contributing to the diversification of the income sources and food security of communities. However, nowadays agroforestry in Ghana still produces minimal landscape transformation due to the lack of synergy between the key actors of the value chain and the very low standards set by both government and certification labels (Sanial et al., 2020).
On the international level, in 2017 the Governments of Côte d’Ivoire and Ghana and the world’s leading chocolate companies signed a partnership to end deforestation and promote forest restoration in the cocoa supply chain: the Cocoa & Forest Initiative. Despite the important results deriving from this platform its full potential remains unexplored mainly due to the absence of an enabling framework in the public sector and to the scarce participation of the involved companies.
Among the private standards, Rainforest Alliance, which applies to several commodities including cocoa, is the most demanding in terms of forest protection but still lacks a reliable monitoring system. Also worth mentioning is the increasing response of cocoa transformation companies to the rising awareness of consumers towards sustainability-related topics. Most cocoa multinationals have recently claim environmental commitment by establishing their own sustainability programs which are, however, rarely substantial, and often merely used to differentiate the products in a very competitive market.

AGROCHEMICALS. Recent analysis shows a 20% increase in the number of households using pesticides and a 10% increase in households using mineral fertilizers between 2013/2014 and 2018/2019 (Sadhu et al., 2020). Agrochemicals do not only harm the environment, leading to soil and water contamination but also expose people, especially vulnerable groups, like pregnant women and children, to major health problems. The common inadequate protective equipment and unmindful handling of pesticides also increases the risks of exposure to chemical substances (Okoffo et al., 2016).
Moreover, Ghana and Côte d’Ivoire are among the main importers of neonicotinoids, highly hazardous pesticides, banned in the EU. Neonicotinoids should be regulated or even banned to protect farmers, chocolate consumers, and natural habitats.

MINING. Gold and cocoa are the backbones of Ghana's exports. Unfortunately, the two activities are increasingly struggling to coexist as gold is searched for in the same lands where cocoa is cultivated. Spread poverty and the low incomes deriving from the cocoa sector make farmers much more likely to cede their lands to miners for extra income. However, artisanal mining, which is mostly surface mining, is highly destructive for the natural vegetation and farmlands, and the use of mercury to extract gold is leading to serious environmental degradation, contaminating fresh water and making it unsafe for human consumption and irrigation (Merem et al., 2020). The recent spread of mining activities and the deriving economic and environmental impact on the Ghanaian territory is generating huge concern both on the economic and environmental side and hence needs to be promptly managed, particularly to prevent the loss of arable land destined to cocoa production and the expansion of the plantations towards new territories (e.g. native forests).

5. MAIN CONCLUSIONS

Given the central role of cocoa production in the Ghanaian and West African economies, the value chain is highly regulated and targeted by public and private initiatives. Despite the efforts, it is still facing significant sustainability problems which need to be handled to lead the value chain towards the SDGs. The main conclusion of this desk analysis is that governance policies should assist the transition to sustainable production all along the value chain, starting from the implementation of good and overall sustainable agricultural practices on field, down to the final consumer's access to sustainable purchasing alternatives. Being poverty regarded as a root cause for other major sustainability issues of the cocoa value chain in Ghana, economic sustainability can be the starting point to enable communities to contribute to the sustainable development of the sector. Working towards Sustainable Development Goal 1 - "No poverty", is a key step to the transition to fair production models which also safeguard human rights and well-being and protect the environment. In order to do so international and national institutions should work jointly to guarantee decent living conditions and incomes for all the individuals at every step of the value chain. Furthermore, even though consumers are becoming increasingly sensitive to sustainability issues, it is still very difficult to access transparent and complete information on the final goods. That's why private standards should be valorized rather than adapted to the companies' need to claim their sustainability commitments.

6. FUTURE DEVELOPMENTS

The proposed literature review is a preliminary qualitative analysis of the topic; future developments of the project will include the design and administration of questionnaires to the stakeholders of the Cocoa Value Chain in Ghana, to deepen the knowledge about its sustainability constraints and the role of international trade and trade agreements in addressing these issues.
The qualitative approach will be followed by the development of an econometric model with the final objective of providing policy recommendations on the major social, economic, and environmental issues to be included in future revisions of the EU-Ghana EPA, which will most likely be aligned to the new generation trade agreement's requirement of promoting sustainable development.

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Revealing perspectives towards health warning labels on wine: the Italian case

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KEY WORDS
Health Warning Labels; Wine Consumption; Q Methodology.

INTRODUCTION AND OBJECTIVES OF THE STUDY

The consumption of alcoholic beverages can have many adverse health effects, causing several types of noncommunicable diseases, including cancer, brain damage and liver diseases (World Health Organization, 2010). The World Health Organisation (World Health Organization, 2018) estimated that every year around 1.7 million people worldwide die of causes of alcohol-attributable deaths, which represent about 3% of all death. According to some scholars (Annunziata et al., 2020; Vallance et al., 2020), only a minority of alcohol consumers are aware of the risks and harms of drinking alcohol. Therefore, measures that promote consumers' risk perception, such as the use of Health Warning Labels (HWLs), are considered among the most promising policy initiatives for reducing the harmful use of alcohol-based products (Annunziata et al., 2019, 2020; Ramlo, 2016; Staub et al., 2022; Staub and Siegrist, 2022).

Some EU member states have already introduced mandatory HWLs on all alcoholic beverages. However, most of these measures are still voluntary and often limited to the potential dangers associated with alcohol consumption in specific circumstances (e.g., "Drinking during pregnancy and driving") (Annunziata et al., 2020). In this context, Ireland has played a pioneering role in the EU, recently signing a law to ensure that, starting from 2026, all alcohol products must have comprehensive HWLs addressed to all types of consumers, including those related to the risk of contracting cancer. In Italy, as in many other important European wine-producing countries, such as France and Spain, there is a strong debate regarding the opportunities and threats related to the adoption of mandatory HWLs on wine bottles. In these countries, where drinking wine is part of the tradition and cultural heritage, the moderate consumption of wine is also associated with health benefits and with principles of the Mediterranean diet (Annunziata et al., 2019;

Minzer et al., 2020). While some scholars have investigated the attitudes and preferences of Italian wine consumers towards wine labelled with different formats of health warnings (Annunziata et al., 2019, 2020), to the best of our knowledge, no studies exist regarding the acceptance of Italian consumers and experts towards the adoption of mandatory HWLs in wine bottles. Given the different perspectives, knowledge and attitudes of consumers and experts, the main objective of this study is to get preliminary insight into how those actors view the potential adoption of health warnings on wine labels, by identifying the main divergence and consensus. This study applies Q-methodology to reveal the different subjective opinions regarding the HWLs (Stephenson, 1953).

METHODOLOGY

Q methodology (Brown, 1980) is a participative approach used to uncover patterns of perspectives in a debate by correlating and grouping participants who are assumed to have diverse points of view on a specific subject matter. A Q study consists of five steps (McKeown and Thomas, 2013).

The first step is collecting the full range of discourses or opinions on the topic of concern, namely the "concourse". In this study, over 240 written statements regarding stakeholders' debate on warning labels formed the concourse. A subset of statements ("Q sample") is derived from the concourse following a structured approach. For this study, four theoretical categories - adapted from the political study of Dryzek & Berejikian (1993) – were used: 1) definitive ("concerns the meaning of terms"); 2) designative ("issues of fact"); 3) evaluative ("expressions of the worth of something"); and 4) advocative ("something that should or should not exist"). These dimensions were combined with two levels (i.e., positive, and negative statements), which yielded a four-by-two matrix. Defined the matrix structure as a heuristic device, the final Q sample should represent the original wording and opinions of the concourse and be balanced. Ten statements were sampled for each cell of the matrix for forty statements. Third, the selection of participants is purposively made (not randomly). Thus, participants broadly familiar with the topic (i.e., wine experts and consumers) formed the "P sample". Fourth, during the data collection, participants are asked to sort the statements into a forced quasi-normal distribution according to their degree of agreement and disagreement (see, Figure 1). Each Q sort represents the perspective of a single participant. Lastly, Q sorts are cross-correlated and factor analysed. A Q-study aims not to generalise results but to provide a better understanding of the different views. Therefore, it assumes that there is a finite set of discourses on any specific topic and factor analysis is used to derive these "perspectives" or "factors". Q sorts highly similar define a shared perspective about the topic, and the diverse social factors provide a snapshot of the variety of perspectives among respondents.

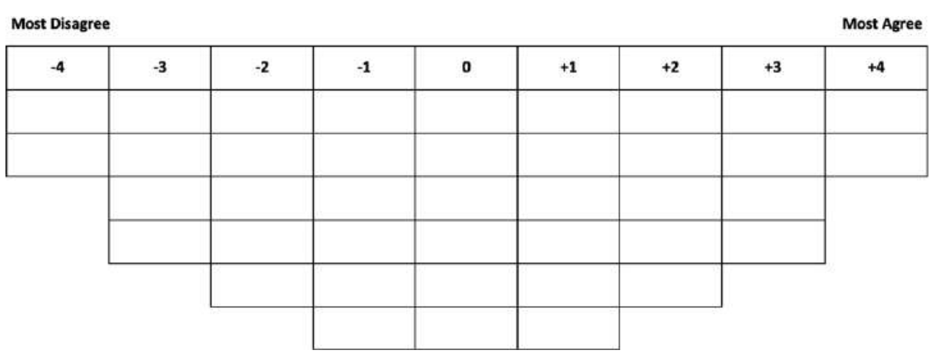

Figure 1 The quasi-normal distribution (shape of a "Q sort").

MAIN RESULTS

Factors were identified using the centroid factor analysis and rotated with varimax and hand rotations (McKeown and Thomas, 2013). Four divergent factors were extracted according to three criteria: 1) Brown's rule (factors with at least two significant factor loadings – correlations between Q sorts - are those that exceed ±2.58xSE, where SE is the standard error given as follows: SE = 1//√(statements), with p<0.01); 2) the Scree-plot analysis; 3) the Kaiser-Guttman criterion (factors with eigenvalue over 1) (Mandolesi et al., 2022; Sneegas et al., 2021). Also, the low correlation between couples of factors indicated the minor similarities between the two perspectives. Of the nineteen participants, nine loaded significantly on Factor 1 (one "bipolar", meaning that negatively loaded into that factor), four on Factor 2, two on Factor 3, and two on Factor 4. Two participants were not assigned to any factor. The total variance explained by the four-factor solution is 52%.

Factor 1 ("Sovranist") is primely committed to protecting national interests against European policies. Warning labels on wine bottles are seen with hostility as a useless tool for consumers and a threat to demonise an ambassador of Made in Italy. For this reason, the Italian government should protect the identity of the national wine sector. The anti-European position was underlined with excessive nationalism, which differs from Factor 1 the others, regarding the fact that wine - as part of Italian culinary tradition - cannot be treated as cigarettes.

Factor 2 ("Market Oriented") is optimistic and strongly focuses on market dynamics. Overall, this view is positive towards adopting health warnings that add value to the product without causing severe setbacks within the wine sector regarding total exports, turnover, and employment. Also, prices will not be affected by the possible introduction of these health warnings.

For Factor 3 ("Healthy first"), using health warnings is necessary and makes sense, and no worries arise about their aesthetic impact. These labels are an effective way to inform and protect consumers from health-related risks.

Factor 4 ("Keep us alive") understates the ability of warning labels to change wine consumption. Health warnings are seen only as a political "disclaimer" since, to this view, there are no "safe" amounts of alcohol consumption. Drinking wine is a pleasure, and these labels will inevitably damage it.

CONCLUSIONS AND IMPLICATIONS

Th study offers a first insight into the still little–investigated issue of perception and acceptance of health warnings on wine labels. The preliminary results of this study identified four main viewpoints, with no prevailing negative or positive sentiment toward HWLs on wine bottles. Factor 1 and Factor 4 were clearly negative about introducing mandatory HWLs for wine. The fact that all wine experts (sommelier, wine retailers, enologists) loaded into these two factors could explain the reason for such a strong refusal. Respondents associated to these two factors believe that in countries such as Italy, where wine production and consumption are part of the tradition, governments should work in synergy with other EU countries to oppose Ireland's law. This is necessary to defend domestic and export demand and to underline wine's central role in representing an essential element of Italy's cultural heritage.

Since the P-sample did not include wine growers, it is expected that they would also load in either Factor 1 or 4. On the contrary, Factor 2 and Factor 3 are positive to mandatory HWLs on all alcohol products, on the ground that this may effectively increase the perceived risk of wine consumption and help people to make better-informed decisions. Among the P-sample, those loading into these factors are consumers supporting the idea that the EU should promote a labelling regulation on alcoholic beverages, including wine, and all EU member states should enforce it. Q methodology, by some Authors considered a mixed-method research approach (Ramlo, 2016), allows generalizations to be made at the level of the "universe of communicability", that is the Q-sample: to put it in the word of Brown (1980) "it is doubtless that the same factors would emerge anywhere else in the country even with another set of statements1, provided that the new sample contained the same breadth of concern represented in this one".

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[1] Brown was showing image posters so he used the word *posters.* We replaced it here with the word *statements* to retain the meaning.

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A comparative Life Cycle Costing (LCC) analysis for economic sustainability assessment of three Mediterranean Crops

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Keywords
Lice Cycle Costing, Mediterranean crops, Olive, Almond, Fig

1. Introduction

Dryland cultivation on inaccessible slopes or plains, both in the past and now, includes drought-resistant trees, composed of a mixture of multipurpose trees, particularly olive (Olea europeae L.), fig (Ficus carica L.) and almond (Prunus dulcis L.) (Correia *et al.*, 2017). High levels of firm profitability should be reached by these three Mediterranean crops whose derived products fall into the category of products with positive health effects and have specific healthful properties of keen interest for consumers.

The evolution of the Italian domestic markets led to a greater interest in these crops, however, there is no greater area invested in almond and fig orchards, but rather a decrease, while that of olive trees is stationary. Supporting investments in farms it is necessary to provide information on the economic viability of the crops.

In this sense, the methodological tool of Life Cycle Costing (LCC) allows the incorporation of initial and operational costs incurred during the life cycle of a product or production system (Gluch and Baumann, 2004), from acquisition to final disposal (Dhillon, 1989), rationalizing long-term decision making when several investment alternatives are available.

Until now, few studies have focused on assessing the economic feasibility of investments in almonds (De Leijster et al. 2020; Sottile *et al.*, 2020), olives (De Gennaro *et al.*, 2012; De Luca *et al.*, 2018; Iofrida *et al.*, 2020; Stillitano *et al.*, 2016) and figs orchards (Stillitano *et al.*, 2017), by using Conventional LCC method, which assesses internal costs along the life cycle of a product, within the economic system.

In this context, the objective of this paper is to assess and compare different agricultural investments through the joint use of Conventional LCC and economic and financial indicators. This evaluation was carried out by the analysis of average agricultural production scenarios, from ordinary farms, to produce almonds in shells, olives for oil, and dried figs, in the same area with agricultural vocation located in Calabria, southern Italy.

The results of the analysis will have key elements identified along agricultural processes to optimize their economic performance for better farm management and will allow for comparison among the crops examined. Moreover, may support the public decision-maker in planning funding for rural development policies.

2. Materials and Methods

To identify the economic insights, a Conventional LCC (Ciroth *et al.*, 2016) based on the cash flows model (ISO, 2008) was applied. Because the study followed a farm perspective, only the real money flows were considered (Swarr *et al.*, 2011). For this study, the entire life cycle of each crop was divided into six main stages: 1) planting stage, 2) unproductive stage, 3) increasing production stage, 4) constant production stage, 5) decreasing production stage, and 6) end-of-life stage.

All costs have been accounted for, and organized into plantation costs, operating costs, and end-of-life costs.

Plantation costs are represented by the design cost (i.e., soil chemical analysis, choice of cultivar, and design of planting distance) and initial investment cost (i.e., the quota on land improvements, purchasing of plant propagation material, the rental cost of machinery for trenching, holes diggings and tree grubbing up).

For *Operating costs*, to calculate each cost item the following assumptions were adopted:

- Input costs such as fertilizers, herbicides, pesticides, and fuel were calculated taking into account the quantity effectively used by farms and the current market prices (i.e., 2021);
- for specific operations such as trenching, hole diggings, and tree grubbing up were considered as provided by third parties and, therefore as rental costs of mechanical means;
- Family labor cost was evaluated in terms of opportunity cost and was equalized to the employment of casual workers for manual and mechanical operations, by assuming the current wage;
- interests on advance capital and capital goods evaluated by applying a rate equal to 4.5% and 2%, respectively;
- The rental cost for land use was deduced from the average local rental prices;
- The administrative overheads were estimated to be 5% of the gross production value, which corresponds to the annual total revenues.

Within the *end-of-life costs,* disposal costs (i.e., fuel consumption, rental cost for tree grubbing up, and labor cost) and disposal useful (i.e., sale of timber assortments) arising from the plant removal were taken into account.

Based on the life cycle of each scenario under study, the LCC approach adopted can be expressed through equations reported below:

$$TLCC^{30}_{j=0(Almond;Fig)} = PC_0 + \sum_{j=1} \frac{OC_{UPstage}}{(1+r)^j} + \sum_{j=4}^{7} \frac{OC_{IPstage}}{(1+r)^j} + \sum_{j=8}^{26} \frac{OC_{CPstage}}{(1+r)^j} + \sum_{j=27}^{30} \frac{OC_{DPstage}}{(1+r)^j} \pm \frac{ELC_{30}}{(1+r)^{30}} \qquad (1)$$

$$TLCC^{60}_{j=0(\text{Olive})} = PC_0 + \sum_{j=1}^{6} \frac{OC_{UPstage}}{(1+r)^j} + \sum_{j=7}^{11} \frac{OC_{IPstage}}{(1+r)^j} + \sum_{j=12}^{56} \frac{OC_{CPstage}}{(1+r)^j} + \sum_{j=57}^{60} \frac{OC_{DPstage}}{(1+r)^j} \pm \frac{ELC_{60}}{(1+r)^{60}} \qquad (2)$$

where:
TLCC = total life cycle costing;
j = 0, …, n represents years of lifetime (30 years for both almond and fig, 60 for olive);
r =
PC0 = Plantation Costs in the "Planting stage";

OCUPstage = Operating Costs in the "Unproductive stage";
OCIPstage = Operating Costs in the "Increasing Production stage";
OCCPstage = Operating Costs in the "Constant Production stage";
OCDPstage = Operating Costs in the "Decreasing Production stage";
ELC30 = difference between disposal useful and disposal cost in the "End-of-Life Stage".

Lastly, the total revenues for the entire life cycle of each scenario were evaluated by multiplying the crop yield by its market price, which referred to the average 2019/2020, 2020/2021, and 2021/2022 harvesting season, including EU Agricultural Policy direct subsidies. For olives, the price of the unprocessed product was considered, for almonds the price of the in-shell product, and for figs the price of the dried product. Figs are harvested already semi-wilted and completely dried on racks placed in tunnels or open air.

An investment analysis was carried out by calculating specific indicators, i.e., Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), Discounted Gross Margin (DGM) and Discounted Life Cycle Costs (DLCC), by assuming:

- All of the costs and revenues were discounted for the entire life cycle of 60 years for the olive scenario and 30 years for the almond and fig scenarios;
- To select a discount rate, the opportunity cost approach in terms of alternative investments with similar risks and times was used (De Luca *et al.*, 2018). Here, a discount rate set to 2% was assumed, which was similar to the average return rate of Italian government bonds in 2019;
- During the life cycle, constant prices by excluding adjustments for inflation were taken into account (Hussain *et al.*, 2005).

A sensitivity analysis was conducted as the final step of the study, considering a variation in product prices from ± 5% to ± 10% to reflect the market price dynamics in a free market (Stillitano *et al.*, 2016) and a variation in costs from± 5% to ± 10% to investigate changes in the farm's internal factors.

3. RESULTS AND DISCUSSION

In line with the proposed methodology, average operating costs for each life cycle stage and per crop scenario under study were quantified as shown in Table 1.

Table 1. Average operating costs of the crops under study per life cycle stages (€ ha^{-1} year^{-1}).

Life cycle stages	**Almond with shell**		**Olive**		**Dried Figs**	
Planting stage	Year 0	9,593.40	Year 0	7,713.40	Year 0	9,993.40
Unproductive stage	Years 1st-3rd	2,912.87	Years 1st-6th	2,200.28	Years 1st to 3rd	2,870.22
Increasing Production stage	Years 4t^{h}-7th	3,504.32	Years 7t^{h}-11th	3,370.11	Years 4t^{h} to 7th	4,831.66
Constant Production stage	Years 8th-26th	4,283.12	Years 12th-56th	4,375.84	Years 8th to 26th	6,476.62
- Soil management	〃	*172.80*	〃	*181.33*	〃	*216.63*
- Fertilization	〃	*710.53*	〃	*700.77*	〃	*670.53*
- Pruning	〃	*307.00*	〃	*617.60*	〃	*358.00*
- Phytosanitary treatment	〃	*211.83*	〃	*306.40*	〃	-
- Harvesting	〃	*591.00*	〃	*741.00*	〃	2,589.00
Decreasing Production stage	Years 27th-30th	4.710,97	Years 57th-60th	4,185.03	Years 27th-30th	5,882.15
End of Life stage	Year 30th	6.440,00	Year 60th	10,822.00	Year 30th	3,600.00

For all almonds and figs the "planting stage" was the most expensive of the entire life cycle, due to the large initial investment costs, which include the quota on land improvements, the purchase of plant propagation material, and the cost of renting machinery for digging trenches, holes, and tree grubbing up. On the contrary, in the case of olive trees, the most expensive phase is the uprooting phase, due to the costs of renting the machines used in uprooting and the high labor input. However, these costs are fully offset by the sale of timber assortments, which in the case of olive wood represents a very active market. In the "increasing production stage", it is possible to notice for the three crops considered an increase in orchard management costs related to harvesting and pruning operations that are carried out from this stage.

In the "constant production stage," there is a general increase in costs compared to the previous stages in all three crops, related to the increased use of waged labor for harvesting against higher production. About the almond orchard and olive grove scenario, while recording higher production, the costs related to management are lower due to the complete mechanization of the harvesting that is carried out through trunk shakers and interceptor nets. Pruning also affects a lot among the cost items.

The “disposal stage” is the most expensive in the olive grove followed by almond and fig tree. The greatest incidence of the total cost item is represented by the rental of the mechanical means necessary for the uprooting of plants.

In Table 2, the fixed and variable costs are reported for the kilogram of the product obtained. The analysis shows that variable costs exceed fixed costs in all three scenarios.

Table 2. Operating costs in the constant production stage per scenario.

Cost item	**Almond with shell**		**Olive**		**Dried fig**	
	(€ kg^{-1})	*%*	(€ kg^{-1})	*%*	(€ kg^{-1})	*%*
Total variable costs (A)	**0.70**	***61.36***	**0.36**	***72.20***	**1.62**	***71.75***
Input costs	0.36	*31.64*	0.18	*36.05*	0.46	*20.56*
Human labor cost	0.32	*28.02*	0.17	*34.52*	1.12	*49.38*
Interests in advanced capital	0.02	*1.70*	0.01	*1.62*	0.04	*1.80*
Total fixed costs (B)	**0.44**	***38.64***	**0.14**	***27.80***	**0.64**	***28.25***
Machinery and land investment ownership costs	0.19	*16.86*	0.05	*9.50*	0.22	*9.96*
Land use rental	0.12	*10.20*	0.06	*11.99*	0.19	*8.54*
Interests in capital goods	0.04	*3.51*	0.01	*1.87*	0.04	*1.98*
Taxes and external technical services	0.03	*2.52*	0.01	*1.11*	0.04	*1.58*
Administration overheads	0.06	*5.55*	0.02	*3.33*	0.14	*6.20*
Total production costs (A+B)	**1.13**	***100.00***	**0.49**	***100.00***	**2.26**	***100.00***

The results of the financial analysis (Table 3) allow for a positive favorability rating for all three scenarios. The best performance is obtained by the fig tree, followed by the almond and olive tree.

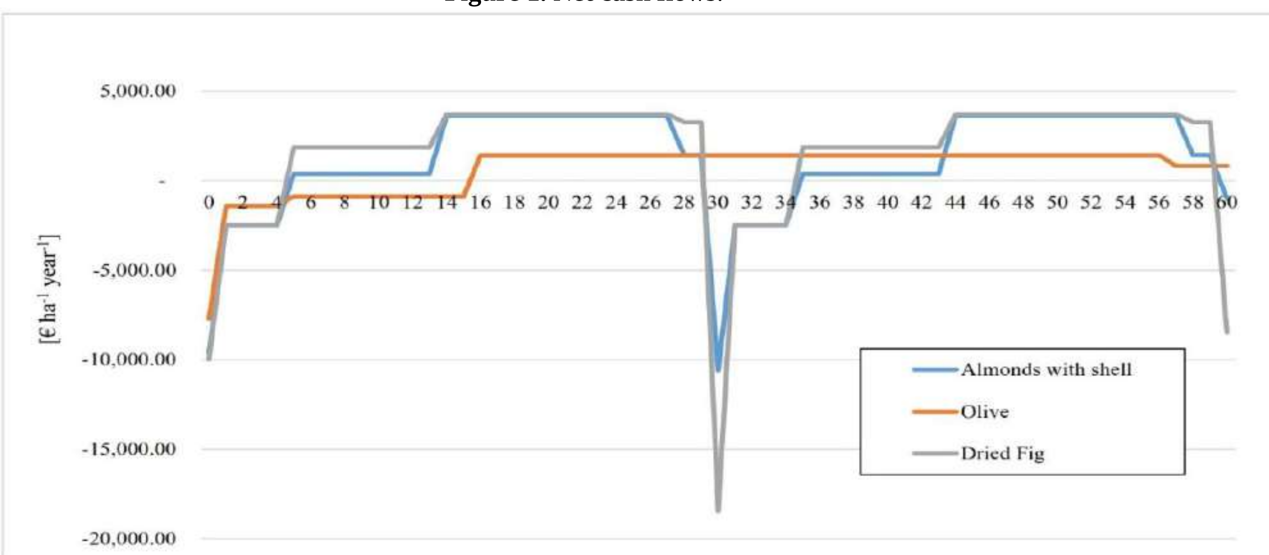
For the almond tree, the positive financial results are consistent with those stated by De Leijster *et al.* (2020) and Sottile *et al.* (2020)

Table 3. Investment analysis results

Economic Indicator	Unit	Including direct subsidy		
		Almonds with shell	**Olive**	**Dried Fig**
Net Present Value (NPV)	€ kg^{-1}	0.26	0.02	0.45
Internal Rate of Return (IRR)	%	5.99%	3.33%	8.68%
Discounted Gross Margin (DGM)	€ kg^{-1}	1.02	0.16	1.44
Discounted Life Cycle Costs (DLCC)	€ kg^{-1}	1.35	0.33	2.04

Figure 1 shows the net cash flows for the three scenarios examined. The results show that, compared with the ordinary management period, the scenarios in which the break-even point between costs and revenues is reached in the shortest time are the fig orchard and almond orchard (10th year), followed by the olive grove (15th year). For the unproductive stage in all scenarios, there are negative profits, as the EU aid to support production does not zero out the high costs incurred.

Figure 1. Net cash flows.



The results of the sensitivity analysis testing different hypotheses on the NPV, IRR, and DGM are presented in Table 4. The positive or negative change in prices and/or costs should be taken into account because of the price volatility that occurs in the market about current socio-economic conditions. Increasing prices and reducing costs are scenarios for which a positive change in results is expected and it appears that the 5% positive price change generates an increase in NPV of 34% for the almond scenario, 24% for the fig scenario, and 50% on olive. The 5% cost reduction shows less significant effects for almonds (+24%) and fig (+22%) while for olives the increase is 90%. This result shows that olive cultivation is more affected by cost trends than by product price. By increasing prices and/or reducing costs by 10% the effects described are even more pronounced. These changes occur with negative signs when price reductions or cost increases are applied, with extreme values of NPV reduction of 150% when costs increase by 10%. Demonstrating that the economic results of olive grove management are more sensitive to cost changes, changes in IRR can be analyzed. In fact, in the case of price changes, the results take on more or less similar increases or decreases for all three crops, while in the case of cost changes, they take on much better or much worse values in the case of olive and values fully comparable with those of price changes in the case of almond and fig. The results of the sensitivity analysis of DGM to price changes are in line with what is expected, showing an increase in price growth and a decrease in price reduction. While, the results show variability in the case of cost variation with always positive results in the case of olive trees and always negative results in the case of almond and fig trees. However, the variations in the DGM generated by the variation in costs are always minimal and not significant.

Table 4. Sensitivity analysis results

Scenario	Criteria	Almond with shell	Olive	Dried figs
Baseline	NPV	0.26	0.02	0.45
	IRR	5.99%	3.33%	8.68%
	DGM	1.02	0.16	1.44
Price + 5%	NPV	0.35	0.03	0.56
	IRR	7.17%	3.96%	9.79%
	DGM	1.11	0.18	1.56
Price + 10 %	NPV	0.42	0.05	0.67
	IRR	7.93%	4.54%	10.81%
	DGM	1.19	0.19	1.68
Price - 5 %	NPV	0.21	0.01	0.34
	IRR	5.47%	2.62%	7.44%
	DGM	0.97	0.15	1.32
Price -10 %	NPV	0.14	0	0.23
	IRR	4.48%	1.81%	6.02%
	DGM	0.89	0.14	1.2
Cost -5%	NPV	0.32	0.04	0.55
	IRR	7%	4%	10%
	DGM	1.02	0.16	1.44
Cost-10%	NPV	0.39	0.05	0.65
	IRR	8%	5%	11%
	DGM	1.02	0.16	1.44
Cost + 5%	NPV	0.19	0.01	0.35
	IRR	5%	2%	7%
	DGM	1.02	0.16	1.44
Cost +10 %	NPV	0.12	-0.01	0.24
	IRR	4%	1%	6%
	DGM	1.02	0.16	1.44

4. CONCLUSIONS

To our knowledge, this is the first study to analyze the comparison of economic costs, benefits, and profitability of three Mediterranean tree crops such as almond, olive, and fig. The production of shelled almonds, olives for oil, and dried figs is found to be profitable in the study area, partly due to the modern and rational cultivation techniques adopted. Among the three crops, olive, despite being more rooted in the Calabrian area and better known to farmers, has the lowest profitability, which cancels out becoming negative in the absence of public subsidies, in contrast to the other two crops that remain equally profitable. Considering that with the new programming of the Common Agricultural Policy 2023-2027, there will be a reduction in direct payments allocated to the olive crop, it is necessary to promote the conditions for such a crop to become profitable even in the absence of public contribution

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale:
politiche e strategie per la sostenibilità e la resilienza
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GREEN CARE AND CULTURAL ECOSYSTEM SERVICES – A REVIEW OF THE ECONOMIC METHODS FOR VALUATION

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KEYWORDS

Green Care, Cultural ecosystem services, Economic valuation, Governance, Nature-based solutions, Health system

Currently, modern societies are facing significant challenges trying to cope with rising pressures related to the negative trends of poor physical and mental health. As developed societies become increasingly urbanised, digitalised, and detached from the natural world, we are observing increasing levels of mental stress, social isolation, as well as the increase in prevalence of other non-communicable diseases (NDCs) (Bloom *et al.,* 2012). NDCs are now the primary cause of deaths worldwide (World Health Organization 2022), leading to increasing pressures and costs for public services (Muka *et al.,* 2015). It is estimated that over a 20-year period up until 2030, the economic burden of NCDs could be as high as US$ 47 trillion (Bloom *et al.,* 2012). It is within this context that nature-based solutions (NBS) have been gaining increased attention for their potential to utilise ecosystem services (ES) to help address these health-related challenges linked with modern lifestyles, such as improving mental health and increasing social interactions (Chen *et al.,* 2019). Moreover, since the COVID-19 pandemic, people are recognising the importance of accessing local green spaces and natural environments, and personal experiences in these locations have been rapidly increasing (Rousseau and Deschacht, 2020). Many of these new NBS include innovative therapeutic approaches involving nature exposure with the overall aim of increasing human health and wellbeing.

Many of these therapeutic practices can be conceptualised by the term Green Care (GC). GC is a catch-all term summarising a wide range of initiatives that primarily address human health, wellbeing, and social inclusion through contact with nature (Mammadova *et al.,* 2021). Despite growing evidence on the physical and psychological benefits of GC initiatives (GCIs), we lack an evidence-based understanding of their economic value (Chen, 2020; Hinde *et al.,* 2021). So far, anecdotal and qualitative evidence suggests that GC, and engaging with nature in general, produces valuable social benefits and could be a cost-effective way to provide public health benefits and increase social cohesion (Dessein and Bock, 2010; Pank, 2011; Hartig *et al.,* 2014; Hinde *et al.,* 2021). Furthermore, recent studies have highlighted the lack of research in general on the monetary valuation of nature's health effects and have called specifically for economists to address this issue (Hartig *et al.,* 2014; Chen *et al.,* 2019). Having scientifically robust estimates of the economic value of these benefits would help to confirm or reject these claims. Moreover, monetary estimates of the benefits generated by GCIs would help to address policymakers and increase financial and institutional support for GC.

Actions aimed at expanding care provision and coverage are often undertaken by the government justified on the grounds of addressing market failures. In other words, governments take action on public economic rounds to reduce the impact of market and information failures that undermine people's ability to maximize their welfare (McDaid *et al.,*, 2015). However, in the case of GC, we argue that the majority of public health institutions and healthcare providers in European countries have not yet recognized GC's potential as innovative to health practice. Thus, public bodies have not yet taken adequate action in terms of increasing social welfare with these innovative approaches. New efforts toward effective collaborations between policymakers and multiple actors are needed in this regard. GCIs involve professionals from different spheres (e.g., private, public) and various sectors (e.g., forestry, healthcare, agriculture) representing diverse environmental, economic, social, and health-related stakes. Thus, the effective implementation of GCIs and their recognition as part of institutionalized care pathways by health providers are inherently linked to a better understanding of partnership composition, decision-making processes, rules, and arrangements fostering integration. All of these aspects are embedded in the concept of multi-actor and multi-sector governance.

Knowledge Gap: Despite growing evidence on the positive physical and psychological effects of GC, we lack an evidence-based understanding of the economic value of the benefits generated by GCIs and, at the same time, the knowledge of the different aspects related to governance for the involvement of healthcare providers and collaboration with other actors remains underinvestigated.

Therefore, the **aims of this research** are twofold:
(i) Firstly, through an environmental economics perspective, this study will aim to identify and evaluate suitable methods for the valuation of the health and wellbeing benefits generated by GC. Using a systematic literature review, we determine what methods are employed in the literature for the economic valuation of CES, with the intention of identifying and evaluating appropriate methods for a subsequent valuation of the health and well-being benefits produced by GCIs;
(ii) Secondly, this research will aim to comprehend the possible paths and strategies needed to integrate GCIs into the public healthcare system through an analytical governance approach. This second objective will be achieved by identifying the involved actors, sectors, and the governance arrangements already implemented in other countries to integrate GCIs into public health systems through a systematic review of the international literature.

Therefore, in order to conceptualise the benefits of GC, stemming from the complex interaction of humans with the natural environment, it can be useful to think of them as cultural ecosystem services (CES) (See Table 1 for a description of the main CESs provided by GC) of which there exist numerous methods for valuation, pertaining mostly from the field of ecological economics. Although methods are available for the valuation of CES, they are complex, and results can sometimes vary across locations and time (Schaafsma *et al.,* 2014; Glenk *et al.,* 2020) hence, it is not always obvious which methods are appropriate. Additionally, CES are inherently difficult to quantify, even in biophysical terms, as they are immaterial. Due to various complexities, CES have in general been undervalued and understudied (Chan *et al.,*, 2012), and so in adopting this lens for the economic evaluation of GC, we will contribute to advancing both the CES literature and the GC literature.

Table 1 - Primary CESs provided by GC, MEA, (2005) **and authors own elaboration**

CES subcategory	Description
Spiritual and religious values	Certain GC initiatives are more aimed towards providing spiritual experiences, such as forest funerals and burial grounds.
Educational values	Many types of GC include as one of the primary goals to provide educational services, in particular social agriculture.
Inspiration	GC is particularly aimed at providing inspiration for people to create art and inspire healthy life choices. In particular, forest-based care is adapted to provide inspirational services.
Aesthetic values	GC activities take place in natural and green areas, and many are places of beauty appreciated by many individuals provided aesthetic values. In particular, this service can be linked with green care tourism and forest-based care.
Social relations	Different types of social relations and interactions amongst members of society is influenced by ecosystems. This is a crucial service provided by many GC projects. One of the primary aims of GC, in general, is to increase social wellbeing of individuals, and this can be achieved through social relations and interactions amongst participants spurred by their participation in GC. In particular, social agriculture and urban green care are geared towards providing this service.
Sense of place	People value the "sense of place" that they attach to particular features of their surrounding environment, including aspects of the ecosystems. "Sense of place" could be an important part of GC initiatives. People could value the sense of place they attach to the environment in which GC takes place. This could apply to all types of GC, but in particular, forest-based care and green care tourism could provide a high sense of place values.
Recreation and tourism	Individuals often choose their locations for leisure time based partly on the features of the landscape in a particular area. GC provides recreational benefits as individuals can enjoy time in natural environments, usually undertaking relaxing and leisurely activities. This is a particularly obvious service provided by, but not exclusively, green care tourism.
Health and wellbeing	One of the main aims of all types of GC is to increase human health and wellbeing through a conscious interaction with the natural environment. This can be considered the primary CES obtained by individuals from GC.

METHODS

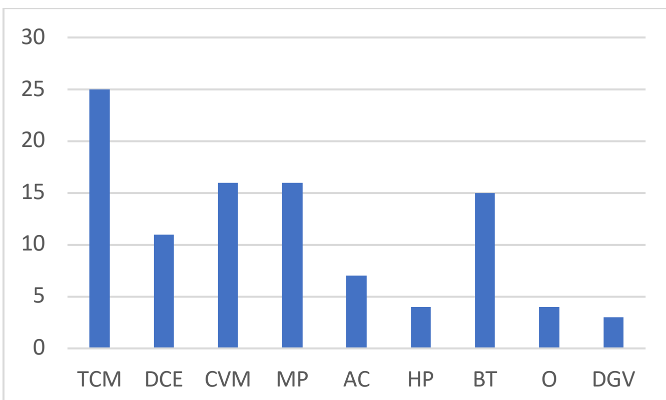
For both objectives of this research, from the economic and governance perspectives, a systematic review of peer-reviewed literature was conducted. However, for the purposes of this presentation, we focus primarily on the methods used to address our first research aim, addressing the economic valuation of the health and wellbeing benefits generated by GCIs.
During preliminary searches focused specifically on the economic valuation of GC, we discovered a very limited number of studies on the topic. The insufficient number of studies on the topic led to our decision to widen our search scope and to undertake a literature review of all studies focusing on the valuation of cultural ecosystem services, as discussed above. Search keywords were selected based on the preliminary review of the literature and the author's own expert knowledge. We organised the search keywords into three different categories representing (i) *intangible benefits of nature*, (ii) *monetary focus*, and (iii) *evaluation.* Different combinations of keywords and Boolean operators were tested and refined by a collaborative process between authors. The final search string implemented in January 2023 was the following: ("cultural service*" OR "cultural eco-system service*" OR "cultural ecosystem service*" OR "nature-based intervention*" OR "valuing nature") AND (economic* OR monet* OR quantitative) AND (analysis OR evaluation* OR valuation* OR assessment* OR valu* OR cost*). This search string was implemented in January 2023 in the Scopus database only. Titles and abstracts were screened for eligibility according to predefined criteria, and from the 851 unique search results, 85 articles were selected for full-

text analysis. The information extracted from each study was the following: study characteristics (country, scale, unit of output, environment), methods employed, CES sub-category, focus on CES (Y/N), variables, population if interviewed, sector of authors and a brief critical evaluation and relevant points in relation to GC.

RESULTS

Our results show that in general, the CES valuation literature is highly skewed towards the valuation of recreation and tourism services. Much fewer studies evaluated the remaining CES categories, such as inspiration, cultural diversity, social relations, and sense of place. We identified 9 different categories of valuation methods: DCE - discrete choice experiment, CVM - contingent valuation method, MP – market-priced based, AC – avoided costs methods, HP - hedonic pricing, BT - benefit transfer, DGV - group deliberative valuation methods and O – Other. Our results show that the TCM is the most popular method, followed by MP and BT; see Figure 1 for details. We also identified many studies that employed a combination of methods, both monetary and non-monetary valuation together and also combinations of more than one monetary method.

Figure 1 - Number of studies employing different methods for economic valuation of cultural ecosystem services



DCE - discrete choice experiment, CVM - contingent valuation method, MP – market-priced based, AC – avoided costs methods, HP - hedonic pricing, BT - benefit transfer, DGV - group deliberative valuation methods, and O – Other.

DISCUSSION

After a full-text analysis of the selected articles and an evaluation of their respective advantages and disadvantages, we discuss the suitability of the identified methods in the context of GC. We characterise the HP and BT methods as less appropriate in this context based on the ease of application, accuracy of measurements, usefulness/generalisability of results, and the typology of values estimated. According to the same criteria, we characterise the following methods as more appropriate: DCE, CVM, TCM, AC, and MP.

CONCLUSIONS AND FURTHER RESEARCH

We identify and discuss the valuation methods employed in the CES literature in the context of GC. We show that each method has different advantages and disadvantages, and no one alone will be sufficient to estimate the total economic value of GC. Further research should be undertaken applying these methods to the valuation of GC interventions, so that findings can be validated and more robust recommendations for valuation can be formulated. These findings, combined with developing a governance analytical framework, could facilitate transparency and evidence-based decision-making and thus support public agencies in integrating GCIs in the multi-sector and multi-level public health system.

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Plant the pot! Understanding consumers' WTP for sustainability in garden shops products

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PAROLE CHIAVE
Sustainability and resilience, choice experiment, garden shops, sustainable pots

INTRODUCTION

In an era of growing environmental consciousness and increasing recognition of social responsibility, understanding consumer preferences towards sustainable products has never been more critical (Behe et al., 2013). As such, exploring the factors that influence these decisions can provide valuable insights to stakeholders, ranging from product designers to policymakers. Consumer behaviour has increasingly become the focus of research in the quest to foster sustainable development, and the purchase of seemingly simple products - like a gardening pot - can be a complex decision-making process that involves various socio-economic and environmental factors (Behe et al., 2010; Hall et al., 2010). This study explores this process through a choice experiment, shedding light on consumers' preferences when faced with multiple product attributes related to sustainability. This study is motivated by the need to assess the impact of several key sustainability-related attributes— an ethical certification, the use of renewable energy sources, recycled material usage, product recyclability and reusability, and product compostability—on consumer choice. By including these factors in a choice experiment, this research seeks to quantify the significance of each attribute and illuminate the trade-offs consumers are willing to make in their purchasing decisions. Despite many studies examine consumers' willingness to pay (WTP) for various products and services, the focus on garden shop offerings represents a novel and crucial area of exploration due to the prevalence of unsustainable materials such as plastic, traditionally used extensively in garden shops (Mason et al. 2008; Yue et al., 2016). However, recent trends demonstrate an encouraging shift towards more environmentally responsible alternatives with eco-friendly products, including biodegradable packaging, labels, and energy-efficient plant cultivation systems. The motivation behind such purchases differs from sustainable food shopping, where perceived health benefits and quality assurance often drive decisions. In contrast, purchasing non-food items such as plants and flowers involves more complex considerations and is less understood. Thus, research into consumer behaviour in this context is pivotal for the broader adoption of sustainable practices within the gardening sector.

METHODOLOGY

This study employed a choice-based conjoint analysis to measure individual preferences concerning a product's attributes. In this experiment, 200 Italian respondents were presented with 12 different choice sets, each containing three alternative options for purchasing a vase. One of these options was a no-buy choice, allowing the respondent to opt out if none of the presented items matched their preferences. The choice experiment was executed with hands-on engagement and active interaction to ensure accurate and reliable data collection. To facilitate this process, the experiment was conducted in several garden shops, a setting chosen for its relevance to the product being evaluated, a vase. Given the importance that respondents fully comprehended the experiment's procedures and the decision-making task they were to undertake, an interviewer was present on-site throughout the data collection process. These trained interviewers played a crucial role in administering the choice experiment, explaining the procedure to each respondent, and answering their queries regarding the experiment.

The vase options varied based on six key attributes, which were included in the model as dummy variables: Fairtrade certification, use of renewable energy sources in production, use of recycled material in the product, recyclability of the product (represented by a flexible pot), reusability of the product (rigid pot), and compostability of the product. Each of these variables represents distinct aspects of sustainability, allowing us to capture a broad spectrum of consumer preferences towards environmentally friendly and socially responsible products. Fairtrade certification is a proxy for ethical sourcing and trading practices, potentially appealing to consumers who prioritize social justice in their purchasing decisions. The use of renewable energy sources in production and of recycled materials are indicators of environmental responsibility. Recyclability, represented by a flexible jar, and reusability, represented by a rigid jar, introduce other layers of waste reduction strategies. They offer alternatives to single-use consumerism and promote the extension of product life cycles. Compostability, on the other hand, points to the ultimate form of waste reduction, where the product breaks down to form nutrient-rich compost that can replenish the soil, potentially attracting consumers keen on reducing landfill waste and supporting the natural cycle. By investigating these various attributes, this study seeks to understand which aspects are given priority by consumers during their purchase decisions, thereby providing valuable insights for manufacturers, policymakers, and other stakeholders in the quest towards more sustainable consumption patterns. Every respondent involved in the study was given a succinct yet comprehensive overview of the main attributes being evaluated in the experiment. This was crucial in ensuring a clear understanding of the factors influencing their decision-making process. In addition, half of the participants were provided additional contextual information through a short informative film about compostable pots. This screening was carried out before they proceeded to complete the section of the questionnaire that contained the choice experiment.

The data collected from the choice experiment were analyzed using a mixed logit model. This model offers flexibility in accommodating preference heterogeneity among respondents, providing richer insights into individual-level decision-making patterns. It also enables the estimation of the random variation in preferences across the population, allowing for the potential correlation in unobserved factors affecting choice. In addition to the mixed logit model, a latent class model was also used. This model groups respondents into distinct segments or 'classes' based on their response patterns, revealing heterogeneity in preferences that might not be captured when treating the sample as a homogeneous group. The latent class model can provide further insights into consumer segments' unique preferences and willingness to pay (WTP) for specific attributes.

RESULTS

The mixed logit model provides a valuable understanding of consumers' average willingness to pay for various sustainable product attributes. The relative WTP values, more than the specific numerical values, highlight the hierarchy of importance that these attributes hold in consumers' minds while making a purchase decision. In this analysis, consumers preferred the 'reusable' attribute, reflected in its top-ranking WTP. This finding underscores the importance consumers place on product longevity and the potential for repeated use. This preference aligns with an environmentally conscious mindset, favouring solutions that minimize waste and promote sustainability. The second and third highest WTP values were associated with 'compostable' and 'recyclable' attributes, respectively. These preferences indicate consumers' keen interest in a product's life cycle end, valuing solutions that facilitate responsible waste disposal or recycling. Consumers are not just considering the immediate use of the product but its longer-term environmental implications. The product from 'recycled materials' also received a positive WTP, albeit lower than the previous attributes. This reflects a consumer appreciation for products that utilize waste as a resource, although this attribute seems to be a lesser priority than the others. Finally, 'Fairtrade certification' and 'use of renewable energy' registered the lowest WTP values. This suggests that, although consumers recognize and value these aspects, they have less influence on purchasing decisions than the more tangible environmental impact attributes. It could be inferred that consumers might perceive these attributes as more abstract or distant from their immediate context or the product's direct impact. The interaction terms consider how being female might change the relationship between these attributes and the choice variable and whether the information treatment in the form of video had any significant effect on respondents' choices. Significant positive coefficients indicate that the treatment was effective in boosting preferences for the compostable vase and that female respondents are, on average, more influenced by some attributes than male respondents when choosing a product. However, it is crucial to note that these findings reflect average tendencies in the population and may not capture potential heterogeneity in consumer preferences. This is where the complementing insights from the latent class model can provide a more nuanced understanding of different consumer segments and their specific preferences.

For Class 1, the 'reusable' attribute is most highly valued, indicating that this consumer segment greatly appreciates products with a prolonged life cycle. This is followed by the 'compostable' and 'recycled material' attributes, showing a focus on waste management and end-of-life product considerations. Class 2 consumers also highly value the 'reusable' attribute, albeit slightly less than the 'compostable' attribute. This suggests that these consumers are particularly concerned with the environmental impact of product disposal and favour solutions that can decompose naturally or be reused. In Class 3, the 'compostable' attribute receives the highest WTP, followed by 'reusable' and 'recyclable'. This group seems to place a substantial emphasis on both the longevity and the disposal of the product, willing to pay a higher price for products that align with these concerns. Finally, Class 4 consumers have the highest WTP for the 'reusable' attribute, considerably higher than any other attribute within this class. This is followed by the 'recycled material' and 'recyclable' attributes. This indicates a strong preference for waste reduction strategies in this consumer group. Overall, these findings emphasize the diversity in consumer preferences, underscoring the importance of acknowledging these differences in product design and marketing strategies. The consistently high WTP for the 'reusable' attribute across all classes highlights the universal preference for durable and long-lasting products, suggesting that emphasizing these features may resonate with a broad range of consumers. However, the particular focus on 'compostable' and 'recyclable' attributes in different classes also calls for targeted marketing approaches that resonate with the unique sustainability priorities of each consumer segment.

CONCLUSIONS AND LIMITATIONS

This study provides significant insights into consumers' preferences towards sustainability-related attributes of a simple product, a gardening vase, revealing that consumers value reusability, compostability, and recyclability most when making purchase decisions. This highlights the need for businesses to focus on designing long-lasting products and facilitating their disposal in an eco-friendly manner. The lower value attached to the 'recycled materials' attribute suggests a need for further consumer education regarding the importance and benefits of utilizing waste as a resource. Moreover, the significant impact of information treatment and gender on certain attributes reinforces the role of targeted communication and consumer education in enhancing sustainability-oriented purchasing decisions. While this study offers insights into consumers' willingness to pay for sustainability attributes, limitations exist. Findings may not be fully transferable to other product contexts, and the general population may have varying degrees of understanding and interpretation of these attributes.

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Beauty and naturalness: exploring consumer perspectives and purchase intentions of edible flowers

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PAROLE CHIAVE
Edible flowers, naturalness, visual aesthetics, consumer preferences, theory of planned behaviour

Introduction

Edible flowers have emerged as a fascinating frontier in the world of food production and consumption, intricately intertwined with consumer preferences. Edible flower production and consumption is closely linked to consumer preferences and is still poorly understood even if it represents an opportunity for product differentiation. There are few studies in the scientific literature that analyse consumer preferences (Chen and Wei, 2017), but many focus on the exalted nutritional characteristics of the product (Mlcek and Rop, 2011; Rivas-García *et al.*, 2021; Rodrigues *et al.*, 2017). The increasing focus on sustainability and health has led to a search also for natural and aesthetically pleasing alternatives to traditional food products (Román *et al.*, 2017). However, the production and consumption of edible flowers are still limited by consumers' lack of knowledge and familiarity with these products. In addition, their aesthetic characteristics play a key role in products acceptance and success. Addressing this challenge requires innovative solutions aimed at fostering a deeper understanding of edible flowers and the implementation of compelling presentation and marketing strategies. To unravel the enigma surrounding consumer behaviour in this context, we turn to the Theory of Planned Behaviour (TPB). TPB is used to understand how consumers' purchase intentions are influenced by their individual beliefs, social norms, and perceived behavioural control. We adapted Ajzen's theoretical framework by adding case-specific validated constructs, i.e., appreciation of aesthetics in food; naturalness; and risk perception. The study aims to identify the main factors that influence consumer preferences for flowers, such as naturalness, aesthetics, and safety and to investigate how these factors interact with each other to shape consumer attitudes towards edible flowers products. We find that the appreciation of aesthetics in food has a positive and significant impact on attitudes towards edible flowers, as also the importance of naturalness in food choices.

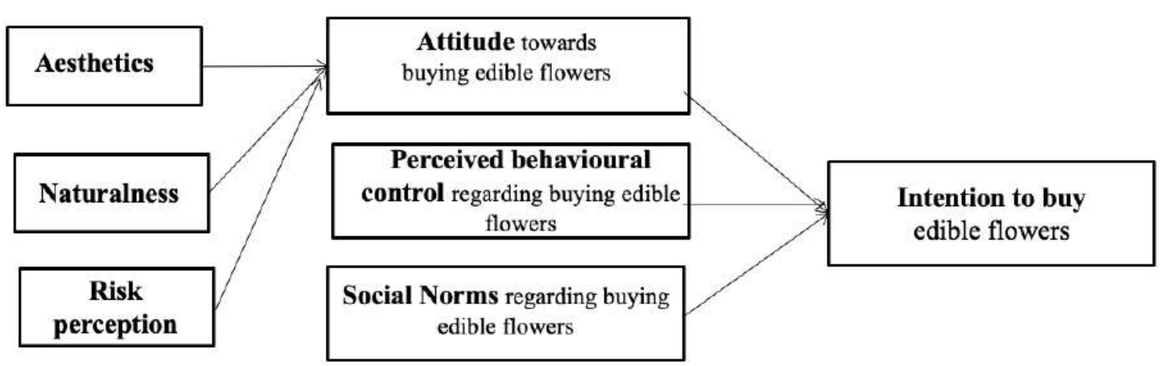
Methods and data

To address these research questions, after investigating consumer knowledge and consumption behaviour in relation edible flowers together with the appreciation for different flower characteristics, we applied the Theory of Planned Behaviour (TPB) to study the determinants behind the purchase intention for edible flowers. More in detail, the conceptual framework considers the standard variables of the TPB: attitudes towards edible flowers, perceived behavioural control in relation to their purchase and social norms on the same purchase, as predictors of purchase intentions (Ajzen, 1991). The research also investigates possible background factors affecting the attitudes towards edible flowers. Three main constructs were considered: the appreciation of aesthetics in food; the importance of naturalness; and risk perceptions with regards to the consumption of edible flowers.

To collect data for the analysis, we built an ad hoc questionnaire, structured to investigate knowledge and preferences regarding the consumption of edible flowers and a set of respondents' individual characteristics. The questionnaire included several sections: introduction to the questionnaire, privacy policy, description of what we define as edible flowers, previous knowledge about edible flowers, buying and consumption habits of edible flowers, and blocks of questions related to the latent constructs included in our conceptual framework reported in Figure 1, namely, intention to buy edible flowers; attitudes, perceived behavioural control and social norms in relation to the purchase of edible flowers; the appreciation of food aesthetics; the importance of naturalness; and edible flower-consumption risk perceptions. Data were collected through online interviews during the period between September and December 2022. The sample consisted of 844 subjects who are representative of the Italian population.

The core constructs of the TPB were measured adapting to our specific research question the standard items included in the TPB questionnaire (Ajzen, 1991). The influence of the visual aesthetic flowers was tested with the scale proposed by Paakki et al. (2019) while the importance of naturalness in food with the scale found in Roman et al., 2017. For what concerns risk perceptions related to edible flowers we adapted the risk perception scale of Albanesi et al. (2011). The food choice questionnaire was also included with the addition of some items dealing with ethical and environmental concern, as proposed by Verain et al. (2021)in the SUS- FCQ.

Figure 1 – Conceptual framework adapted from the Theory of Planned Behaviour



Results

In this study, we investigated the level of prior knowledge and attitudes towards edible flowers among respondents. A majority of the respondents had prior knowledge of edible flowers (68%), with 41% having consumed them previously. Additionally, a smaller proportion of respondents had purchased edible flowers before (32%). Aesthetic appearance and product authenticity are important attributes for most respondents: visual aesthetic beauty and naturalness were identified as the main attributes of edible flowers. In addition, the sensory aspect of the product was also considered important, with taste, smell and colour identified as key factors. Interestingly, product size was found to be less relevant to the respondents.

Moreover, moving the results of the relations among latent constructs, the confirmatory factor analysis confirms the validity of the scales adopted. These also show good levels of internal consistency that are all above 0.7 except for the items pertaining to the risk evaluation. SEM Model fit are reasonable with RMSEA of 0.08. Results from the structural equation model analysis (Table 1) confirms the relations of the TPB theory in relation to the effects on purchasing intentions of attitudes towards edible flowers, perceived behavioural control and social norms in relation to purchase of edible flowers, that have all a significant and positive effect. Moreover, we find that the appreciation of aesthetics in food has a positive and significance impact on attitudes towards edible flowers, as also the importance of naturalness in food choices. This means that consumers who value food appearance and colour, and those who look for natural products seem to have positive evaluations of edible flowers. Instead, as it would be expected, the greater the perception about the risks of eating edible flowers, the lower the attitudes towards such products. This highlights that the most concerned consumers may prefer not to purchase these novel foods.

Table 1 – Results from the Structural Equation Model analysis

	Estimate	*Std. Error*	*P-value*	*Significance*
Effect on Intention				
Attitude	0.779	0.027	0.000	***
Social Norm	0.201	0.020	0.000	***
Perceived behavioural Control	0.443	0.072	0.000	***
Effect on Attitude				
Naturalness	0.295	0.050	0.000	***
Aesthetics	0.631	0.042	0.000	***
Risk perception	-0.095	0.036	0.009	***

Notes: Significance. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The study confirms the validity of the scales used and the relationships among latent constructs. The findings suggest that attitudes towards edible flowers, perceived behavioural control, and social norms all have a significant and positive effect on purchasing intentions. Furthermore, appreciation of aesthetics in food and the importance of naturalness in food choices positively influence attitudes towards edible flowers. The perception of risks associated with eating edible flowers negatively impacts attitudes towards them, indicating that some consumers may be hesitant to try them. The study provides a contribution to the limited existing literature and allows a deeper understanding of the factors that drive consumer preferences for flowers and how these preferences influence buying behaviour. It will also offer practical implications for businesses and marketers who want to promote flower products to consumers more effectively. Overall, these findings provide useful insights for businesses and individuals interested in promoting the consumption of edible flowers.

Discussion and conclusion

In this study, respondents' prior knowledge levels and attitudes toward edible flowers were analysed. The results show consumer perceptions in this area. A significant majority of respondents (68 percent) showed that they were familiar with edible flowers and 41 percent that they had consumed them before. In addition, a considerable percentage (32%) have even taken the step of purchasing this product. It is evident that the aesthetic appeal and authenticity of the product are key attributes in the minds of most respondents. Aesthetic beauty and naturalness emerged as the main attributes that fascinate consumers when it comes to edible flowers. In addition, the sensory dimensions of these flowers, which include taste, smell and colour, played a key role in determining consumer preferences. Interestingly, product size seemed to be less important to respondents. The confirmatory factor analysis solidly validated the scales we adopted, underpinning the robustness of our research methodology. Furthermore, these scales exhibited commendable levels of internal consistency, with coefficients exceeding 0.7 across the board, except for items related to risk assessment. Our structural equation model analysis, coupled with reasonable model fit indicators such as an RMSEA of 0.08, elucidated the intricate relationships envisioned by the Theory of Planned Behaviour (TPB). The results confirm that attitudes towards edible flowers, perceived behavioural control, and social norms wield substantial and positive influence over purchasing intentions. The study reaffirms the validity of research constructs and sheds light on the multifaceted factors that steer consumer preferences for edible flowers. These insights hold profound implications for businesses and marketers seeking to effectively promote flower products to consumers. They provide a robust foundation for understanding the drivers of consumer choices and offer invaluable guidance for those interested in stimulating the consumption of edible flowers.

In conclusion, the study adds a valuable contribution to the limited existing literature on edible flowers, offering a deeper understanding of the intricate factors influencing consumer preferences and purchase behaviours. These findings will empower businesses and individuals alike expand the product market enriching both our culinary landscapes and the choices available to discerning consumers.

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Metodi e approcci per l'identificazione di obiettivi e priorità per la digitalizzazione della filiera ovina in Toscana: il caso del Caseificio di Manciano

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PAROLE CHIAVE

Digitalizzazione; filiera ovina toscana; innovazione; caso studio.

INTRODUZIONE

La digitalizzazione del settore agricolo e delle aree rurali rientra nell'obiettivo trasversale di promozione della conoscenza e innovazione della PAC 2023-2027. La percentuale di agricoltori che beneficiano dei mezzi a sostegno dell'agricoltura di precisione rappresenta un indicatore chiave per il raggiungimento di questo obiettivo (Cristiano et al. 2019). Tuttavia, non sempre le tecnologie digitali per l'agricoltura rispondono alle necessità degli agricoltori (Lindblom et al. 2017, Burch et al. 2023). Risulta, pertanto, necessario applicare un modello di innovazione dinamico, basato sull' interazione tra attori (Lundvall, 2016, Fieldsend et al. 2021). Nonostante il crescente bisogno di identificare le tecnologie digitali adeguate ai sistemi produttivi locali da supportare con interventi *ad hoc*, in letteratura il tema dell'identificazione delle tecnologie digitali sulla base delle priorità contestuali non è attualmente adeguatamente trattato.

L'obiettivo di questo lavoro è proporre un approccio metodologico basato sullo studio dei flussi di informazione, delle reti di relazioni intercorrenti e delle problematiche dei diversi settori e territori che permetta di identificare obiettivi di applicazione delle tecnologie digitali alle filiere agroalimentari locali.

Nello specifico la metodologia è stata applicata per questo contributo alla filiera ovina Toscana del Caseificio di Manciano, in provincia di Grosseto.

CONTESTO TERRITORIALE

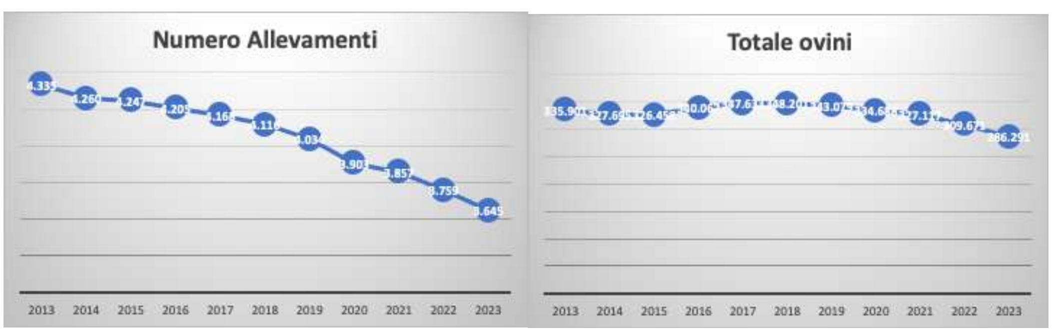
L'allevamento ovino in Italia è determinante per la funzione ambientale, sociale e culturale di mantenimento e presidio di aree marginali in cui non sarebbero possibili altre attività produttive (ISMEA, 2022). La filiera ovina si caratterizza per l'elevato numero di operatori nella fase agricola (80.665 aziende), per l'alta concentrazione produttiva in un numero ristretto di regioni e per un trend strutturale in costante diminuzione. Nel corso dell'ultimo decennio si è osservata nel comparto ovino una perdita media annua di 1.113 aziende e un aumento medio della dimensione aziendale del 35%.

Considerando i dati della Banca Dati Nazionale dell'Anagrafe Zootecnica (BDN) del primo semestre 2023 le regioni in cui si concentra la filiera ovina italiana e che vantano una media capi/azienda, superiore alla media nazionale pari a 74 sono la Sardegna (211), il Lazio (86), la Sicilia (85) e la Toscana (79).

Il 36% degli allevamenti toscani è ubicato nelle provincie di Siena e Grosseto, con una presenza di capi ovini pari al 73% dell'intera popolazione ovina regionale (3.654 aziende), e una dimensione media capi/azienda pari a 165 per la provincia di Grosseto e 153 per quella di Siena. Il latte prodotto negli allevamenti toscani, pari a 3.460 tonnellate nel solo mese di Maggio 2023 (ISMEA, 2023), è destinato quasi esclusivamente all'industria di trasformazione che lo utilizza per la produzione di formaggi spesso a denominazione d'origine protetta (D.O.P.).

La trasformazione casearia unita all'elevato know-how di tradizioni e tecniche casearie che gli allevatori custodiscono rappresentano punti di forza della filiera ovina toscana. Il limitato ricambio generazionale e la scarsa propensione degli attuali allevatori ad investire in innovazione rallentano però lo sviluppo del settore. Il comparto lattiero-caseario ovino in Toscana detiene un importante ruolo di presidio del territorio e tutela della biodiversità animale pertanto risulta importante sviluppare nuovi scenari produttivi.

Figura 1 – Andamento delle consistenze degli allevamenti e dei capi ovini in Toscana 2013-2023



Fonte: Dati forniti dalla BDN dell'Anagrafe Zootecnica istituita dal Ministero della Salute presso il CSN dell'Istituto "G. Caporale" di Teramo

LE TECNOLOGIE DIGITALI NELLA FILIERA OVINA

Le tecnologie digitali vengono usate nel settore zootecnico per controllare, monitorare e gestire l'attività degli animali. La conoscenza comportamentale dei singoli animali permette di migliorarne la salute ed il benessere con impatti positivi sulla sostenibilità del settore zootecnico. Le tecnologie digitali sono state finora applicate alla zootecnia intensiva, prevalentemente bovina per l'alto costo di alcune tecnologie e della omogeneità del funzionamento delle aziende intensive (Silva et al.2022, Neethirajan e Kemp, 2021).

I problemi affrontati con la tecnologia digitale possono essere diversi tra sistemi intensivi ed estensivi e questi ultimi, pongono particolari sfide all'applicazione della tecnologia. Nonostante ciò, è generalmente ritenuto che l'applicazione della tecnologia digitale possa avere un impatto positivo sul benessere e la salute degli animali e, più in generale, sulla loro performance. I problemi degli allevamenti estensivi sono legati non solo alla scarsa disponibilità di manodopera e la bassa produttività, (Bertolozzi-Caredio et al. 2021), ma anche alla nutrizione e riproduzione degli animali (Goddar, et al. 2006, Villalba et al. 2016).

La diversità dei sistemi di produzione e la presenza di numerose barriere socioeconomiche richiedono di integrare l'uso della tecnologia con i saperi tradizionali delle comunità locali dedite alla pastorizia (Caja et al. 2020, Rutter, 2017, Herlin et al. 2021). Per questo tipo di sistemi, che necessitano del supporto pubblico per beneficiare della tecnologia digitale, è auspicabile l'utilizzo di approcci partecipativi e di strategie di co-creazione per identificare le tecnologie rilevanti per le diverse realtà territoriali (Rinaldi et al. 2018).

METODOLOGIA

Per rispondere alla domanda di ricerca sulle priorità di digitalizzazione della filiera ovina del contesto del sud della Toscana, questo studio utilizza il caso studio (Yin, 2003) per sviluppare un approccio metodologico a partire dal contesto del Caseificio sociale di Manciano, che è parte integrante del Consorzio del Pecorino Toscano D.O.P., quest'ultimo composto da 245 allevatori, 17 caseifici, uno stagionatore e un confezionatore.

Il disegno di ricerca è stato strutturato a partire dal coinvolgimento degli attori coinvolti nella filiera, con i quali sono stati identificati i problemi per poi pianificare gli steps conseguenti e la possibile implementazione di azioni reali criticamente valutate insieme agli attori coinvolti (Cavicchi et al, 2021), seguendo un approccio orientato alla *Participatory Action Research* (PAR). Tale approccio prevede la collaborazione tra ricercatori e comunità di interesse nello sviluppo di un processo in cui, in maniera circolare gli attori lavorano insieme all'identificazione delle problematiche, alla progettazione di azioni adeguate al problema, e dall'osservazione e dalla raccolta dei risultati strutturano il successivo ciclo di ricerca-azione (Cornish et al. 2023).

La partecipazione degli attori è avvenuta attraverso 3 workshops: due in presenza, uno presso il Caseificio di Manciano, il 24 Febbraio 2023, il secondo, presso l'Università di Pisa il 26 Maggio 2023 ed infine, un terzo online il 1° giugno 2023. I diversi attori della filiera (allevatori, caseificio, consorzio, veterinari, agronomi, esperti di ICT), identificati dal gruppo di ricerca in collaborazione con il personale del Caseificio di Manciano sono stati invitati a partecipare ai workshops.

L'obiettivo del primo incontro è stato quello di identificare gli obiettivi per l'applicazione delle tecnologie digitali nella filiera ovina locale. La discussione di gruppo è partita dall'esposizione di ogni partecipante delle problematiche ritenute rilevanti secondo la propria esperienza, fino ad arrivare con l'aiuto di un facilitatore, ad identificare gli obiettivi collettivi di applicazione delle tecnologie digitali.

Nel secondo workshop, attraverso un focus group sono stati mappati gli attori direttamente e indirettamente interessati dalla filiera, le risorse e i sistemi digitali. L'analisi dei flussi di informazioni ha contribuito ad approfondire, come avviene attualmente, lo scambio di dati e quali sono le informazioni e le conoscenze utili per ciascun attore da implementare attraverso tecnologie digitali.

Nel terzo workshop, c'è stata una restituzione agli attori locali dell'analisi dello scambio di informazioni all'interno della filiera e, attraverso una discussione di gruppo, sono state definite le tecnologie su cui avviare una sperimentazione ed un processo di sviluppo partecipato per contribuire a migliorare il sistema dal punto di vista del prodotto, del processo e dell'organizzazione della filiera osservata.

Una tema trasversale ai tre incontri è stata l'identificazione delle soluzioni digitali attualmente utilizzate nel sistema. Sulla base delle informazioni raccolte sono state descritte le tecnologie digitali attualmente utilizzate o in via di sperimentazione nella filiera osservata.

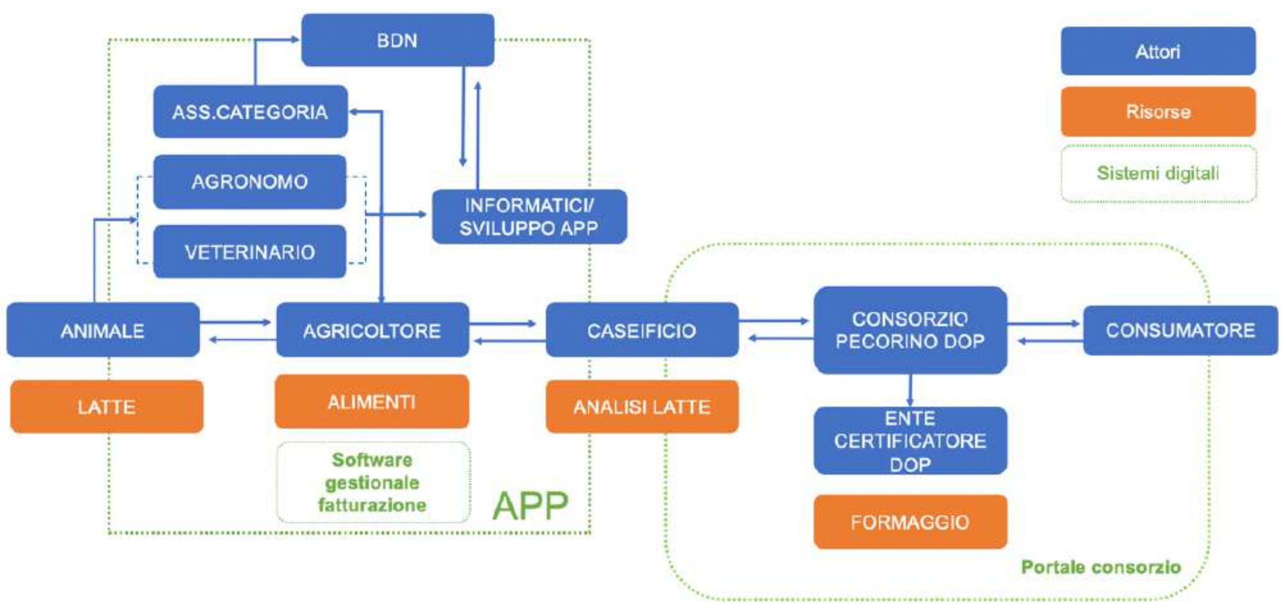
RISULTATI E DISCUSSIONE

Il problema principale emerso dalla discussione del primo workshop è la riduzione annuale del numero di allevamenti che conferiscono il latte al Caseificio di Manciano. Confermato anche dai dati, tale decremento comporta una riduzione nella produzione di Pecorino Toscano D.O.P. e, dal punto di vista del territorio, una modifica del paesaggio agrario ed una riduzione del presidio degli agricoltori nell'area maremmana già caratterizzata da una bassa densità abitativa. La discussione ha dunque sottolineato che l'innovazione digitale potrebbe e può rendere il lavoro degli allevatori ovini più semplice e "attraente" per le giovani generazioni partendo dalla possibilità di avere una assistenza tecnica aggiornata e radicata sul territorio.

L'aumento dell'efficienza nella gestione dell'allevamento ovino è stato dunque identificato come obiettivo generale dell'applicazione della tecnologia digitale. La riduzione del lavoro burocratico, la possibilità per il settore della trasformazione di stimare in anticipo quantità e qualità del latte ed il miglioramento della qualità del lavoro dei tecnici sul territorio sono stati identificati come i maggiori benefici attesi dall'applicazione delle tecnologie digitali nella discussione collettiva durante i workshop.

Il secondo workshop ha identificato i flussi di informazione presenti nella filiera ovina del Caseificio di Manciano attraverso la mappatura di attori, risorse e sistemi digitali attualmente utilizzati. La seguente Figura 2 ne propone una panoramica.

Figura 2 – Mappatura della filiera osservata



Fonte: Elaborazione degli autori.

Dalla figura emerge come le aziende siano soggette a diversi scambi di informazioni con attori istituzionali e commerciali. L'allevatore spesso raccoglie dati sui propri capi e sulle proprie pratiche agronomiche li immette in diversi sistemi gestionali che gli permettono di comunicare con altri soggetti quali tecnici, istituzioni e caseificio. L'immissione manuale di dati da parte dell'allevatore è un aspetto critico, che andrebbe limitato il più possibile per evitare errori di inserimento e consentire agli allevatori di utilizzare il proprio tempo in altre attività aziendali. Il passaggio di informazioni maggiormente digitalizzato al momento è quello tra Caseificio e Consorzio. Il Consorzio del Pecorino Toscano D.O.P. ha infatti sviluppato uno specifico portale che permette di raccogliere i dati dai 17 caseifici che controlla attraverso l'ente certificatore della D.O.P. Inoltre, grazie ad alcuni progetti di ricerca, il Caseificio di Manciano è attualmente impegnato nella sperimentazione di una App che permetterà ai tecnici di gestire i dati aziendali e quelli relativi alla salute degli animali.

Durante il terzo workshop lo sviluppo di una app per la gestione dei dati in azienda, dal singolo animale all'allevatore e al tecnico e la sperimentazione di un collare per la gestione dei predatori sono state identificate come tecnologie prioritarie su cui lavorare ed investire ulteriori risorse.

Le tabelle 1 e 2 che seguono descrivono le tecnologie attualmente utilizzate dal Caseificio di Manciano.

Tabella 1 – Tecnologie utilizzate per lo scambio di informazioni tra Caseificio e Consorzio

Funzione	Tecnologia	Descrizione	Stato
Monitoraggio quantità di formaggio prodotto	Portale Consorzio	Raccoglie i dati di tutti i caseifici, gli allevatori, e gli stagionatori: produzione di latte da zona D.O.P., quantità destinata alla produzione di Pecorino Toscano, numero e peso delle forme prodotte e vendute distinte per tipologia a pasta tenera e stagionato, etichette autorizzate per singola azienda, verbali di autocontrollo ed esito analisi su latte e formaggio, verbali di ispezione dell'agente vigilatore del Consorzio eseguiti presso i punti vendita ed esito delle analisi di verifica.	Utilizzato dal Consorzio, non pubblico - dati sensibili
Monitoraggio quantità di latte per la produzione di Pecorino D.O.P.	Portale Consorzio	Trasmette le informazioni dal Caseificio al Consorzio	Utilizzato dal Consorzio

Fonte: Elaborazione degli autori

Tabella 2 – Tecnologie utilizzate per lo scambio di informazioni tra Allevatore e Caseificio

Funzione	Tecnologia	Descrizione	Stato
Monitoraggio quantità latte consegnato al Caseificio	App Gestionale	Ritiro del latte in azienda dati relativi al latte consegnato.	Utilizzabile
	Gestionale Caseificio	Fogli di calcolo per gestire ingresso e uscita del prodotto	Utilizzato
Monitoraggio qualità latte consegnato al Caseificio	Database analisi di laboratorio del latte	Raccoglie le analisi del latte ricevuto dalle singole aziende per rilevarne la qualità. Ha bisogno di un controllo manuale da parte del Caseificio. Il dato non può essere trasmesso automaticamente alle aziende	Utilizzato – dati riservati
	Gestionale Caseificio	Fogli di calcolo con dati sulle analisi del latte ricevuto dalle aziende	Utilizzato
Monitoraggio numero di animali in azienda	AEDIT App	App che facilita la gestione dei dati dell'anagrafe ovina e la gestione dei dati per singolo capo in termini di entrate e uscite.	Prototipo in sperimentazione
Identificazione animali presenti in azienda	Bolo identificativo	Permette di identificare ogni animale univocamente	Usata
	Registro elettronico BDN	Archivia i dati di ogni animale nel sistema nazionale	Usata
	AEDIT App	App che si interfaccia con i lettori di boli bluetooth, collegandoli con la scheda di rilievo. Archivia le letture bluetooth.	Prototipo da sviluppare

Monitoraggio quantità di latte prodotto	AEDIT App	App gestione dati: deve essere adattata sul singolo animale, al momento è possibile identificare la produzione media aziendale.	Prototipo da sviluppare
Monitoraggio stato di salute dell'animale	AEDIT App	App che facilita la gestione degli eventi per singolo capo: ecografie, parti, saute, lattazione etc.	Prototipo in sperimentazione
Identificazione delle razioni per gli animali	NDS	software di Alimentazione - www.rumen.it utilizzabile solo dai tecnici - complessità dell'applicativo.	utilizzabile
Protezione degli animali dai predatori	Sheepwolves	Collare per segnalare il pericolo di predazione - https://www.espaceelab.com	In sperimentazione

Fonte: Elaborazione degli autori

Le tecnologie attualmente utilizzate e sperimentate presso il Caseificio di Manciano mostrano l'interesse degli attori coinvolti nel territorio toscano per lo sviluppo di tecnologie digitali nella filiera ovina, evidenziando come le singole tecnologie possano essere migliorate e messe a sistema, lavorando sulla loro interoperabilità, attraverso specifici progetti di sviluppo dell'innovazione.
I partecipanti ai workshops hanno identificato, inoltre alcune possibili applicazioni della tecnologia digitale nello specifico contesto come: la digitalizzazione delle relazioni tra organismo di controllo e caseificio; lo sviluppo di tecnologie che sostituiscano, almeno in parte, la manodopera che oggi è difficilmente disponibile; lo sviluppo di un sistema gestionale interoperabile adattabile alla filiera ovina che migliori il lavoro dei tecnici, permettendogli di costruire una relazione con le aziende basata su informazioni ottenute dai dati raccolti in azienda.

CONCLUSIONI

Nell'ambito dei tre workshops consecutivi di Ricerca-Azione partecipata, sono state sviluppate competenze tecniche e capacità di analisi dai diversi attori coinvolti che hanno evidenziato come il coinvolgimento delle comunità locali nella definizione degli ambiti prioritari di applicazione della digitalizzazione permetta di facilitare il contributo della tecnologia allo sviluppo rurale.

Partendo dallo stato dell'arte delle tecnologie disponibili sul territorio e dalle necessità della comunità locale, è stato possibile identificare gli ambiti su cui investire risorse per lo sviluppo di nuove tecnologie o l'adattamento di tecnologie esistenti. Gli steps identificati dai partecipanti al processo e che possono essere applicati, adattandoli, ad altri contesti, sono: l'identificazione degli attori e dell'ecosistema digitale; l'identificazione degli obiettivi di applicazione della tecnologia digitale, la mappatura dei flussi di informazione attraverso la filiera e degli attori, risorse e tecnologie attualmente usati per lo scambio di informazioni. Sulla base delle informazioni raccolte nel processo circolare di ricerca-azione partecipata è stato possibile identificare le tecnologie su cui investire ulteriori risorse per migliorare la filiera locale identificata.

Il processo messo in pratica, l'interazione tra ricercatori di diverse discipline, tecnici e allevatori con aziende specializzate nello sviluppo di software può essere considerato una esperienza di co-design transdisciplinare delle tecnologie digitali in agricoltura (Burch et al. 2023). La diversità degli attori coinvolti, la struttura dei flussi di informazione e degli scambi tra pari tra ricercatori, tecnici ed agricoltori e la loro capacità di analisi collettiva permettono di considerare il gruppo di lavoro stabilito nel contesto del Caseificio di Manciano un *Agricultural Knowledge Innovation System* (AKIS) come definito da Fieldsend (2021).

Tale processo è ancora in corso, e per valutarne gli impatti bisognerà aspettare l'applicazione delle nuove tecnologie sviluppate. Nonostante ciò, la metodologia proposta ha permesso di identificare le tecnologie digitali auspicabili di finanziamento attraverso il coinvolgimento delle comunità locali, garantendo lo scambio di conoscenze, la formazione *peer-to-peer* tra attori e facilitando l'adozione dell'innovazione a livello territoriale e di filiera secondo quanto emerge dalla letteratura.

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Women entrepreneurship in agriculture – a bibliometric analysis

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KEYWORDS

women in agriculture; female entrepreneurship; gender roles; bibliometric analysis.

INTRODUCTION

Women's involvement in entrepreneurship is becoming more recognised as an important aspect of economic development, particularly in agriculture, where women represent a significant proportion of the workforce. In many countries, the livelihood of women is highly dependent on agrifood systems. 66% of women in Sub-Saharan Africa are employed in agrifood systems, compared to 60% of men's employment, and a similar situation is in Asia (71% to 41%, respectively) (FAO,2023). However, despite accounting for 43% of the workforce in agriculture worldwide, women still encounter significant challenges in accessing resources, markets, and decision-making positions (FAO, 2020). The barriers women face include gender roles in family and work environment, gender stereotypes about entrepreneurship and gender inequalities in access to information and networking opportunities (Stratigaki, 2005). Furthermore, women's entrepreneurial activity is low in the agriculture sector and across all economic activities, accounting for only 10.3% of women entrepreneurs, and the gender gap in entrepreneurship rates is 42% (Boutaleb, 2023).

Research on women's participation in agriculture remains limited despite increasing interest in female entrepreneurship. Our study builds on previous research highlighting the importance of examining the gender aspect of entrepreneurship and agricultural development. Female entrepreneurship in agriculture can have broader social and environmental impacts, including empowering women, enhancing food security, and promoting sustainable farming practices.

DATA AND RESEARCH METHODOLOGY

To conduct this study, we searched the Web of Science database for articles published from 1993 to 2023 using keywords related to women in agriculture and agricultural entrepreneurship. The database was cleaned, and only articles in English were analysed, as most of the literature is disseminated in this language (López-Fernández et al., 2016). Therefore, only published articles were included, excluding books, book chapters, proceeding articles, and other non-peer-reviewed sources. Furthermore, a manual data cleaning took place based on the topics of the articles, as many articles related to human health, mainly published in medicine-related journals, were also excluded from the final database. We used bibliometric analysis to quantitatively analyse scientific publications and provide valuable insights into the research trends, themes, and patterns related to female entrepreneurship in agriculture.

By analysing the publications from 1993 to 2023 in the Web of Science database, we aimed to identify the key research themes, influential authors and institutions, and most frequently cited articles related to this topic. This included analysing the distribution of articles over time, the authors' countries of origin, and the keywords used in the articles. To analyse the data, we used descriptive statistics, including frequency distributions and percentages. We used the bibliometrix package in R Studio and VOS Viewer software to generate visualisations and maps to help visualise the data.

DISCUSSION OF RESULTS

Our study seeks to contribute to the literature on female entrepreneurship in agriculture by providing a comprehensive overview of the research landscape and highlighting the gaps and opportunities for future research. In doing so, we aim to inform policy and practice by identifying key areas for further investigation and effective channels for disseminating knowledge to promote the participation of women in agricultural entrepreneurship.

The dataset for this study was retrieved from the Web of Science database and contained 900 documents from 510 sources. The dataset covers the period from 1993 to 2023, the average document age is 6.25 years, and the average number of citations per document is 13.29. The dataset includes 2917 authors, with 162 single-authored documents and an average of 3.44 co-authors per document. Among the co-authorships, 25.78% were international collaborations.

MOST PRODUCTIVE INSTITUTIONS

The data shows that the top affiliations in the bibliometric analysis of the topic of women entrepreneurship in agriculture are predominantly from developing countries like Nigeria, Ghana, and India that are among the top affiliations, which indicates a growing interest in this topic in these regions. The presence of universities from developing countries shows that research on women entrepreneurship in agriculture is not limited to traditional research institutions, and that there is a growing interest in this topic in regions where women have historically faced significant barriers to entrepreneurship. From the developed countries United States, Australia, Sweden and the United Kingdom are among the most productive institutions. It is important to note that the ranking is based on the number of publications and does not reflect the quality of the documents.

KEYWORD ANALYSIS

Keyword analysis is a bibliometric tool that identifies and analyses the frequency, co-occurrence, and trends of keywords used in research articles, documents or publications. Based on the analysis of the authors' keywords in the literature on women entrepreneurship in agriculture, it is clear that this field of study has matured and evolved substantially over the years. Figure 1 presents the thematic evolution of the keyword co-occurrence of our database. Initially, the research focused on identifying and addressing socio-economic challenges women entrepreneurs face by the presence of the 'poverty' keyword. The keywords also reflect an interest in understanding the transition process from traditional to modern agricultural practices and the implications for female entrepreneurs. 'Education' highlights the need for skills and knowledge development to overcome and empower women entrepreneurs in this context. In the following years, a transition of thematic evolution can be noted as a stronger focus on economic aspects occurs, including keywords such as 'economy', 'growth', and 'income' investigating the economic implications of female entrepreneurship and the potential to reduce social and economic disparities. Growing research emphasises understanding the changing nature of work and employment for women in the agricultural sector. The study of determinants and factors influencing entrepreneurship is evident, with keywords like 'self-efficacy'. Furthermore, 'biodiversity' and 'technology' keywords emerge as significant research areas, reflecting the interest in addressing environmental challenges, promoting sustainable practices and the role of technology and digital platforms in supporting women entrepreneurs. The analysis reveals attention to social and cultural factors such as family, roles, gender differences, and stereotypes. More recent research focuses on understanding the factors influencing the performance and success of female entrepreneurs in agriculture, including the determinants of their decision-making, the role of education in empowering women in this field, and the potential for growth and diversification. Lastly, the keyword co-occurrence in 2022 and mid-2023 suggests a focus on understanding the factors contributing to women entrepreneurs' success and well-being in agriculture, including their knowledge acquisition, policy implications, work-related dynamics and the role of family farms in female entrepreneurship. The presence of keywords like 'performance', 'productivity', 'management', and 'enterprises' suggest that the research is evolving towards studying female entrepreneurship as economic drivers rather than actors in contributing to the economic survival of communities. The analysed keywords underscore the complex and multidimensional nature of women's entrepreneurship in agriculture and the need for interdisciplinary research to fully understand the challenges and opportunities for women in this sector.

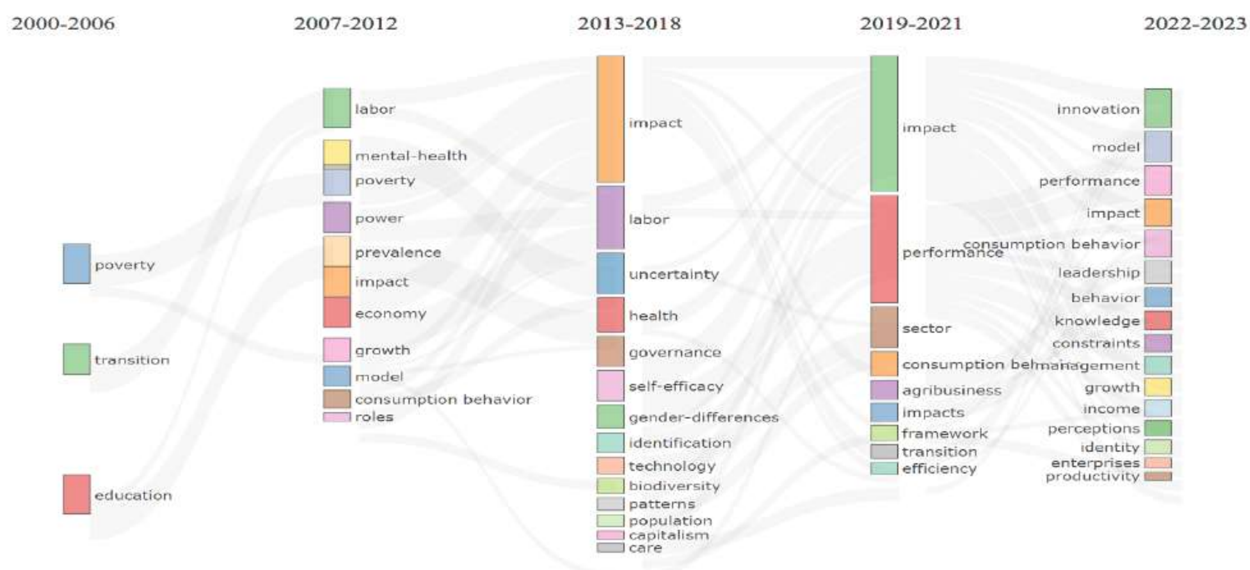

Figure 1 Author's keyword analysis (2000-2023)

CO-CITATION ANALYSIS

The co-citation analysis reveals that the literature on gender in agriculture encompasses various topics, including women's entrepreneurship and tourism, technology adoption, farm survival, and rural immigration. The co-citation analysis is a bibliometric analysis technique that analyses the frequency with which two documents are cited in the same reference list of a third document.

The first cluster presented in Figure 2 comprises a diverse set of references on various topics. It includes studies on economic development, food policy, and gender issues. The primary objective of these studies is to examine the impact of multiple factors, such as household surveys, poverty, productivity, and land ownership, on economic development and gender equality (Doss 2001, 2002, 2017; Quisumbing and Pandolfelli, 2010). The results of these studies provide valuable insights into the complex relationships between economic development, gender, and food security.

The second cluster primarily focuses on women's role in agriculture and entrepreneurship. The studies in this cluster aim to examine the impact of various factors, such as access to resources, education, and social norms, on women's participation in agriculture and entrepreneurship (Fairlie and Robb, 2009; Bock 2004; McGehee et al., 2007). The results highlight the importance of addressing the barriers that prevent women from participating fully in these areas. Other papers explore the potential for entrepreneurship to contribute to rural development and the importance of social networks and community support for rural entrepreneurs (Seuneke et al., 2013).

The third encompasses key themes that emerge, including the changing role of women in agriculture, the challenges and opportunities faced by women farmers, the gendered division of labour in agriculture, and the importance of community-based agriculture (Alston, 2010; Contzen 2016). Other papers examine how women adapt to changes in the agricultural sector, including the increasing use of technology, and highlight the importance of supporting women farmers to promote sustainable agriculture (Brasier, 2014; Hay and Pearce, 2014).

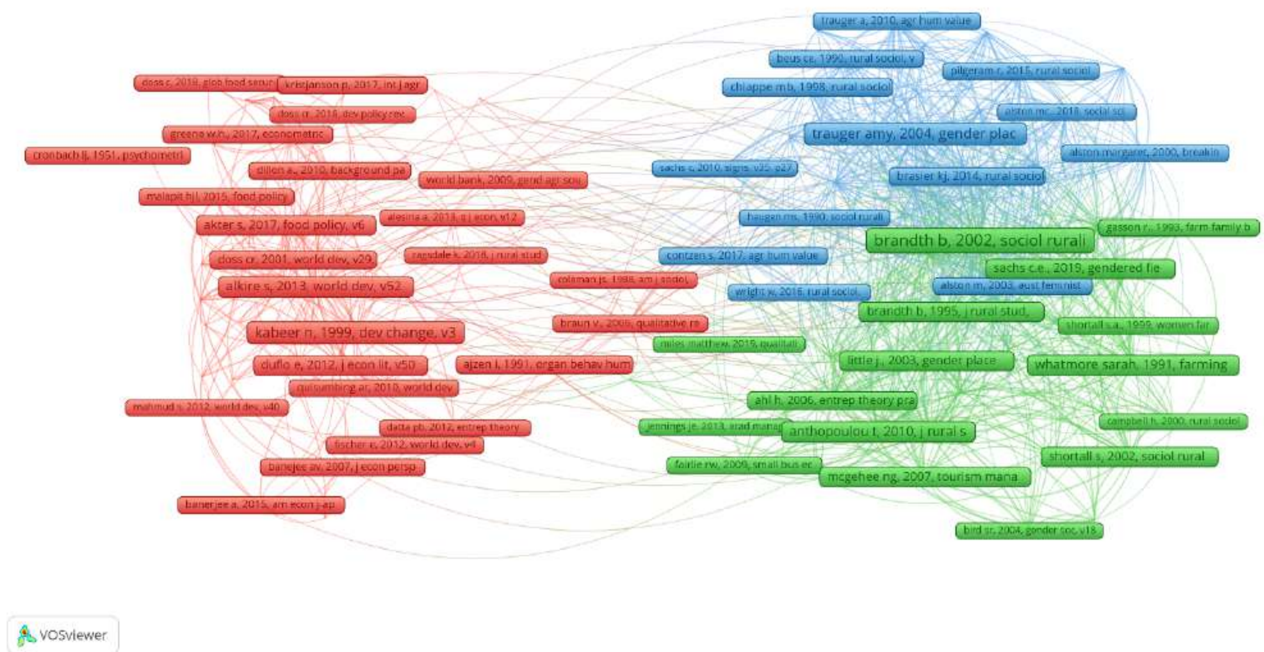

Figure 2 Co-citation analysis

MAIN CONCLUSIONS

In conclusion, our bibliometric analysis sheds light on the research trends, themes, and patterns related to women's entrepreneurship in agriculture. Our findings indicate that while research in this area has been growing steadily over the past few decades, there is still a need for more studies that focus specifically on the experiences of women entrepreneurs in agriculture. It can be noted that women construct and reproduce their entrepreneurial patterns while attempting to balance their professional and familial responsibilities, as seen within the cultural context of gender and entrepreneurship (Bruni et al., 2004). Furthermore, our analysis highlights the importance of sustainability and environmental impact in this field, indicating that researchers are increasingly interested in understanding how women-led businesses in agriculture can contribute to sustainable development and environmental protection. By identifying the key research themes, influential authors and institutions, and most frequently cited articles related to this topic, our study can serve as a guide for future research, helping to identify gaps in the literature and providing a foundation for further exploration of this important area.

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INNOVATIVE AND SUSTAINABLE SOLUTIONS TO INCREASING THE SHELF LIFE OF FRESH MEAT INDUSTRY AND CONSUMER ACCEPTANCE

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1. Introduction

With the rising demand for high-quality meat products and growing concerns about food waste and environmental impact, finding sustainable methods to preserve meat freshness is of utmost importance.

Concurrent with this issue, the problem of food safety is increasingly emerging, as microbiological hazards in food products are still a major source of foodborne illness (Realini et al., 2014). In fact, according to the World Health Organization, there are about 420,000 deaths caused by unsafe food each year (World Health Organization, 2015).

The main causes of food spoilage include the growth of microorganisms, which can be already present in the food or resulting from external contamination, and lead to the formation of undesirable byproducts making the food unhealthy and unsuitable for human consumption (Ruiz-Capillas et al., 2019). In response to these major issues, in recent years the food industry is more focused on finding new methodologies to monitor food quality and freshness (Calabretta et al., 2020).

In addition, meat sector appears to be one of the most investigated for innovations, as consumption is expected to increase; recent studies highlight how meat availability and consumption are expected to increase by 5.9 and 14 percent by 2030 (Dirpan et al., 2022). The main causes of this increase are related to the rising household incomes, especially in developing Asian countries, and to the growth of world population. Considering this increment and the risks mentioned above, a general improvement of meat quality in terms of shelf life is necessary.
Within this context, this study examines various potential differentiation strategies that could be implemented by industry players in a large scale to address these challenges while also considering consumer preferences and acceptance.

To this aim, this critical review highlights advancements of meat industry in packaging technologies, such as active packaging and intelligent labels, which not only improve meat preservation but also align with sustainability goals. Additionally, innovative processing techniques including advanced meat and meat product treatment with natural antimicrobial agents are discussed.

Indeed, the validation of technological innovations is inextricably linked to consumer perception. Only after investigating their propensity to buy and willingness to pay for these innovative solutions can such productions be launched on an industrial scale. By combining more sustainable approaches with consumer acceptance, the industry can effectively increase the shelf life of fresh meat while minimizing waste and reducing the environmental impact associated with meat production and distribution.

2. Materials and Methods

This research focuses on exploring innovative solutions within the meat industry to extend the shelf life of fresh meat and meat products while incorporating a sustainable approach and ensuring consumer acceptance. With this purpose, a Preferred Reporting Items for systematic reviews and meta-analyses (PRISMA) was provided in order to combine more sustainable approaches, increasing the shelf life of fresh meat and meat products, with consumer acceptance. The bibliographic search, according to the PRISMA methodology, was carried out in the Scopus and Web of Science (WOS) databases, through the combination of the main keywords using boolean operators (AND/OR): ("food" OR "agr*" AND "meat" AND "packaging " AND "consum*" OR "innovati*" OR "consum* behav*" OR "consum* preference*" OR "consum* attitude" OR "consum* concern*" OR "consum* intention*").

A total of 1.344 articles resulted from this string. From these, all papers referring to conference proceedings, reviews and book chapters were excluded; after this selection, 981 articles were obtained. These articles were read generically and 162 were selected. These were carefully analyzed with a final result of 102 papers included in this study.

3. Theoretical background and research hypothesis

In a highly competitive business landscape, firms seek to gain a competitive edge through technological product and process differentiation (Porter, 1985). Technological product differentiation involves creating unique and innovative products that stand out in the market, providing distinct features, functionalities, or benefits to customers (Dirisu et al., 2013). This differentiation can be achieved through advancements in product design, materials, or technological components. Similarly, technological process differentiation involves implementing efficient and advanced manufacturing or operational processes that enhance productivity, quality, or cost-effectiveness (Thomas and Gilbert, 2014; Baumers et al., 2016). By adopting cutting-edge technologies, firms can streamline their operations, improve efficiency, and deliver superior products or services to customers (Shah et al., 2022).

This research examines the importance of technological differentiation as a key strategy for firms that could successfully differentiated themselves through technological innovation, and it discusses the consumers perception associated with this strategy.

Starting from these assumptions, the study emphasizes the significance of consumer acceptance in implementing these innovative solutions.

H1: What is the consumers *perception of innovative packaging for fresh meat?*

4. Results

4.1 Technological innovations in meat Industry packaging

This first part of review divided the technological innovations *in meat Industry packaging* into: a) *active packaging* due to the constitution of the basic matrix biodegradable and the added active compounds, b) *product-centered innovations*, through the direct application of active substances or external product treatments and c) *intelligent packaging*.

The innovations related to the active packaging include the basic materials for constituting the packaging itself, by : Cellulose, (Liu et al., 2022, Niaz et al., 2022, Zabihollahi et al. 2020, Dirpan et al., 2022, Gedarawatte et al., 2020) Chitosan (Afroz Ali et al., 2023, Contini et al., 2022, Nowak et al., 2022, Tan et al, 2021) Starch (Erna et al., 2022 , Medina et al., 2012) Natural gums (Molaveisi et al., 2022), Whey protein (Tsironi et al., 2022 and Badr et al., 2014), Alginates (Cazón et al., 2017, Guo et al, 2023), Glycerol (Yahaya et al., 2019) and Polylactic acid (Abdel-Khalek .et al., 2022, Duan et al., 2022 and Theinsathid et al., 2011). These packages contain additives with antimicrobial function which can extend the shelf life of the product as they limit the growth of microbes through evaporation of these compounds from the packaging and diffusion on the surface of the food (Yildirim et al, 2018, Wrona et al, 2021).

The exploration of natural substances to add to meat packaging has led to the identification of a number of compounds and this has been the focus of innovations in the meat industry. Some of the natural additives added to fresh meat packages are reported: Quercitin **(**Aaslyng et al., 2023), Garlic extracts (Dirpan A. M.

et al., 2022), Curcumin (Erna et al., 2022), Lysozyme (Hu X. et al., 2022), Lemongrass essential oil (Contini L.R.F. et al., 2022), Ononized olive oil (Nowak N. et al., 2022), Feijoa (Sganzerla.et al., 2021) and Persicara minor (Yahaya et al., 2019).

As regards the *product applications* the industry can rely on the innovations divided into direct applications and coating with edible substances. Regarding direct applications, the incorporation of natural antioxidants into meat products can be done during their preparation.

This can be done by spraying the antimicrobial solution on the surface or by soaking the meat in it (Hosseini et al., 2021). The types of antimicrobial additives for this use including Apple and citrus peel (Ahmad et al., 2021), Essential oils of rosemary and oregano (Badia et al., 2020), Lemon Verbena and Clove essential oils (Hosseini et al., 2021), Essential oil of hyssop and coriander (Michalczyk et al., 2012) and Lactic acid (Han et al., 2021). The use of edible coatings with the function of increasing shelf life are made with Chitosan and Gallic acid (Fang et al., 2018) with Chitosan and Sodium alginate (Kulig, et al., 2017) with Soy-based protein isolates (Guerrero et al., 2015 and Danowska-Oziewicz,2014), Gelatin (Wang et al., 2018, Antoniewski et al., 2007) and also with Apple fruit extracts (Ravishankar et al., 2009).

Other emerging technologies within treatments to shelf-life extension include low-energy electron beam (Yang et al., 2022), atmospheric cold plasma (Huang et al., 2019, Bauer et al., 2017), moderate electric field (Hu et al., 2020) gamma radiation (Nisar et al., 2020) ohmic heating (Ito et al., 2014).

Also, *intelligent packaging,* which provides indications of the fresh meat's preservation status, can be made from natural matrices to which equally natural additives are added, including anthocyanins from potatoes (Niu et al., 2021) and curcumin (Yildiz et al., 2021).

4.2 Consumer acceptance

Testing consumer perception is a key aspect of validating the feasibility of previously proposed solutions. The following studies report the most important findings of consumer studies regarding the perception of innovative packaging for fresh meat.

According to world location and time period, the consumer studies analysed the acceptance of innovations, from the simplest to the most elaborate.

In the study by Wang H. et al. (2018) on a sample of fresh meat Chinese consumers, they analyze the willingness to pay (WTP) for packaged, refrigerated, and imported meat versus meat sold in bulk in local markets. The cold chain of meat is not yet widespread globally, and the purchase of "hot" meat is still widespread and accepted by Chinese consumers as a guarantee of freshness.

The result is a higher propensity to purchase packaged and also refrigerated meat, as these two conditions provide more reassurance to the end user about food safety.

Slightly more elaborate, however, was the packaging proposed to consumers in the study by Polkinghorne et al., 2018, in which consumer acceptance covers oxygen permeable film (OWP) packaging, vacuum packaging (VSP), and modified atmosphere packaging (MAP, 80%O_2 and 20%CO_2). The propensity to purchase meat in MAP was found to be the lowest.

The same result was obtained by Aaslyng et al, (2010), who showed that consumers prefer oxygen-free packaged samples. Grebitus et al. (2013) showed that consumers attach interest in MAP-packed meat after receiving specific information about the technology. In this specific case, the technology allowed for an extended shelf life of 14 days compared to 3 days for plain packaging. For this shelf life, consumers were willing to pay $0.36 more than the 3-day shelf life.

Additionally, Wezemael et al. (2011), revealed that the most accepted packaging for beef was vacuum packaging (accepted by 73.0 percent of participants), followed by MAP packaging (54.7 percent). While packaging technologies with which consumers were less familiar, such as packaging with different types of additives, were less readily accepted. This condition is related to unfamiliarity with the innovative technology, as revealed by factor and cluster analysis. However, packaging with added natural agents was better accepted (36%) among unfamiliar packaging technologies (30%).

Erden et al. (2014) investigated the acceptability by British consumers of nanotechnology in innovative packaging in the context of chicken meat. The work shows that, focusing on food risk, consumers do not

show different preferences between the use of nanosensors and more conventional methods. However, the significant positive change in "price" suggests that consumers are willing to pay more for chicken with nanosensors.
In addition, the study shows that consumers who purchase nanotechnology-packaged chickens are more concerned about animal welfare than consumers of conventional chicken.
Wang et al. (2022) surveyed a sample of Chinese consumers to assess consumer acceptability with respect to meat processing using traditional thermal technologies and several innovative technologies: high-pressure processing (HPP), irradiation (IR), bacteriophage (BP), antimicrobial packaging (AP), pulsed electric fields (PEF), and rinsing meat carcasses with antimicrobial solutions (RMCA). For each technology, the acceptability survey was conducted three times: (i) based on current knowledge, (ii) after providing information on one of the most important meat contaminants, Listeria monocytogenes, (iii) after reading a brief description of the technology. Based on consumer knowledge alone, heat treatment (6.00 out of 7 on a Likert scale) and high-pressure treatment (5.73 out of 7) were ranked as the most acceptable technologies, while rinsing with antimicrobial solutions (4.43 out of 7) was ranked as the least acceptable technology. However, after providing information on the benefits of a technology, all proposed applications had a greater positive effect on acceptance (increase from 0.14 to 0.49 units depending on the technology).
Among the new technologies submitted, HPP had the highest acceptance score in all three evaluations. Compared with AP and RMCA technologies, although both are associated with the use of antimicrobial compounds, the acceptance by Chinese respondents was very different. Most respondents (94.2%) accepted AP, unlike RMCA, which was the least accepted technology. Respondents' awareness of foodborne bacteria and knowledge of Listeria monocytogenes were found to have a significant positive influence on the acceptance of all food technologies studied.
Among other innovations, the perception of smart labels was analyzed by Barone et al. (2022) among UK consumers. The study showed that most participants were enthusiastic about this innovation, as it was perceived as a reliable guarantee of product freshness, beyond expiration dates and sensory perception. In addition, the smart label is seen as an effective tool for reducing household food waste, even allowing for changes in storage practices.

5. Conclusions

The study shows that many innovative technologies exist to increase the shelf life of fresh meat. In addition, there is a large number of natural and renewable substances that can be used either for packaging, highly sponsored by European Green Deal policies, or as bioactive compounds.
Furthermore, the review highlights the need for ongoing investment in research and development, continuous monitoring of technological advancements, and effective intellectual property protection to sustain and strengthen the competitive advantage derived from technological differentiation. The findings underscore the significance of technological product and process differentiation as a means for firms to thrive in dynamic business environments.
Regarding the consumer acceptance, the results show that not all technologies have been studied with the same intensity, especially those of the latest generation. Therefore, it would be important to conduct more consumer studies to test consumer perception. Among the studies conducted that have been reported, it emerges that not all innovations are accepted equally, with a preference for more "familiar" technologies. It also emerges that acceptance of innovative technologies, such as antimicrobial packaging, is linked to knowledge of the technology itself and the risks associated with food contamination.
In addition, among the barriers yet to be overcome is the equating of innovations with the addition of food preservatives (Guzek et al., 2020), for which instead the perception is purely negative.
These findings have important implications for the food industry to direct investments toward innovations that are more accepted by consumers without neglecting the economic sustainability of the production process, as the price component of the final product is always one of the most important discriminants influencing the product choice (Grebitus et al.2013).

From an executive perspective, however, new technologies may be incompatible with existing food business structures, as they add technical complexity and require expensive investment (Htun et al., 2023). In parallel, the development and implementation of the food industry is linked to the government control of each country, especially in terms of food safety control, so there is a need for continuous interaction between industry and government policies (Henchion et al., 2013). In addition, government policies, by providing simple public health messages and information, have great power in relation to sponsoring healthier products. (Whittall et al., 2023). In public health, messages increase awareness and knowledge, and scholars have found an association between information and detected behaviors (Appleton et al., 2018). In conclusion, it emerges that only an integrated vision of all supply chain actors will be able to bring useful solutions to improve food safety and reduce food waste.

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Consumers' preference for sustainable wines: an explorative analysis

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Keywords: sustainability, organic, CSR, experimental auction, WTP.

Background and objectives

Agri-food sector adversely impacts the environment as it is responsible for natural resources exploitation and for more than 10% of greenhouse gas emissions in the atmosphere (Climate Watch, 2017). Such dynamics affect people's health, climate change and biodiversity, resulting in social, environmental, and economic costs. Recently, food system is playing a central role in the European debate to become the first climate neutral continent by 2050. In particular, the 'farm-to-fork strategy', as part of the European 'Green Deal', aims to food system sustainability, creating a fair, healthy, and environmentally friendly food system, emphasizing the link between healthy people, societies, and planet. Also, the 'biodiversity strategy' goes in this direction, preserving nature and contrasting the ecosystems' degradation. Consequently, the European Commission is looking at new green business models to renew the social pact with the agri-food sector (EC, 2020). The Common Agricultural Policy (CAP) addresses these issues as well, promoting the ecological and digital transition in agriculture. Therefore, the European Union (EU) aims for a more sustainable agriculture in which innovation and technology play a crucial role (EC, 2017). Consequently, and considering the citizen-consumers' new instances concerning environmental issues, lifestyles, and consumption habits (Marotta and Nazzaro, 2012; 2020; Rhein and Schmid, 2020), agri-food companies are putting into place a set of voluntary initiatives aiming at reducing the effects of their business operations on the environment and people involved in the production process (Lerro et al., 2018). Recently, the attention is moving on the wine sector due to the growing consciousness about the impact it has on the environment (Ginon et al., 2014; Szolnoki, 2013). In response to such interest, wineries are implementing several initiatives aiming at preserving soil biodiversity, protecting workers' health and safety, and promoting economic sustainability, also through precision agriculture systems (Corbo et al., 2014; Pomarici and Vecchio, 2014). The latter allows for the supply of nutrients and water resources in a targeted manner, according to the specific needs of the vineyard. The goal is to improve grapes yield and quality, reduce production costs and minimize environmental impact. Scientific evidence is needed to evaluate market acceptance and willingness to pay (WTP) a premium for products that employ innovative precision technologies.

Information concerning production processes can influence acceptance and willingness to pay for wine (Mauracher et al., 2019; Lanfranchi et al., 2019; Stanco and Lerro, 2020; Valenzuela et al., 2022; Vecchio et al., 2023). Perceiving a wine as sustainable positively affects citizen-consumer preference in virtue of the environmental benefits that this type of wine can bring (Sogari et al., 2016; Bonn et al., 2016; Pomarici et al., 2016; Sellers-Rubio and Nicolau-Gonzalbez, 2016; Schäufele and Hamm, 2017). Furthermore, perceiving a wine as sustainable can lead citizens-consumers to consider it as healthier, and therefore they will pay a premium price for it (D'Amico et al., 2016).

Literature uncovering the impact of different sustainable initiatives on citizen-consumer decision making process has flourished. Scholars have focused mainly on western consumers, European and US, revealing their willingness to support socially responsible companies by paying more for sustainable wines (Schäufele and Hamm, 2017). Previous studies mostly investigated the environmental impacts of wine production. Further, they assessed citizens-consumers' WTP for sustainable wines in hypothetical scenarios raising doubts about their behaviour in a real market.

The contribution of the current study to the literature is twofold: i) it addresses both the environmental and social dimension of sustainability in the wine sector; ii) it assesses citizen-consumers' WTP for sustainable wines in a non-hypothetical incentive compatible field-experiment.

Data and methods

The analysis was based on a non-hypothetical experimental auction (Costanigro et al., 2011; Nayga et al., 2006). Experimental auctions simulate a real market where participants make decisions that have a financial impact. Indeed, winners pay and receive the product (Gallet & List, 2003; Vecchio & Borrello, 2019). Therefore, compared to other methodologies, experimental auctions make it possible to measure the economic value of goods recognized by the participants as well as to evaluate the effect of any determinants (De Steur et al., 2014). For this purpose, the experimental auctions have been combined with a structured questionnaire aiming at detecting consumers' sociodemographic (i.e., age, gender, education, household size and income), consumption habits (i.e., frequency of consumption, place of purchase, place of consumption, consumption occasion, and wine purchase by price point) and psychographic characteristics (i.e., subjective knowledge, involvement) (Mittal and Lee, 1989; Flynn and Goldsmith, 1999).

In particular, the goal was to analyse the WTP for a Falanghina white wine made through the application of a precision irrigation and fertilization system, managed through an automatic control system, which allows to optimize the administration of irrigation and nutritional resources (reducing their waste), mitigate the effects of climate change on the vines and safeguard the quality of the wines and soils.

The recruitment of participants was carried out by a market research company. Participants (N=150) were all regular wine consumers (drinking wine at least once a month) and were endowed with a 750ml bottle of white conventional wine. Respondents were asked whether they were willing to exchange the endowed bottle of wine with the other sustainably produced using the precision irrigation and fertilization system. An affirmative answered was followed by a BDM auction to assess consumers' WTP for the sustainable wine. The BDM method can be performed with only one participant at a time (Lusk & Shogren, 2007). Then, it compares the price the participant is willing to pay with a random price, with no competition between participants. Therefore, the answers of each participant do not influence those of the others (MacFie, 2007; Ribeiro et al., 2022). Subsequently WTP was then characterized based on consumers' sociodemographic and psychographic characteristics.

Results and Conclusions

The aim of this study was to analyse citizens-consumers' WTP for a wine obtained with sustainable production methods and to estimate the price premium compared to a conventional wine.

Preliminary results have shown consumers' willingness to support environmental and socially responsible initiatives in the wine sector by paying more for sustainable wines.

Study findings contribute to the growing literature on consumer evaluation of sustainable wines and are in line with those of previous studies, which showed a general consumer interest in environmentally friendly or socially responsible wines (Mueller and Remaud, 2013; Pomarici and Vecchio, 2014; Lanfranchi et al., 2016). The study also shows that some socio-demographic and psycho-attitudinal characteristics play a significant role in guiding the choices for the purchase and consumption of sustainable wines. More deeply, the decision to pay a price premium for a bottle of sustainable wine is positively influenced by age, educational level, and income, as well as the environment and personal health concern. Indeed, citizens-consumers' increasingly associate sustainable production methods with positive externalities and a greater assurance in terms of health (Menghini, 2018; Marinelli et al., 2014).

The results of the study also provide broad implications for marketers, wineries and retailers interested in successfully targeting consumers in a rapidly growing market. In fact, increasingly fierce competition on the world market pushes wineries to differentiate production methods to adapt their offer to consumer demand. From this point of view, sustainable wines, obtained from precision agriculture, can represent an interesting market opportunity for wineries.

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UNEARTHING THE DETERMINANTS OF INTENTION TO ADOPT BLOCKCHAIN: A PRELIMINARY STUDY ON THE ITALIAN WINE SECTOR

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blockchain technology; wine; adoption; questionnaire; willingness to pay

INTRODUCTION

Transparency is a prerequisite in today's modern agrifood supply chains. It helps reduce information asymmetry among stakeholders and allows a relationship of trust to be established between the company and consumers. The lack of transparency leads to food safety and quality issues, inefficiencies, and the arise of frauds (Trienekens *et al.*, 2012; Astill *et al.*, 2019). According to ICQRF, wine is one of the Italian products with the highest number of seizures and warnings for criminal behaviour, receiving the highest number of controls (1 in 3 companies). Counterfeit is one of the most common fraudulent activities, consisting in copying the brand name, packaging concept, recipe, and processing method of food products for economic gain, consciously deceiving the consumer behaviour. The use of emerging digital technologies, such as blockchain (BCT), could be the winning solution to make the sector more transparent, resilient, and ready to step into the future of our economy (Rejeb *et al.*, 2021).

BCT belongs to the group of distributed ledger technologies, storing any kind of data and information. The great features of BCT are decentralization and transparency. Rather than being maintained in one location, many identical copies of a blockchain database are held on multiple computers (nodes) spread out across a network. Simpler, a BCT can be seen as an ordered list of blocks, each one containing a set of transactions occurring among the participants of network (Di Pierro, 2017; Battaglioni *et al.*, 2022; Rodeck & Curry, 2022). In the food supply chain, blockchain is trying to impose itself as a new traceability system, able to ensure transparency by storing data in chronological order and in a way so that they are impossible to manipulate and change, reducing the risk of frauds (Galvez *et al.*, 2018; Creydt & Fischer, 2019; Feng *et al.*, 2020). Despite the important advantages that this technology brings, several barriers were identified in their adoption, being the lack of awareness among stakeholders one of the most relevant (Sadhya, & Sadhya, 2018). Notwithstanding the potential role of BCT in the agri-food supply chain, winemakers are still hesitant to adopt this technology (Luzzani *et al.*, 2021).

In light of this, the present contribute aims to assess the determinants affecting the adoption of the blockchain technology by the Italian wine producers. This work is part of the PRIN 2020 project "WEBEST", aiming to evaluate the applicability of BCT to support traceability, protect against fraud and promote transparency in international trade for an increase in the excellence of Italian agri-food (wine and extra-virgin olive oil).

METHODOLOGY

The analysis was performed by using a survey-based approach with an online questionnaire. The questionnaire was divided in five main sections to assess:

- Level of digitalization.
- Degree of knowledge of BCT.
- Determinants affecting blockchain adoption.
- Willingness to pay for an annual fee (story telling of their products, QR code, and saving of data in the BCT).
- Socio-demographic information.

After its design, the questionnaire was pre-tested with a small group of wine farms, and consequently adjusted according to the received suggestions. Finally, it was launched online for data collection.

For the level of digitalization, winemakers were asked about the digital tools they use in their company, selecting items on an established list (e.g., email; management software; DSS; electronic invoicing system etc.). Moreover, we evaluated the farmers' perceptions of the digitalization of their winery using a Likert-type scale of 1 to 5 (stated perceptions). In this way, the declared level of digitalization was assessed.

Subsequently, the interviewees were asked if they already knew about the concept of BCT; if stating yes, they were asked to provide their personal definition of the technology. Through these statements, a word cloud was built as a graphical representation of the keywords of BCT definition given by the interviewees. Word clouds represent an initial screening tool for qualitative research data (Heimerl *et al.*, 2014). The behaviour intention to adopt BCT was studied using the research model developed by Queiroz *et al.* (2021) based on the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh *et al.*, (2003) with the addition of the trust construct. Therefore, the model consists of five constructs, assuming that they may more significantly affect the behavioural intention to adopt BCT.

The first construct "facilitating conditions" (FCON) refers to “the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system”. In our study, FCON refers to interviewee’s understanding of the resources that are available in organizations to support the use of blockchain in the wine supply chain (Queiroz and Fosso Wamba, 2019).

The second construct "performance expectancy" (PEXP) is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance”.

The third construct "Social influence" (SINF) refers to “the degree to which an individual perceives that important others (peers, colleagues, and family) believe he or she should use the new system”.

The fourth construct "effort expectancy" (EEXP) represents “the degree of ease associated with the use of the system”.

Finally, the "trust" (TRUST) construct is included. It refers to the willingness to take risks and to be vulnerable. In detail, it considers the risk of taking a relationship and sharing data. In fact, trusting blockchain entails the availability and confidence in the information that is shared between the members of the supply chain.

The five identified constructs were transformed into items in a scale for the questionnaire. The items were measured by a 5-point Likert agreement scale (i.e., “1 = strongly disagree” to “5 = strongly agree”). In addition, the reliability of the scale was measured by means of the Cronbach’s alpha.

The structural model for the behaviour intention to adopt BCT was estimated using linear regression analysis with STATA 14 software.

Finally, the willingness to pay was assessed using the contingent valuation with an interactive bid design presenting a series of dichotomous choice questions (yes, no) starting with an initial bid (from 1,000 €/year to 6,000€/year). The starting point was defined from a market analysis and survey with experts.

RESULTS

This section presents the preliminary results of this study, as the survey questionnaire is still ongoing. The sample is currently composed of more than 100 wineries. Starting from the level of digitalization, the mostly used digital tools in the investigated wineries are tools for internal and external communication (i.e., e-mail, WhatsApp, etc.), financial management tools (i.e., electronic invoicing), and tools to manage the economic accounting. Almost 50% of the sample stated that its digital level could be considered as an average knowledge. Only 28% of the sample considers itself above the average concerning the level of digitalization. 64% of the investigated wineries affirmed that they already knew the concept of BCT. From the given definitions, in the world cloud, the most recurring words were supply chain or product traceability, shared digital register, blocks, and data security. Winemakers associate the BCT to its use for traceability and data storage, as they believe that the technology could provide security, transparency, guarantee of origin of the product, and protection against food frauds. Moreover, they perceive the system as useful for both producers and consumers.

In the preliminary results for the determinants affecting blockchain adoption, the performance expectancy (PEXP), and the risk to create relationships, share data and become vulnerable (TRUST) constructs resulted significant with a positive coefficient. This means that winemakers believe that using BCT will help them to attain gains in job performance. They also believe that trust can generate more transparency, trustworthiness, and responsibility between BCT members. In detail, who decides to adopt BCT takes the risk of entering in a relationship with others and share data, becoming more vulnerable. Consequently, the higher the trust towards the BCT members, the stronger the possibility that you implement this technology. In line with the literature, both PEXT and TRUST are recognized as good predictors of technology adoption intention (Queiroz *et al.*, 2021).

Finally, winemakers were asked about their willingness to pay for an annual fee including the story telling of their products, a QR code, and saving of data in the BCT. Only 26% of the sample were available to pay for these services. Among those who declared to accept to pay for the BCT service, the willingness to pay was determined to be higher than 2,000 €.

CONCLUSION

This paper represents a preliminary study to assess the determinants affecting the adoption of the blockchain technology by Italian wine producers. From the study emerges that who believe that BCT brings food supply transparency and improvements in job performances is more willing to adopt this technology.

Digitalization through blockchain is an innovative solution that should be part of the modern strategic management approaches of winery producers. BCT could guarantee product authenticity, origin, and quality, starting from the raw materials of origin and moving along the supply chain. It is a useful tool for efficient management of supply chain, including the environmental goals (organic production, sustainable certifications, water food print, waste management). The adoption will require a change in organizational structures and, in particular, the need for highly qualified human resources able to implement, manage and maintain this new technology.

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Consumers' preferences for Pecan Nuts: exploring the Italian market via a multiple discrete continuous choice approach

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PAROLE CHIAVE
Consumer preferences, choice modelling, multiple discrete-continuous choice; milk.

1. Introduction

The demand for pecan nuts, until recently, was mainly linked to their desirable flavor that commonly serves as an ingredient for desserts, ice creams, or candies (McWilliams, 2013). Lately, they have been also recognized for their numerous nutritional and health benefits. Pecan nuts are a healthy source of protein, fiber, vitamins, and minerals (i.e., vitamin A, vitamin E, folic acid, calcium, magnesium, potassium, etc.). Due to its high monounsaturated fatty acid content, a pecan-rich diet may reduce the risk of heart disease, reduce the risk factors of cardiometabolic disease such as type 2 diabetes and promote weight maintenance, among other benefits (Viguiliouk et al., 2014).

Due to the increased attention to the health properties of pecan nuts, their cultivation, consumption, and appreciation are slowly growing in Mediterranean and Western countries (Ros, 2015). There is an increasing interest in cultivating pecan trees in Italy, where they are not well known among consumers, and favorable climatic conditions exist. Although several authors have gathered demand-related information about the market of pecans in the U.S. and Mexico, there is a lack of equivalent research in Italy.

In this study we contribute filling this gap by collecting information on consumers and potential consumers of pecan nuts in Italy and by investigating the characteristics of the Italian market demand. To this end, we designed a choice experiment entailing multiple discrete continuous choice addressed to a representative sample of the Italian population.

2. Methods

2.1 Data collection

The data utilized in this study was obtained from a web-based survey that was conducted in January 2023. The survey targeted a sample of 2,000 Italian householders and was administered through a panel supplied by a market research firm. The sampling approach employed ensured a balanced representation of the primary socio-economic variables, namely age, gender, and income, as well as a geographically even distribution across the Italian national territory, which was achieved via a tessellation-stratified sampling design. The Italian territory was partitioned into 72 quadrants, each containing approximately 27 randomly selected respondents located in the municipalities that fall within them.

The survey included a section that utilized a choice experiment to gather information on consumer preferences and willingness to pay for a novel product, in this case, pecan nuts with various attributes.

The non-monetary attributes of the pecan nut included place of origin, which could be foreign, national, or regional, presence of a shell, and health and nutrient claims, namely heart-healthy or high in antioxidants. The monetary attribute was the price per unit, with four levels ranging from 0.2 to 0.35€. Respondents were presented with eight choice scenarios, each including two varieties of pecans described in terms of their attributes. They were asked to imagine a €5 budget and to indicate their desired quantity for each alternative, with the option to spend all or part of their budget or indicate that they would not make any purchases.

2.2 Econometric approach

Considering that respondents were allowed to choose between two varieties of pecan in each choice task and could select the desired quantity for both, the choice data was analyzed by means of the multiple discrete–continuous extreme value (MDCEV) model proposed by Bhat (2005). The MDCEV model is based on a direct utility function $U(x)$ that individuals maximise by consuming a vector x of quantities of each of the *K* products, $x = \left(x_1, \ldots, x_k\right)$. The total consumption level is subject to a budget constraint **x'p** = *E*, where *E* is the budget and **p** is the vector of prices. In our case, the vector x includes a unit-priced outside good which represent the expenditure on goods other than the food products included in the experiment. The utility formulation is expressed as:

$$U(x) = \frac{1}{\alpha_1}\psi_1 x_1^{\alpha_1} + \sum_{k=2}^{K} \frac{\gamma_k}{\alpha_k}\psi_k\left(\left(\frac{x_k}{\gamma_k} + 1\right)^{\alpha_k} - 1\right) \quad \text{(Eq. 1)}$$

In the above equation, $U(x)$ is quasi-concave, increasing and continuously differentiable with respect to x and ψ, and ψ_k, γ_k and α_k are parameters associated with the *k* product. ψ_k corresponds to the baseline utility of product *k*, i.e. the marginal utility of the first consumed unit. It is assumed that ψ_k is composed by a deterministic part V_k and by a stochastic one ε_k:

$$\psi_k = exp\left(V_k + \varepsilon_k\right) \quad \text{(Eq. 2)}$$

Given that utilities can be interpreted only in relative sense, V_k is fixed to zero for the first (baseline) good, so that $\psi_1 = \varepsilon_1$. The γ_k parameter in Equation 1 is a translation parameter that allows for corner solutions and also measures satiation effects. Specifically, the lower is the value of γ_k, the higher is the satiation effect associated with consumption of the product *k,* i.e. the higher is the rate at which marginal utility of consumption decreases. The α_k parameter measures satiation effects as well. In this case, the higher is the value of α_k, the lower is such effect.

The probability that a consumer chooses a specific vector of consumption quantities $x_1^*, x_2^*, \ldots, x_M^*, 0, \ldots, 0$ where *M* of the *K* goods are consumed, is given by:

$$P\left(x_1^*, x_2^*, \ldots, x_M^*, 0, \ldots, 0\right) = \frac{1}{p_1}\frac{1}{\sigma^{M-1}}\left(\prod_{m=1}^{M} f_m\right)\left(\sum_{m=1}^{M}\frac{p_m}{f_m}\right)\left(\frac{\prod_{m=1}^{M} exp\left(\frac{V_i}{\sigma}\right)}{\left(\sum_{k=1}^{K} exp\left(\frac{V_k}{\sigma}\right)\right)^M}\right) \quad \text{(Eq. 3)}$$

where $p_1, \ldots, p_m$ are the unit prices of the *M* chosen goods, σ is a scale parameter and $f_m = \frac{1-\alpha}{x_m^* + \gamma_m}$. The above probability formulation is obtained assuming an i.i.d. extreme value distribution for the stochastic part of utility (ε_k in Equation 5).

3. Results

The estimates of the MDCEV model highlighted how all attributes significantly affect the baseline utility for pecan nuts. Specifically, concerning origin, the order of preferences is foreign, national and regional.

Nuts having a full shell are preferred to those not having it, while we found no significant difference between not having a shell and having a broken one. Both health claims have a positive effect on utility, with the claim on heart health being slightly more impactful than the claim on antioxidants. The variety of pecan nut, instead, had no significant effect on baseline utility, i.e. consumers have the same preference for the two variates included in the experiment.

We found no significant effect of the attributes on satiation effect, that is the attributes of pecan nuts do not seem to affect purchased quantities, but only the probability of choosing to purchase them.

Overall, our results support investments in production, marketing and logistics for pecan nuts in Italy.

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Production contracts for the ecological transition in the agri-food supply chain: a best-worst scaling analysis of farmers' preferences

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KEYWORDS
Production contract, agri-food, BWS, sustainability, transition, Italy

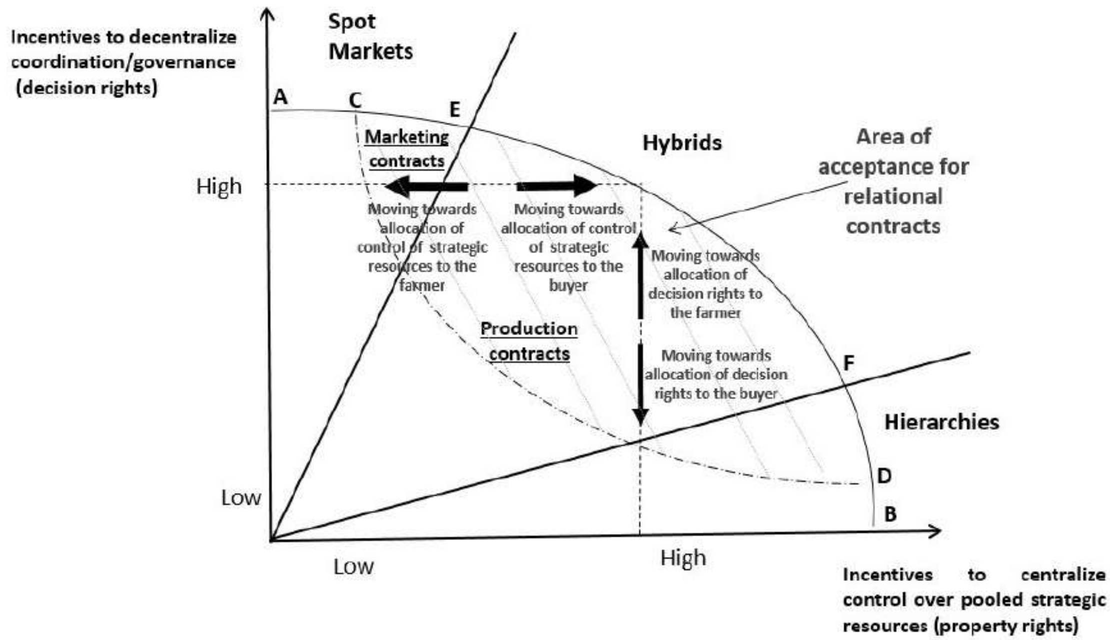
1. Introduction

The Covid-19 outbreak and the Russo-Ukrainian war have impacts on food security, in a framework where farmers are striving to meet the growing demand from citizen-consumers and public institutions for a transition towards a sustainable agri-food system (Priewe, 2022). The need for combining private good provisioning and environmental services and protection introduce multiple sources of uncertainty and asset specificity for farmers which, in turn, affect their decision making process. Such a situation calls into question coordinated, resilient and responsive governance mechanisms regulating transactions in local and global agri-food supply chains.

In the NIE framework, to govern this process it is necessary to choose the mechanisms that minimize transaction costs, i.e. the ex-ante and ex-post costs of planning, adapting, and monitoring task completion of an agreement (Williamson, 1985). These transaction costs are intrinsically related to different sources, mainly asset specificity (e.g. dedicated equipment, brand-name, geographical site, human resources) and uncertainty (e.g. market, behavioural, technological).

Henceforth, we adopt the Ménard's (2022) representation in order to conceptualize the role of production contracts as governance solutions to lower transaction costs. Figure 1 shows how the combination of contractual incentives to centralize/decentralize, respectively, decision rights (that is, the governance) and/or the control over strategic investments affects the choice of the decision-maker to minimize both production and transaction costs.

Figure 1. Setting the research problem under the NIE lens: contracts, incentives, rights and organizational settings.



Source: our elaboration based on Ménard (2022).

Going into details, the curve from A to B (or external frontier) identifies the optimal alternatives with respect to the degree of control and coordination required. The curve from C to D (or internal frontier) designates more formal agreements. The intersection between these two curves delimitates the area of relational contracting covering markets, hierarchies and mainly hybrids arrangements. This latter is the zone where commonly production contracts and their clauses occur, with stronger incentives to centralize decision rights and control over strategic assets than a marketing contract.

Going into details, since economic agents seek to combine the contractual arrangements economizing on both transaction and production costs (Martino and Polinori, 2019), a production contract is seen as the combination of specific clauses (also named attributes and terms) that affect both governance and production costs. As a consequence, the profit of the farmer i (i = 1, 2, 3 . . ., N) for each contract c (c = 1, 2, 3. . .) is:

$$\pi_{ic} = V_{ic} - (C_{ic} + T_{ic}) \quad (1)$$

where π_{ic} is the profit, V_{ic} is the value of the final product obtained from the contract m the contract under the form of revenue, C_{ic} represents production costs and T_{ic} represents the transaction costs.

In this paper we adopt a comparative approach that considers the alternative combinations (of property and decision) rights that are derived from different contractual attributes, entailing different values and costs. As a consequence, all other things being equal, insertion/removal of a contractual clause affects both value and (production and transaction) costs involved, as follows:

$$\sum_{J}^{J} \beta R_{ijk} = V_{ijk} - (C_{ijk} + T_{ijk}) \, (2)$$

where R_{ijk} represents an index for the alternative j from a choice situation k of contractual attribute which are included in a contract by the i_{th} farmer, and β represents the unit monetary value of each term. In our case, each contractual term brings its own value (that we assume constant for simplicity) as well as production and transaction costs. In practical terms, the farmer maximizes profit π by choosing, among alternatives, a contract c including combinations of contractual attributes j that minimize the expected variations of both production and transaction costs.

Against this backdrop, since a contract is based on a combination of property and decision rights affected by transactional attributes, agents attempt to maximise their profits by choosing the best and feasible combination of contractual clauses, given a negotiation process (Martino and Polinori, 2019; Oliveira et al., 2021; Ménard, 2018). We henceforth elaborate research hypotheses on the causal relationships between transactional attributes (uncertainty and asset specificity) and seven contractual clauses among many used in the agri-food sectors (for a detailed review see Tuyen et al., 2022), matching the provisioning of private and environmental good and introducing incentives aimed to centralize governance and control over strategic resources:

H1. A contractual clause related to price affects farmers' preferences due to its ability to reduce market uncertainty.

H2. A term establishing the duration of the contractual relationships affects farmers' preferences due to its ability to reduce market uncertainty.

H3. A contractual term that involves modality of payment affects farmers' preferences due to its ability to reduce behavioural uncertainty.

H4. A contractual term establishing technical rules and conditions to reduce environmental impact of the production affects farmers' preferences due to its ability to reduce behavioural and technological uncertainty.

H5. A contractual term introducing technical rules and conditions to improve quality of final output affects farmers' preferences due to its ability to reduce behavioural and technological uncertainty.

H6. A contractual term that involves technical assistance and/or provision of inputs affects farmers' preferences due to its ability to reduce behavioural uncertainty and asset specificity;

H7. A contractual term that involves monitoring and control affects farmers' preferences due to its ability to reduce behavioural uncertainty.

2. Data and research methodology

We focus on Case 2 best-worst scaling (profile case), which is a question-based survey method for measuring preferences for attribute levels (Louviere et al., 2015). It foresees that respondents are presented with so-called profiles, each containing information about several attributes and, in turn, several levels for each attribute-levels. From each profile, which is expressed as a combination of levels, respondents select the best and worst attribute-levels. Attributes and their levels were first selected on the basis of previous analyses related to contracts in agriculture (table 1).

Table 1. Contractual attributes and their levels

Contractual attributes	Attribute-levels
Price formula	• Guaranteed minimum price • Mixed (50% open–50% fixed) price
Length	• 1 year • 2 or more years
Modality of payment	• 1 step: 100% in September • 2 steps: 50% in September, 50% in March
Technique and production rules to reduce environmental impact	• Join product specification • Join environmental certification scheme
Technique and production rules to guarantee high quality product	• Minimum requirements • High standards with premium price
Provision of inputs (PI) and technical assistance (TA)	• PI, with TA at farm level • PI, with remote TA thanks to a decision support system

Monitoring and control	• On farm • Remote

The set of profiles used are constructed using an experimental design according to Louviere et al. (2015). It consists of designing choice situation, generating an orthogonal main-effect design (OMED) and, lastly, creating questions for the profiles. Going into details, combining attributes and their levels we created a 2^7 OMED, made of 8 (out of 128) profiles with 7 attributes each.

A purposive sampling strategy was adopted to collect data between September and December 2022, using a structured questionnaire including a profile case to investigate farmers' preferences over contractual terms under analysis. The survey was spread by professional interviewers using both the SosciSurvey platform and paper copies during technical workshops and seminars. As a result, the (preliminary) sample under analysis is composed by 128 Italian farmers, whose characteristics are shown in table 2.

Table 2. Descriptive statistics of the sample under analysis (n=128)

Variable code	Variable meaning	Mean	Std. Dev.	Min	Max
Age	n. of years	50.66	15.19	20	88
Exp	n. of years of experience as farmers	27.11	16.46	0	70
Family workers	n. of family workers in farms	1.50	1.40	0	5
External workers	n. of external workers in farms	1.60	3.40	0	20
UAA	n. of hectares of utilized agricultural area	92.53	14.90	3	1250
UAA_owned	n. of hectares of owned UAA	40.12	64.35	3	400
UAA_rented	n. of hectares of rented UAA	51.59	11.05	0	850
Sex_m	Male farmers (y/n)	0.80	0.40	0	1
Educ_high	Farmers that own of high school diploma, degree of Ph.D. (y/n)	0.70	0.46	0	1
Inherit_y	Inherited farms (y/n)	0.53	0.50	0	1
Altzone_pl_y	Farms located in a plain area (y/n)	0.26	0.44	0	1
Altzone_hill_y	Farms located in a hill area (y/n)	0.63	0.48	0	1
Org_y	Organic farms (y/n)	0.22	0.41	0	1
Pdo_pgi_y	Farms joining PDO/PGI indications (y/s)	0.34	0.47	0	1
Arable_crops_sp_y	Farmers specialized in arable crops (y/s)	58.59	0.49	0	1
Orch_crops_sp_y	Farmers specialized in tree crops (y/s)	15.62	0.36	0	1
Livestock_sp_y	Farmers specialized in livestock farming (y/s)	12.50	0.33	0	1

Fodder_sp_y	Farmers specialized in fodder production (y/s)	5.47	0.22	0	1
Prec_farm_y	Farmers adopting precision farming (y/s)	0.36	0.48	0	1
Advisor_y	Farmers benefitting of advisory systems (y/s)	0.48	0.50	0	1
Contract_no	Farmers not using contracts (y/n)	0.45	0.50	0	1
Contr_1year_y	Farmers signing one-year contract in the last 5 years (y/s)	0.30	0.46	0	1
Coop_y	Farmers joining cooperatives (y/n)	0.15	0.36	0	1
Coop_contr_y	Farmers joining cooperatives and using contracts (y/n)	0.31	0.46	0	1

We employed a marginal sequential BWS model to estimate farmers' preferences. Since the theoretical underpinning of BWS is the random utility theory, we assume farmers maximise their utility by selecting those attribute-levels that allow them to better address sources of transactions costs. In more detail, to check for preference heterogeneity, we estimate latent class models which group respondents sharing similar preferences into homogenous classes.

In order to facilitate the interpretation of coefficients, we calculate shares of preference (SOP) for attribute-levels, which reveal the importance of each attribute-level (i.e. the probability that one level has been selected as more important than another level) (Ola and Menapace (2020).

3. Results and discussion

Latent class models allowed to identify homogenous classes of farmers as for preferences towards contractual attributes. We select the model that minimises the Bayesian information criteria and yields the highest posterior probability of class membership across all respondents ensuring a well prediction of choice behaviour. As a consequence, we opted for a model with 3 classes. Findings reveal a certain heterogeneity among classes, both in terms of farmers and farms characteristics and farmers' preferences for contractual clauses (table 3).

Table 3. Latent class model: share of preferences scores

Attribute-levels	Class1	Class2	Class3
1 year length	0,089 **	0,018 **	0,023
2 or more years length	0,236 ***	0,019 **	0,023
Fixed price	0,218 ***	0,050	0,183 ***
Open price	0,061	0,070	0,519 ***

1 step payment	0,102	**	0,036		0,044	
2 steps payment	0,067		0,107		0,057	
Join product specification	0,028	**	0,070		0,009	**
Join environmental certification	0,024	***	0,062		0,010	*
Minimum quality requirements	0,031	**	0,055		0,029	
High quality standards + premium price	0,049		0,145	**	0,072	*
Input provision + on farm technical assistance	0,023	***	0,131	*	0,013	
Input provision + remote technical assistance	0,025	***	0,147	**	0,012	
On farm monitoring and control	0,025	***	0,045		0,004	***
Remote monitoring and control	0,019	***	0,044		0,004	***
Class Share	0,539		0,180		0,282	

Significance levels: *** 1% ** 5% * 10%

Empirical evidences substantiate the first hypothesis about contractual terms related to price which affect farmers' preferences. This evidence confirms previous studies reporting smallholders' preferences for a floating price, when the spot market price is expected to exceed the price proposed in the contract (Abebe et al., 2013).

Also contractual clauses establishing the length of contracts affect farmers' likelihood to join contracts, confirming hypothesis two. In this regard, Raimondo et al. (2021) showed that farmers tend to prefer shorter contracts, since longer contract allow to reduce market uncertainty, but they require also a higher level of reciprocal trust in order to manage and reduce opportunistic behaviour.

Contractual terms involving the modality of payment only mildly affect farmers' preferences, confirming a moderate role of this class of clauses highlighted by previous works in this field (Anh et al., 2019).

Results allows also to confirm the role played by clauses establishing technical rules to improve environmental sustainability, reducing technological and behavioural uncertainty. This result endorses the potential role of contractual arrangements in promoting environmental sustainability in the agri-food sector.

Terms introducing quality requirements are able to affect farmers' preferences confirming hypothesis five. This result is coherent with previous studies testing the acceptance of contractual clauses introducing quality standards and premium prices (Arouna et al., 2017).

Contractual terms that refer to input provision and technical assistance are able to affect farmers' inclination towards contracts, confirming hypothesis six. This result is in line with evidences from Anh et al. (2019), showing that extension and advisory services are largely accepted from farms. Likewise, Ciliberti et al. (2022) highlighted that the provision of input contributes to reducing the so-called lock-in effect due to the presence of farmers' dedicated investments and equipment.

Lastly, as concerns clauses imposing control and monitoring, they are also able to affect farmers' willingness to accept or not a contract, confirming the seventh and last hypothesis. Results revealed that, in line previous evidences from Anh et al. (2019), these contractual terms are used to negatively affect farmers' participation in contract farming.

4. Final remarks

Investigating production contracts under a NIE lens, our paper contributed to shed lights on the role production contracts for the green transition. Results proved that farmers' preferences are responsive to different types of contractual terms to cope with source of transaction costs such as uncertainty and asset specificity. However, being based on a small and not representative sample of Italian farmers' any generalization of results is not allowed.

Notwithstanding, empirical evidences offer valuable indications for stakeholders involved in contract design, especially in presence of both private and environmental public goods. First, farmers are usually more attracted by typical clauses related to price, duration and modality of payment. Second, it is worth noticing a certain interest for clauses introducing transferring decisional rights to buyers in order to manage farming in a different and innovative way. In this regard, certification, product specification and monetary incentives can play a role to steer and orient the production process towards high quality output and a higher level of environmental sustainability.

All that said, a strong heterogeneity affecting farmers' preferences for contractual clauses emerged, both in terms of farms and farmers' characteristics. Moreover, farmers' involvement in different agri-food supply chain and territorial contexts where contractual arrangements are more or less widespread because of different levels of specific investments and uncertainty may certainly have affected the results. However, this does not imply that such a heterogeneity should not be properly taken into account by private companies and public authorities when promoting contractual solutions along the food supply chains. Along the road towards the green transition, further research in this field could be therefore of help in order to better sort out sectoral, geographical and institutional specificities at stake so as to identify and define more targeted and tailored governance mechanism for the co-production of food and environmental goods.

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Trade-off between the economic and environmental sustainability in the sheep farms using the FADN database

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PAROLE CHIAVE
Livestock production; European policy; Sustainability indicators; Dairy farming.

TESTO

The European Union (EU) is committed to a comprehensive sustainability transition of the European primary sector. It plays a central role in the European economy (Finco *et al.*, 2018), supporting millions of employed and considerably contributing to total economic output and government revenue (FoodDrinkEurope, 2021; Juchniewicz and Łukiewska, 2021). Several studies have investigated this transition, highlighting the relevance of agriculture and livestock in the sustainable development paradigm (Atzori *et al.*, 2022). Especially, agriculture significantly contributes to the success of all SDGs of Agenda 2030 (Arru *et al.*, 2022; European Investment Bank *et al.*, 2019) and partly positively affects circular economic processes (Díaz de Otálora *et al.*, 2021).

The EU's new policies – i.e., the "Green Deal", the "Farm to Fork" and "Biodiversity" strategies, the "Next Generation EU", and the new Common Agricultural Policy (CAP) - operate organically to support the food system transformation, switch Europe's agricultural sector towards a more sustainable model, and aim at making the EU the first climate-neutral continent. However, moving to a new agricultural and livestock production system is unavoidably contested as each solution inevitably generates positive or negative outcomes and new patterns of winner and loser among actors (Morris *et al.*, 2021). Therefore, sustainability assessment is useful to support the development of agricultural and livestock systems (Boggia *et al.*, 2022).

To date, there is increasing attention on analyzing agricultural production's economic and environmental performance and balance the objectives of these two dimensions of sustainability in the primary sector (Sidhoum *et al.*, 2022). However, to our knowledge, studies that have analyzed the sustainability of farms often have been exclusively focused on the environmental aspects or the detriment of economic ones and a measure of the degree of sustainability has not been estimated.

In this research, the focus was placed on the extensive dairy sheep farming. European sheep farming is an important sector, playing sociocultural, economic, and environmental roles, ensuring livelihoods for vulnerable populations in rural and marginal areas (Paraskevopoulou *et al.*, 2020). Indeed, the agricultural economy of various regions of Mediterranean Europe is strongly related to sheep milk production, for which Greece, Spain, Italy, and France contributed 31.8%, 19.0%, 16.6%, and 10.8%, respectively (FAOSTAT, 2022). This mainly occurs due to the significant Greek or Roman cultural heritage where dairy products are typical ingredients of the human diet (Caja, 1990).

Among the European Union (EU) regions, Sardinia (Italy) is the most important for sheep milk production. It reaches approximately 320,000 t per year (ISTAT, 2020), contributing about 40% of the total gross agricultural production value of the EU and accounting for 10% of the total EU supply (FAOSTAT, 2020).

This paper focuses on this wave of interest and aims at investigating the existence and magnitude of the trade-off (or synergy) relationship between the economic and environmental dimensions in extensive dairy sheep farming. In particular, the research was carried out on dairy sheep farms located in the Sardinia region, which, due to its peculiarities, is a good benchmark for analyzing this sector and the challenges it faces today in Europe. Different stakeholders have varying objectives and concerns at different spatial scales (i.e., global to local and individual crop fields), which heavily influences the trade-offs and indicators considered (Kanter *et al.*, 2018). The research analyses farm scale, where farmers aim to maximize incomes and minimize environmental impact (Kanter *et al.*, 2018). Specifically, it has two different objectives.

Firstly, this paper seeks to identify economic and environmental indicators that reflect the sustainability degree of Sardinian dairy sheep farms and, secondly, using trade-offs analysis, the study detects relations between these two dimensions of sustainability.

Trade-off analysis is based on two concepts: resource scarcity and opportunity cost. It determines the effect of the decrease of one or more key factors and the simultaneous increase of other key factors within a process. This framework has been increasingly used to assess agricultural sustainability (Xiao *et al.*, 2023). The reason mainly lies in the necessity to adequately measure the presumed mutual of the components of sustainability and verify if environmental objectives envisaged by the new EU policies can be achieved without penalizing the economic sphere in agricultural and livestock farming.

The farms' data were selected from the Italian Farm Accountancy Data Network (FADN), a database showing greater detail as it collects approximately 1,500 variables with more respect to the EU FADN (Turchetti *et al.*, 2022). Before selection, the farms were screened for the following criteria:

- Availability of data over the years 2019 and 2020;
- Animal heritage composed of at least 75% of dairy sheep.

A total of 219 firms were selected.

The research used a set of indicators because sustainability is a multi-dimensional concept, and agricultural trade-off analysis relies on indicators (Giller *et al.*, 2014). Specifically, the economic dimension includes six indicators describing agricultural productivity, cost, and profitability, which have already been used in previous research (Coppola *et al.*, 2022; Díaz de Otálora *et al.*, 2021). The procedure for calculating indexes based on the Italian FADN variables is indicated below. The code SE indicates the FADN variable used for calculating the indicator.

- ECI1: Farm Net Value (NVA) added per agricultural work unit (AWU) (NVA/AWU) (SE425). It indicates the ability to remunerate all resources used in farm activities and is a source for labor, land (rent), and capital (interest) cost coverage. AWU is the full-time equivalent of employment.
- ECI2: Total output per AWU (SE131/SE010). It considers sales of individual products, in-house use, captive consumption, and changes in closing stocks from opening ones.
- ECI3: Output per unit of measure (Crops units: ha of utilized agricultural area (UAA), SE135/SE025; Livestock units: livestock unit (LU), SE206/SE080). It differentiates between crop and livestock production specifics, e.g., the direct unit cost indicator.
- ECI4: Specific cost per unit of measure (Crops units: ha of UAA, SE284/SE025; Livestock units: LU, SE309/SE080). It includes direct production costs, e.g., the costs of seed, fertilizers, feed, veterinary expenses, etc.
- ECI5: Productivity of intermediate consumption (SE131/SE275). It is the ratio between total output and total intermediate consumption. It estimates the production cost-effectiveness, i.e., the ability to cover production costs without considering depreciation and externalities, make a profit, and allow expanded reproduction without state intervention.
- ECI6: Return on equity (ROE). It measures how efficiently the company uses resources. Based on RICA, it is calculated as the ratio of net income to equity.

The environmental dimension was assessed using data from eleven indicators, some already used in various combinations in a previous research (e.g., use of organic fertilizers, application of pesticides, and stocking rate) (Cardillo *et al.*, 2023; Liberati *et al.*, 2022; Riera *et al.*, 2023; Weltin and Hüttel, 2023) and others, such as the animal emissions and the carbon sequestration that, to our knowledge, were not previously used in the trade-off analysis. Following the procedure for calculating the eleven environmental indicators.

- ENI1: Organic fertilizers used. It was elaborated by comparing the total cost of organic fertilizers indicated in the RICA to the company UAA (SE025). For organic fertilizers have been considered humus and manure of cattle, buffaloes, horses, granivores, sheep, goats, and other animals.
- ENI2: Use of industrial mineral fertilizers per UAA. It was elaborated by comparing the total cost of industrial mineral fertilizers indicated in the RICA to the company UAA (SE025). The fewer industrial mineral fertilizers are applied the higher the farm scores. The category of industrial mineral fertilizers includes solid mineral and organic mineral solid fertilizers.
- ENI3: Use of pesticides per UAA. It was elaborated by comparing the total cost of pesticides to the company UAA (SE300/SE025). The fewer pesticides are applied the higher the farm scores.
- ENI4: Use of water, energy, and fuels. It was elaborated by comparing the total cost of water, energy, and fuels indicated in the RICA to the total production (SE131). The lower the consumption, the higher the company's score.
- ENI5: Share of clover. Using data from the RICA, the ratio between meadows hectares with leguminous crops and the farm UAA (SE025) has been calculated.
- ENI6: Stocking density. It is the ratio between total livestock units and the business UAA (SE080/SE025).
- ENI7: Multiannual and perennial crops per UAA; Taking data from the RICA, the ratio between Multiannual and perennial crops and the company UAA (SE025) has been calculated.
- ENI8: Greening. Based on RICA are grasped the number of measures a company adheres to.
- ENI9: Renewable energy. Based on RICA, the presence of renewable energy sources in the company was assessed.
- ENI10: Animal emissions. It is calculated as the share of animal emissions per LU (CO_2eq/SE080). Precisely, based on FADN data and the refined Tier 1 method elaborated by the Intergovernmental Panel on Climate Change (IPCC, 2019a, 2019b), three emission types were calculated. The enteric methane (CH_4) emissions from fermentation occur in the rumen and the CH_4 and nitrous oxide (N_2O) emissions from manure management. These emissions have been converted into a single indicator that measures the animal CO_2eq emission by each farm.
- ENI11: Carbon sequestration. It is calculated as the share of carbon sequestration per UAA (CO_2/SE025). Using coefficients of potential carbon sequestration indicated in previous literature (i.e., (Dondini et al., 2023))and on the base of RICA, the carbon sequestration potential rate for each farm has been calculated.

The analysis was conducted through different steps.

1. Initially, all economic and environmental indicators were estimated for each farm. Afterward, each farm's economic and environmental indicators were aggregated to form two different composite indicators. Composite indicator means the mathematical combination of individual scores representing different aspects of the phenomenon under investigation (Saisana and Tarantola, 2002). Their use is debated, but politicians and stakeholders find them useful and want to create and use them (Talukder *et al.*, 2017).
   In creating a composite indicator, it is important to reduce multidimensionality in favor of a standard scale through the normalization process. In this research the normalization was performed in two phases. Firstly adopts the ranking normalization, the single score of each

indicator of the economic (ECi) and environmental (ENi) dimensions for each farm is calculated based on the distance from the maximum value. In this way, the individual values of each indicator fall within the range [0,1]. Afterwards, the z-score normalization was used. Such normalization is calculated by subtracting the mean from an indicator value and dividing it by its standard deviation. This technique provides a dimensionless output, and the differences between the normalized values are preserved thanks to the use of a linear transformation. Moreover, z-score is preferred when extreme values are present in the dataset (Nardo et al. 2005).

2. After normalization, the second step involves merging singular scores into composite indicators. For this purpose, this work adopts the arithmetic mean, a common aggregation technique where the normalized indicators are summed to compute the arithmetic mean (OECD et al. 2008). The economic (EC) and environmental (EN) aggregated indicators are calculated as follows:

$$\mathrm{EC} = \frac{\sum_{n=6}^{1} \mathrm{ECI_i}}{N} \quad (1)$$

$$\mathrm{EN} = \frac{\sum_{n=11}^{1} \mathrm{ENI_i}}{N} \quad (2)$$

Finally, the trade-off analysis was calculated using the Pearson correlation analysis.

3. Furthermore, a set of linear regressions was run to understand which variables mainly affect both indicators.

Analyzing the relationships between EC and EN and socio-demographic variables allows us to identify if the two dimensions of sustainability were influenced by these latter. For this purpose, the following socio-demographic variables were considered:

- Gender (G), binomial variable with a value of 0 if the farm manager is male or with a value of 1 if he is female.
- Young (Y), binomial variable with value 0 if the farm manager is over 40 years old or value 1 if the farm manager is less than 40 years old.
- Education (E), this variable can assume four different values: 1 if the company manager does not have an elementary school leaving certificate, 2, if he has a lower middle school leaving certificate, 3, if he has a high school diploma or a professional diploma and 4 if he has a degree.
- Organic (O), binomial variable whit a value of 0 if the farm is not organic or a value of 1 if it is organic.
- Diversification (D), binomial variable with a value of 0 if the farm does not diversify or a value of 1 if, instead, it implements the diversification.

To identify the relationships between these variables and the indicators EC and EN, two regressions were performed:

$$\mathrm{EC} = \alpha G + \beta Y + \gamma E + \varepsilon O + \zeta D \quad (3)$$

$$\mathrm{EN} = \alpha G + \beta Y + \gamma E + \varepsilon O + \zeta D \quad (4)$$

Concerning the results, the trade-off analysis shows a significant synergy between the economic and environmental spheres (correlation coefficient of 0.12; p-value 0.07), indicating that the two dimensions of sustainability are, as desirable, positively related. In the following tables the average values of the single indicators are shown.

Table 1 – Average values of EC indicators

	NVA/ AWU (€)	Tot Output/AWU (€)	Output/LU (€)	Output/LU (€)	Direct cost/LU (€)	Productivity/ Intermed. (%)	ROE
Mean	68,245.05	108,590.89	2,846.62	2,705.50	1,384.02	4.96	0.27

Table 2 – Average values of EN indicators

	Organic fertilizer/UAA (€/UAA)	Mineral fertilizer/UAA (€/UAA)	Pesticides/ UAA (€/UAA)	Water, energy, fuels/total revenues	Share of clover (% UAA)	Stocking rate (LU/UAA)
Mean	20.35	97.68	0.33	0.00	4.43	1.43

Table 2 – Average values of EN indicators (continuous)

	Share of multiannual crops (% UAA)	Greening	Renewable energy	Animal emissions (CO_2eq/LU)	Carbon sequestration (CO_2/UAA)
Mean	62.22	2.30	0.03	5.35	1.79

Regarding the regression analysis, the economic sphere appears to be positively and significantly influenced by two factors, young and organic. The environmental area, on the other hand, is not correlated to any of the factors considered.

The implications of this workare multiple. In the first instance, the results contradict those who indicated the sector as one of the most impacting on an environmental level, showing instead how an increase in it would correspond to a rise in its positive environmental externalities. Moreover, it actively contributes to achieving the new EU policy. Finally, the sector that was investigated for its social role (i.e., safeguarding the livelihoods of populations located in disadvantaged and/or rural areas by ensuring jobs or preventing depopulation) shows that policy action aimed at supporting it could generate benefits in all three dimensions of sustainability.

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ANIMAL WELFARE AND ENVIRONMENTAL SUSTAINABILITY IN EGG PRODUCTION. CONSUMER PREFERENCES FOR AGROFORESTRY FARMING MODELS

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PAROLE CHIAVE
Choice experiment, willingness to pay, egg attributes, organic food, egg production system.

1. INTRODUCTION

Consumer food choices are changing. The growing awareness of the intensive production systems' impacts on the environment and animal welfare is leading to ever-increasing research for products that pay attention to these aspects (Grunert et al., 2014; Rahmani et al., 2019).

For example, in the poultry sector, and especially in the egg market, public opinion has been affected by past sanitary crises (e.g. avian flu epidemic) and ethical issues concerning animals' living conditions (Abín et al., 2018; Vecchio and Annunziata, 2012).

As a result, the European Union (EU) has taken concrete initiatives. In the latest 23-27 CAP reform, environmental sustainability and animal welfare play a fundamental role. (EC, 2018). Moreover, the EU has established detailed rules on quality and production standards for the approximately 6.7 million tonnes of eggs produced each year (EC, 2023). According to EU Regulation 2017/1185, the following types of livestock are authorised, according to a growing level of animal welfare: (i) cage, (ii) barn, (iii) free-range, and (iv) organic. Italy is the 4th European producer with annual per capita consumption of approximately 210 eggs. (ISMEA, 2022).

In eggs food consumption habits extrinsic characteristics related to origin, production method (closely connected to animal welfare in the consumer's mind), price and freshness are decisive in the choice (Baba et al., 2017; Rahmani et al., 2019; Rondoni et al. ., 2020). Certified organic eggs have a greater willingness to pay because environmental sustainability issue is linked to practices that improve animals living standards. (Gerini et al., 2016; Vecchio and Annunziata, 2012; Yeh et al. al., 2020).

In this context, the challenge for the sector is to combine all these requests, i.e. maintain production system sustainability by increasing animal welfare and guaranteeing supply chain operators' profitability (Dahlhausen et al., 2018; Montossi et al., 2018). In fact, more resilient production model could lead to higher costs (Rocchi et al., 2018; Yates et al., 2007).

This work aims to understand through a Choice Experiment (CE) if sustainability and animal welfare communication for eggs produced in a diversified-organic-agroforestry system influence consumers' preferences and Willingness To Pay (WTP).

The production system combines a shrub (olive/walnut), herbaceous (aromatic plants and herbaceous essences) and animal components according to the "Ecoinpascoli" project experimental model. This farming system has confirmed an increase in animal welfare and environmental sustainability. By eating aromatic herbs, hens improve parasites and lameness resistance. Moreover, the herbaceous/shrub system increases egg production system biodiversity and resilience (Altieri et al., 2015; Yates et al., 2007).

For an overall assessment, we will estimate the economic sustainability of the transition to this system. It makes it possible to determine if the potential higher costs for the producer can be compensated by consumers' choice. These evaluations will be used to understand if an agroforestry farming model can be adopted on a large scale at the supply chain level, if the (potential) additional costs can be absorbed by the market or if this system could act as a competitive lever.

2. DATA AND RESEARCH METHODOLOGY

2.1 The discrete choice experiment methodology

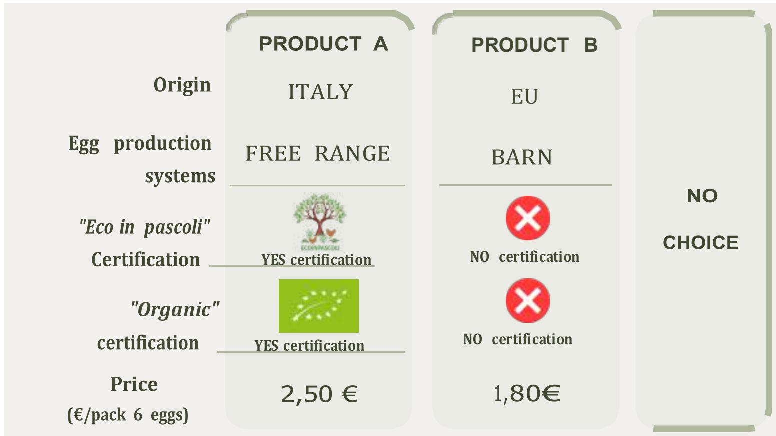
A choice experiment was developed to investigate consumer preferences for the hypothetical "Ecoinpascoli" certification resulting from diversified-organic-agroforestry farming system compliance. Characteristics such as origin, farming system and price, that literature indicated as relevant to egg purchasing habits, will be analysed (Rahmani et al., 2019; Rondoni et al., 2020; Vecchio and Annunziata, 2012). Organic certification was also included to understand how the two labels might interact. The CE focuses on a 6 eggs-pack according to the most purchased on the Italian market. Table 1 shows CE attributes and levels.

Table 1. Choice Experiment attributes

Attributes	Description	Levels
Geographical origin	Product geographical origin	• Italy • UE
Egg production systems	According to Commission Implementing Regulation (EU) 2017/1185	• Barn • Free range
Organic certification	According to organic production methods	• Certification • NO certification
"Ecoinpascoli" certification	According to "Ecoinpascoli" and organic production methods	• Certification • NO certification
Price	€/6 eggs-pack	• 1.80 €/pack • 2.15 €/pack • 2.50 €/pack • 2.90 €/pack

A D-efficiency design was applied including 2 blocks of 4 choice sets each, consisting of two choice options and the alternative "no choice". Both blocks were randomly distributed to participants. Figure 1 shows a choice set example. To mitigate the potential hypothetical bias a solemn oath at the beginning of the survey was introduced (Haghani et al., 2021).

Figure 1: Choice set example



2.2 Empirical approach

A Mixed Logit Model (MXL) was developed to estimate consumer preferences and willingness to pay taking into account heterogeneity presence. In applying the mixed logit model, we used the following utility function:

$$U_{nit} = ASC + \beta_{1n}\, Italy_{njt} + \beta_{2n}\, Freerange_{njt} + \beta_{3n}\, Organic_{njt} + \beta_{4n}\, Ecoinpascoli_{njt} + \beta_{5n}\, Ecoinpascoli\_Organic_{njt} + \beta_{6n}\, Price_{njt} + \varepsilon_{njt} \quad (1)$$

where ASC, the "alternative specific constant," is a dummy variable that takes the value 1 when the choice option is the no-buy option. **Italy** is a dummy variable concerning country-origin production (value 1 if eggs for Italian eggs and 0 otherwise), **and free-range** is a dummy variable assuming the value 1 for eggs produced according to this production system and 0 otherwise. **Organic** is a dummy variable that assumes the value 1 for organic eggs and 0 otherwise. **"Ecoinpascoli"** is a dummy variable that assumes the value 1 if the eggs are produced according to **this** system and 0 otherwise. The model assesses the interaction between " **Ecoinpascoli** " and "**Organic"** certification (**EcoinpascolixOrganic**). **Price** is the variable referred to as the price attribute. Once the parameters have been estimated, it is possible to compute WTP for each attribute. The WTP is calculated by taking the ratio of the attributes' coefficients (**βk**) and the mean price coefficient (**βp**), as follows:

$$WTP_k = -\beta k / \beta p \quad (2)$$

2.3 Cost analysis

Farm income statement focused on both conventional and experimental farming management. For this purpose, 4 scenarios were recreated considering different techniques and production factors combinations (Tab. 2):

Table 2. Experimental farming typologies description

Farming typology	Description
0_Baseline	certified organic ordinary management
1_Shrub	certified organic ordinary management+ shrub species in the pasture
2_Herbaceous	certified organic ordinary management+ herbaceous essences in the pasture
3_Shrub+Herbaceous	certified organic ordinary management+ shrub species and in the pasture and herbaceous essences in the pasture

The partial budget was used as a tool for the economic evaluation and validation of the proposed system. The economic items elaboration has been limited to the experimental farming unit. The passive components sum is equal to the total cost (Kt) of production of the eggs from the farming system considered.

$$Kt = Q + Sv + Tr + Sa + St + I \tag{3}$$

Dividing by the number of units produced (n) we obtain the unit cost index (Ku) of single egg production. This index was calculated for each considered scenario**.** It enables us to compare and identify the actual cost of production arising from the different combinations of inputs required by the experimental project.

$$Ku = \frac{\mathrm{Kt}}{\mathrm{n}} \tag{4}$$

3. RESULTS

3.1 Sample

Data were collected through a web-based survey during April/June 2023. Since quota sampling is not a probabilistic approach, the study sample is not representative of the Italian population (Iliyasu and Etikan, 2021). The total sample includes 306 responses.

Table 3. Descriptive statistics

Variables	Categories	Sample
Demographic variables		
Gender (%)	Female	62.09
	Male	37.91
Age (years) (%)	18-29	35.95
	30-49	38.56
	50-64	19.61
	64+	5.88
Education (%)	High school or lower	20.26
	High education level	79.74
Income (%)	Low (<500-1499)	54.25
	Medium (1500-2499)	32.68
	High (>2500)	13.07
HHsize (%)	1	11.11
	2	21.57
	3	32.03
	4	28.76
	5 or more	6.54

3.2 Costs analysis results

The analysis showed that farming in different agrozooforestry production scenarios generates an increase in unit production costs ranging from approximately 0.6% to 5.4%. The high-value scenario in terms of diversification (3_Shrub+Herbaceous) generates an increase in the unit production cost around 4%. These calculations, if transposed to the increase in the consumer price of organic eggs, generate the projections shown in table 4:

Table 4. Price analysis

Farming typology	Average consumer price (€/6 eggs-pack)
0_Certified organic egg	3.00
1_Certified organic egg + shrub	3.16
2_Certified organic egg + herbaceous	3.02
3_Certified organic egg + shrub and herbaceous	3.12

By attributing the total cost of the transition to a diversified Agrozooforestry system to the final consumer, the latest should be willing to pay an average of €0.10 more per 6-eggs pack produced according to the methodology proposed by the “Ecoinpascoli“ project.

3.3 Mixed logit model

Table 5 shows MXL results. Considering origin and production method, consumers prefer an Italian product from free-range hens. National origin and an alternative farming system to cages are considered by consumers as better in terms of quality and animal welfare (Baba et al., 2017; Gracia et al., 2013; Miller et al., 2016; Pettersson et al. al., 2016).

The negative price coefficient indicates that the probability of choosing decreases as the price increases. The ASC coefficient is also negative showing the negative utility associated with not choosing between the two options. In the case of both certifications (positive and significant coefficients), it may be assumed that consumers are generally more inclined to buy certified products. It is consistent with the literature (e.g. Tebbe and von Blanckenburg, 2018). It is particularly important for the "Ecoinpascoli" certification. Based on this, we can assume that the sample shows potential interest in this label.

The positive and significant value of the interaction term "Ecoinpascoli" with "Organic" shows that the two certifications are perceived as complementary. It could imply that consumer preferences increase in the market if the two certifications on the packaging coexist.

The standard deviation parameters are statistically significant. It suggests the heterogeneity in consumer preferences and highlights the importance of using a model, such as MXL, to capture this variability.

Table 5. Estimation results for mixed logit models.

Variables	Coefficients	p-value
Mean		
Price	-0.873 (0.210)	0.000
ASC	-2.95 (0. 630)	0.000
Italy	1.030 (0.172)	0.000
Freerange	0.317 (0.156)	0.042
Ecoinpascoli Certification	0.962 (0.350)	0.006
Organic Certification	1.030 (0.342)	0.002
Ecoinpascoli_Organic_Certification	1.526 (0.582)	0.009
St. dev. of parameters		
Organic Certification	-1.036 (0.245)	0.000
Ecoinpascoli Certification	-0.885 (0.264)	0.001
Italy	1.592 (0.237)	0.000
Freerange	0.667 (0.312)	0.033
Price	1.051 (0.150)	0.000
LR chi2(5)	164.69	

Source: authors' estimates. Standard errors in parentheses; The sign of the estimated standard deviations is irrelevant: interpret them as being positive

3.4 Willingness to pay

The Mixlogit model enabled us to calculate the WTP for each attribute (Tab.6). Respondents attribute Italian origin and organic certification to a similar economic value (around € 1.10 6-egg pack). "Ecoinpascoli" certification WTP is above €1 6-egg pack. The two certifications interaction deserves attention. The complementary relationship brings the WTP to around €1.70 per 6-egg pack. Considering the "Ecoinpascoli" system as an "advanced" organic production model, we can assume that consumers seem to perceive this strengthening relationship between the two labels. From these findings, the market appears inclined to increase its WTP for a product that incorporates a value system linked to environmental sustainability and animal welfare.

Table 6. WTP estimation results

Variables	Willingness to pay
ASC	-3.382 (-4.607 – -2.157)
Italy (base EU)	1.180 (0.271 – 1.937)
FreeRange (base= Barn)	0.363 (-0.900 – 0.816)
Ecoinpascoli Certification	1.102 (0.271 – 1.937)
Organic Certification	1.185 (0.290 – 2.081)
Ecoinpascoli_Organic_Certification	1.747 (0.225 – 3.27)

Lower and upper limit in parentheses - Source: Authors' contribution

These results also allow us to understand if consumers are potentially willing to pay a price that can cover farmers' higher costs in transitioning to a diversified agroforestry system. The cost analysis of the "Ecoinpascoli" system showed a range of €0.10/0.20 6-egg pack as an increase in the unit production cost. Based on these preliminary results, we can see that consumers value this certification more than the costs of implementing the system that generates it.

4. MAIN FINDINGS

In this study, we analyzed the WTP of Italian consumers and their preference for the "Ecoinpascoli" certification. While the study does not represent the population, the preliminary results suggest some interesting implications. In the first place, there could be a market space for the "Ecoinpascoli" certification that combines environmental aspects with animal welfare. The analysis shows an important result from the point of view of laying hens farms sustainability. The consumer is inclined to transition to a more sustainable system, based on the co-presence of several plant species according to agroforestry systems. The species were chosen based on a careful analysis conducted within the "Ecoinpascoli" project focused on the search for the positive properties of essences on animal welfare. The declared consumers' WTP totally covers the higher costs due to this new breeding method implementation. Furthermore, heterogeneity analysis lead us to propose future research that could allow consumer segmentation by highlighting the factors that could influence "Ecoinpascoli" certification WTP. Separating the interviewees into different groups could help to understand which consumer target could be more interested in this label. From a marketing point of view, this can be useful for developing communication campaigns that convey the most effective information content. Moreover, it would be interesting to investigate if providing an informative claim relating this "new" farming system could shift consumers' WTP and preferences towards the "Ecoinpascoli" certification.

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Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
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ECONOMIC AND ENVIRONMENTAL OUTCOMES OF ALTERNATIVE ECONOMIC POLICY TOOLS TO CURB GHG EMISSIONS FROM ITALIAN LIVESTOCK SECTOR

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KEYWORDS
Mathematical programming model; livestock sector; methane emissions; economic policy tools.

The European Climate Law has written into regulation the goal set out by the European Green Deal for EU's economy and society to become climate-neutral by 2050 (European Commission, 2019). EU's agriculture and forestry will have to play a crucial role in achieving this ambitious goal, being the only productive sectors that can naturally store carbon in soil and biomasses. This is fundamental to offset greenhouse gases (GHGs) emissions that cannot be decreased. However, sinks deriving from soils and biomasses will not be sufficient to meet the environmental target, thus the agricultural sector should also contribute with a reduction of its so-called non-CO_2 emissions (namely, methane-CH_4 and nitrous oxide-N_2O). Recently, attention has been particularly devoted to CH_4 emissions from livestock (European Commission, 2020). Political attention on CH_4 emissions is justified, as this gas is the second after CO_2 in terms of total emissions and it is more powerful of 28 times than CO_2 in terms of global warming potential. Hence, reducing CH_4 emissions would help to both slow down climate change and improve air quality. Along this line, in April 2022, the Commission has proposed to extend the application of Industrial Emissions Directive (IED; 2010/75/EU) to curb CH_4 emissions from big livestock farms. In particular, the proposal included cattle farms together with pig and poultry farms, that were already subject to the (old) Directive (European Commission, 2022). The reduction of CH_4 emissions should stem from the introduction of Best Available Techniques (BAT), establishing proportionate requirements for different farming practices (intensive, extensive, organic). However, BAT adoption will result in higher production costs for targeted farms, possibly requiring new investments to be put in place. This is why BAT adoption by farmers will hardly ever be spontaneous, requiring to be normatively imposed. An equivalent approach could consist in the application of economic policy instruments: namely, a tax to incentivize farms to reduce the negative environmental externality towards an established level, or a subsidy to those farms that reduce this negative externality beyond the established level (Fellmann *et al.*, 2018; Himics *et al.*, 2018; Pérez Domínguez *et al.*, 2016; Van Doorslaer *et al.*, 2015).

The present contribution wants to bring a first assessment of the impacts of achieving growing levels of reduction of CH_4 emissions from Italian cattle, pig and poultry farms, by mimic the application of a tool that can alternatively simulate the application of a tax on emissions exceeding a given reduction threshold and a subsidy on emissions reduced below the threshold. Modelled farms are those described by the 2020 sample of Farm Accountancy Data Network (FADN) of specialized livestock farms. The impacts assessed concern Operating Income (OI) of farms, the number of livestock units (LSU) reared and the level of CH_4

emissions. These impacts are shown and discussed with reference to the different livestock specializations reported in the FADN sample. Table 1 reports information about the representativeness of FADN sample farms with respect to the universe of specialized livestock farms, obtained using measures of statistical representativeness provided by the same FADN.

Table 1 - Representativeness of FADN sample with respect to the universe of farms.

	Farms (n.)	OI (,000€)	LSU (n.)	CH_4 (t CO_{2eq})
Dairy cattle	30,226	1,722,807	2,466,983	8,003,096
Beef cattle	23,693	442,640	1,014,051	2,128,038
Mixed dairy & beef	6,035	100,134	221,354	572,093
Pigs breeding	419	14,863	55,279	18,197
Pigs fattening	2,213	232,114	850,738	249,898
Mixed pigs br. & fat.	330	16,590	56,122	21,695
Laying hens	743	77,850	121,192	19,487
Poultry meat	535	37,229	113,691	35,290
Mixed hens & poultry	261	7,298	104,358	15,135
Total	64,456	2,651,525	5,003,768	11,062,928

The analysis has been carried out using the "AGRIcultural TerritoriAL tIme econoMic" (AGRITALIM) model, an agroeconomic supply model that uses large part of the information reported in the FADN dataset on economic, financial, productive, market, political and structural aspects. The model distinguishes among geographical areas, altimetric levels and farm types (Cortignani *et al.*, 2022; Dell'Unto *et al.*, 2023) and was recently implemented to quantify CH_4 emissions from livestock farms (Cortignani and Coderoni, 2022), following an approach that adapts IPCC methodology at the farm level (Coderoni and Vanino, 2022). Growing thresholds of CH_4 emissions reduction (expressed as CO_{2eq}) were set to perform the simulations (-10%, -20%, -30% with respect to the baseline level). In order to reach each threshold, two types of economic policy instruments were combined: (1) a tax paid by farms for each unit (t) of CH_4 exceeding the established reduction threshold; alternatively, (2) a subsidy granted to farms for each unit (t) of CH_4 reduced below the threshold. The unitary amounts of tax and subsidy were the same, and modulated to achieve the desired threshold of emissions reduction. In other words, the single farms could opt for: (1) maintaining at a certain extent their productive level (and CH_4 emissions), paying the tax on the quota of their emissions exceeding the established threshold; (2) reducing their productive level, in order to curb the level of their CH_4 emissions below the established threshold, receiving the subsidy on this quota of avoided emissions. This yielded a total of three scenarios, schematized in table 2. Tax and subsidy amounts reported in the first row are those actually needed to achieve the established reduction thresholds, and were applied to all the modelled farms.

Table 2 - Scenarios description.

		SIM10	SIM20	SIM30
Tax & Subsidy level	EUR t^{-1} CO_{2eq}	29.2	67.5	110.5
Target of emissions reduction	% over baseline	-10.0	-20.0	-30.0

The mathematical structure of the model is specified in the following equations (1-6).

$$max_{\boldsymbol{X}} = \boldsymbol{C}\,\boldsymbol{X} - \boldsymbol{TL}\,\boldsymbol{\Delta E^{+}} + \boldsymbol{SL}\ \boldsymbol{\Delta E^{-}} \tag{1}$$

$$s.to\ \boldsymbol{A}\,\boldsymbol{X} \leq \boldsymbol{B}\,[\boldsymbol{\lambda}] \tag{2}$$

$$\boldsymbol{LE} = \boldsymbol{UE}\,\boldsymbol{X} \tag{3}$$

$$\boldsymbol{LEB} = \boldsymbol{UE}\,\boldsymbol{X^{0}} \tag{4}$$

$$\boldsymbol{LER} = \boldsymbol{LEB}\,\boldsymbol{rid}\% \tag{5}$$

$$\boldsymbol{LE} - \boldsymbol{\Delta E^{+}} + \boldsymbol{\Delta E^{-}} = \boldsymbol{LER} \tag{6}$$

where $\boldsymbol{C}$ are the unitary incomes of the various $\boldsymbol{X}$ production activities, $\boldsymbol{TL}$ is the tax level for $\boldsymbol{\Delta E^{+}}$ emissions above the threshold of emissions, $\boldsymbol{SL}$ is the subsidy level for $\boldsymbol{\Delta E^{-}}$ emissions below the threshold of emissions. The model is subject to various structural constraints: (2) $\boldsymbol{A}$ is the matrix of technical coefficients and $\boldsymbol{B}$ is the matrix of resources availability; (3) calculates the $\boldsymbol{LE}$ level of total emissions from the $\boldsymbol{UE}$ unitary emissions and the level of $\boldsymbol{X}$ variables; (4) – (5) calculate the $\boldsymbol{LEB}$ level of observed emissions in the baseline and the $\boldsymbol{LER}$ level of reduced emissions (or cap emissions) reducing $\boldsymbol{LEB}$ by a ***rid%*** percentage (e.g., 10%), but can be eliminated from the model as long as the $\boldsymbol{LEB}$ and $\boldsymbol{LER}$ levels are previously calculated as parameters; (6) refers to the relationship between $\boldsymbol{LE}$ and $\boldsymbol{LER}$ via the positive and negative delta emissions. It is important to specify that the AGRITALIM model currently does not account for the adoption of mitigation options reducing the level of CH_4 emissions per LSU. The only option available consists in cutting the number of LSU.

Table 3 reports the impacts on OI and CH_4 emissions of the single livestock specializations and of the whole sample, expressed as percentage variations over the baseline. In the last two rows, the same impacts are reported distinguishing between the two groups of farms opting for paying the tax or for receiving the subsidy.

Table 3 - Percentage variation of OI and CH_4 emissions.

	Δ% OI			**Δ% CH_4**		
	SIM10	**SIM20**	**SIM30**	**SIM10**	**SIM20**	**SIM30**
Dairy cattle	-0.6	-2.7	-6.7	-9.6	-18.7	-28.4
Beef cattle	-0.3	-1.3	-3.1	-12.8	-27.8	-40.0
Mixed dairy & beef	-0.5	-2.5	-5.9	-11.5	-23.5	-36.6
Pigs breeding	-0.3	-1.2	-2.8	-1.5	-3.5	-5.8
Pigs fattening	-0.2	-1.1	-2.6	-6.1	-12.0	-17.7
Mixed pigs br. & fat.	-0.2	-1.0	-2.5	-1.9	-4.4	-7.6
Laying hens	-0.1	-0.4	-0.9	-1.6	-3.6	-5.8
Poultry meat	-0.2	-0.7	-1.7	-5.8	-12.7	-19.0
Mixed hens & poultry	-0.5	-1.2	-2.6	-15.4	-28.6	-43.4
Total	-0.5	-2.1	-5.0	-10.0	-20.0	-30.0
Taxed farms	*-0.6*	*-2.8*	*-6.3*	*-4.8*	*-10.8*	*-17.4*
Subsidized farms	*0.3*	*0.3*	*-1.1*	*-21.1*	*-36.7*	*-49.2*

Reducing productive levels to curb CH_4 emissions determines overall negative impacts on OI, at an extent that grows as the imposed reduction threshold increases. The values reported for the single livestock specializations and for the whole sample average the impacts on farms opting for the tax and the subsidy. The impacts on the two groups of farms show that taxed farms undergo to stronger negative impacts on OI (due to the financial burden of the tax) and reduce their emissions far less than the established thresholds. On the contrary, subsidized farms reduce their emissions far beyond the thresholds. On average, the amount of the subsidy received compensates OI loss due to the partial disposal of productive activities under the lower and middle reduction thresholds. Analysing the impacts on OI of the single livestock specializations, the worst affect cattle farms, which (apart from mixed hens and poultry farms) are also those reducing the most their emissions. This evidence finds explanation in their higher emission intensity (i.e., the higher level of CH_4 emitted per LSU), compared to pig and poultry farms. Despite this huge emissions reduction, the tax paid on emissions exceeding the thresholds adds a financial burden to the OI loss caused by the disposal of rearing activities. The hugest reduction of emissions is operated by mixed hens and poultry farms, characterized by the highest OI reduction in the group of poultry farms. However, the latter is not dramatic in face of such a level of disposal of rearing activities. The reason for this lies in the very low level of profitability of these activities, pushing to their dismission in order to avoid tax payment and to benefit from the subsidy. Average emission reductions far below the thresholds characterise instead farms specialized in pigs breeding, pigs breeding and fattening and in rearing hens. These farms have a good level of profitability of rearing activities: combined with a low emission intensity, this determines a high emissions productivity (i.e., OI generated by each unit of CH_4 emitted). The milder impacts on OI can be just explained considering the low amount of emissions generated, that would not justify any further disposal of productive activities.

Table 4 reports the percentage of farms that opt for the subsidy and the ratio between the total amount of subsidy and tax for the single livestock specializations and the whole sample.

Table 4 - Percentage of farms receiving the subsidy and incidence of subsidy on the tax.

	Farms receiving the subsidy			Subsidy/Tax		
	SIM10	SIM20	SIM30	SIM10	SIM20	SIM30
Dairy cattle	33.8	37.8	41.0	89.9	78.7	79.1
Beef cattle	33.7	36.9	41.2	207.4	287.3	294.2
Mixed dairy & beef	45.1	50.3	56.2	164.8	208.1	315.6
Pigs breeding	4.5	4.5	4.5	0.1	0.1	0.1
Pigs fattening	11.9	12.7	14.4	36.7	31.4	26.6
Mixed pigs br. & fat.	0.0	0.0	0.0	0.0	0.0	0.0
Laying hens	0.0	2.9	2.9	0.0	0.0	0.1
Poultry meat	23.5	26.5	29.4	24.2	29.2	26.7
Mixed hens & poultry	33.3	22.2	22.2	983.2	712.4	380.3
Total	31.7	35.2	38.7	100.1	99.9	100.2

Considering overall results, only a minority of farms opts for reducing emissions below the thresholds to receive the subsidy, although their share increases raising the threshold. Given the equal unitary value of tax and subsidy, subsidy amount tends to equal tax amount, determining a net zero balance of the policy for the public sector. However, very heterogeneous effects are foreseen for the single livestock specializations. In particular, high shares of adhesion to the subsidy occur among cattle farms, and poultry meat and mixed hens and poultry farms. In the case of mixed cattle farms, this percentage exceeds 50% under the middle and upper reduction threshold, which is indicative of their low level of emission productivity. Mixed hens and poultry farms are the only showing a share of adhesion to the subsidy that decreases as the reduction threshold raises, and are characterised by the highest (though decreasing) incidence of the subsidy received on the tax paid. The lowest shares of adhesion to the subsidy occur instead among the farms specialized in pigs breeding, pigs breeding and fattening and in rearing hens, for the same reasons explained analysing the impacts on OI and CH_4 emissions. Consistently with the high level of profitability of their activities and their low emission intensity, these farms to undergo to the mildest impacts from the simulated policy tools.

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Reducing food waste at retail stores: Sales forecasting results from Machine Learning-based software in Italy

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PAROLE CHIAVE
Inserire in questa sezione alcune parole chiave (4-6) per il contributo.

TESTO

Introduction and objective of the study

In 2020, the food waste (FW) recorded at retail stage in Europe consist of 4 million tonnes of fresh mass, that represents about the 7% of the total FW along the supply chain (Eurostat, 2023). Although retailers produce a small percentage of the total FW recorded across the food chain, their contribution to tackle the problem of FW can be crucial, since their strategies have an impact both on customer preferences and on the suppliers (Cicatiello and Franco, 2020; Cicatiello et al., 2017; Gruber et al., 2016).

Fresh fruits and vegetables (FFV) account for 54% of the total food loss and waste in Europe, making them the most wasted food products (Brautigam et al., 2014). These products also represent the main fraction, in mass, of the FW generated at the retail level (Cicatiello and Franco, 2020; Brancoli et al., 2017; Cicatiello et al., 2017; Lebersorger and Schneider, 2014).

In Italy, it has been assessed that in one Italian store in 2015 the quantity of FFV waste detected over one year was 24,035 kg, corresponding to a value of 36,372 € (Cicatiello et al., 2017). In Sweden, a study covering three stores detected 68 t of FFV wasted (Mattsson et al., 2018), while Eriksson et al. (2012) found that the rate of waste of FFV varied between 2.0% and 4.0% of the 9,605 t supplied to six stores, and that reclamations (pre-store waste) contributed to 67% of the wasted mass (Eriksson et al., 2017).

The primary drivers behind this high wastage can be attributed to the perishable nature of FFV products and the inadequate technological equipment to support their preservation (Tort et al., 2022). Retailers also face the challenge to predict the demand of products; inaccurate forecasting often results in overproduction and excessive stocks (Magalhães et al., 2021).

Despite the availability of validated technological tools to improve the sustainability of FFV supply chain, the key actors involved often lack the entrepreneurial skills necessary to understand the benefits of implementing innovations and engaging with other relevant stakeholders directly and or indirectly (Simms et al., 2020; Blasi and Cicatiello, 2019). Various authors have studied how innovations can impact the FFV supply chain and have examined the drivers and barriers to their adoption (Aramyan et al., 2021; Tort et al., 2021). Significant opportunities to improve food supply chain efficiency, traceability, transparency, and overall sustainability emerge from digital technologies. In particular, Artificial intelligence (AI), by simulating human cognitive functions including learning and reasoning, has the potential to push these changes in food systems (Onyeaka et al., 2023). Among the applications of AI, machine learning is widely studied in the field of food waste prevention to prevent overproduction, detect non-compliance causes and target products in the appropriate market, by means of forecasting, monitoring and grouping (Ciccullo et al., 2021).

The objective of the paper is to test the efficacy of a newly developed machine learning technology that provides retailers with accurate forecasts of the sales. The study aims to determine the reliability of the forecasts against real sales of FFV recorded at a panel of three retail stores in Italy. The results of the study contribute to determine whether the stores can improve the efficiency of their orders, thus avoid surplus ordering, by using the forecasts as input data for the decision making. In turn, this helps understanding and assessing the extent to which these innovations can food waste of FFV at the retail level.

Research methodology

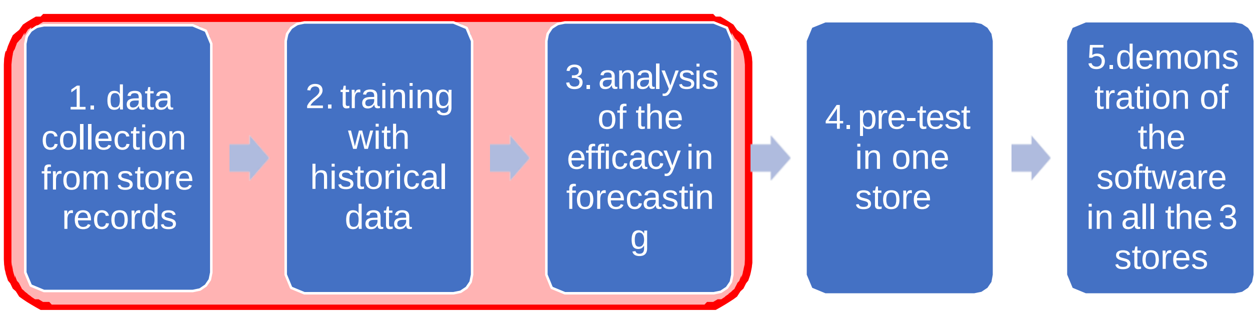
This work is part of the H2020 project LOWINFOOD, which foresees a package of activities focused on implementing and evaluating the efficacy of innovations against losses and waste of FFV, from agricultural production up to retail.

The study has been conducted in three large retail stores (sales area >3,500 m^2) located in Italy, belonging to the same retail chain, and it was specifically focused on the FFV department of the stores.

The overall research is composed of five different stages (**Figure 1**) and this study discusses the results of the first three:

1. collection of historical data from stores' records;
2. training of the forecasting algorithm with historical data;
3. analysis of the efficacy of forecasts, focused on a set of key products;
4. real-time test of the algorithm in one pilot store;
5. demonstration of the software in all the three stores for a period of three months.

Figure 1: Step of the research; the steps underlined in red are those implemented and analysed in this contribution



As for point n.1, a set of historical data was acquired from the records of the three stores, referring to the years from 2016 to 2021. Collected data included the code of the store, family, category and sub-category, product unique number, date of the sale, quantity sold, revenue, purchases, stock at the beginning and at the end of each month, data on promotions (beginning, ending, price and quantity sold), quantity of recorded waste, surplus of products (difference between purchases and sales), inventory gap (shrink), corresponding to quantities of products that are missing in the inventory (but never sold) at the monthly recording.

In total, the dataset was composed by 2003 FFV products of which at least one sale was recorded, grouped in 109 families. The database includes 497 products which are sold by the weight (data expressed in kg and €/kg) and 1506 products which are sold by the unit (data in number of packs and €/pack). Data on all these products were used to train the algorithm.

A selection of FFV key products was made on the dataset of the year 2021. For each product, the revenue and the mass of surplus products that becomes waste were calculated, summed up for the three stores. This data includes the total quantity of waste recorded for each product and the inventory gaps for the same products (corresponding to the unrecorded waste), summed for the three stores. A percentage rate of waste was also calculated, by dividing the mass of surplus that becomes waste, for each product, and the mass of the same products supplied to the three stores.

A set of 96 key products was selected, having a turnover higher than 10,000 € and, at the same time, a rate of waste exceeding 2.5% in the year 2021. The forecasting algorithm was then trained to generate daily sales forecasts for these specific products, using a range of input variables, including sales data from the previous 30 days, day of the month, month of the year, and day of the week. Additionally, the algorithm takes into account holidays, pricing information, and promotional periods. To predict the quantities sold for each product, a machine learning approach is taken, using a multilayer perceptron model.

To assess the accuracy of the model, forecasts were generated for the entire year of 2021, and compared to actual sales data recorded on the corresponding days. The accuracy was then measured as the mean absolute error between the forecasted quantity and actual sale. In the results, the sales forecasting quantity (kg or unit) is indicated for each product studied. In the future, a reliability indicator for the forecast will also be incorporated, which is currently in development.

Basing on the results presented in this contribution, the implementation of the forecasting software in one pilot store, and then in all the three stores involved in the research, is planned. During the implementation period, the stores will feed the algorithm with the sales data every day, and they will receive the sales forecasts of the following day as an output, focusing on the key products selected.

Main results

The purchase value of all surplus quantity, across all products, is estimated on average to be 260,065 €, 189,015 € and 201,265 € annually for the three stores, resulting in waste rates of 12%, 8% and 11%, respectively. The most wasted products, among the key products considered, are oranges (rate of waste from 15% to 27%, depending on the specific product code), radicchio (21-26%), fresh tomatoes (17%), potatoes (27%) and artichokes (20%). In 2021, an analysis of recorded waste products reveals that yellow and red peppers, round eggplant, and artichokes had the highest volume of documented wastage. On the other hand, when considering the inventory gap, which represents unrecorded waste, the products with the highest volume were iceberg salad, rocket salad, and bananas. The unrecorded FFV waste across all stores constitutes approximately 88% of the total surplus. Details are presented in

Table **1**.

Table 1: Details for different stores and their total surplus, surplus per year, waste rate, and unrecorded waste in euro and percentage. Based on the data from the stores that cover all the years that data were available (2016-2021)

	STORE 1	STORE 2	STORE 3	TOTAL
Total surplus that become waste (€)	1,560,392	1,134,091	1,207,592	**3,902,075**
Surplus per year (€)	260,065	189,015	201,265	**650,346**

Waste rate (%)	12.20%	8.01%	10.56%	**10.16%**
Unrecorded waste (€)	1,360,325	878,311	1,201,479	**3,440,115**
Unrecorded waste (%)[1]	87.18%	77.45%	99.49%	**88.16%**

Table 2 presents a sample forecast of 15 arbitrary products for a single day. This information is meant to be available to the food category manager of every store for daily product ordering. The forecast serves as a decision support tool to assist them in their ordering activities. By utilising this forecast, staff members can make informed decisions regarding the quantities of products they need to order each morning.

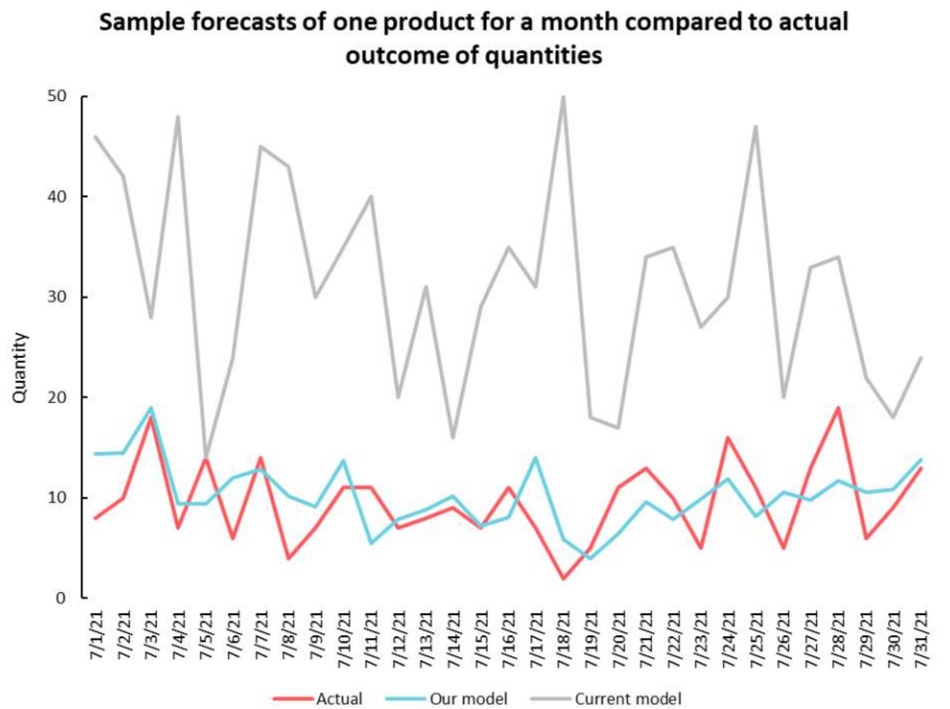
Table 2: The table shows how the forecast information is displayed to the staff. As unit of measurement, kilogram (kg) or Number of Units (NU) have been used.

Type of product	Unit of measurement	Date	Forecast
Carrots	kg	20210524	11.35
Cabbage	kg	20210524	5.68
Zucchini	kg	20210524	56.33
Round aubergine	kg	20210524	32.27
Peppers	kg	20210524	55.53
Pack of 500 gr tomato	NU	20210524	5.23
Lettuce “romana”	kg	20210524	15.75
Red radish	kg	20210524	4.09
Cucumber	kg	20210524	45.27
Pumpkin seeds	NU	20210524	6.27

Figure 2 shows a sample forecast for a single product over the course of one month, alongside the corresponding actual outcome. To provide a benchmark for comparison, the figure also includes the data that are considered by food category managers to forecast sales in the “business-as-usual” situation: this consist of the sales data of the year before, without any further processing or formal analysis, because other variables potentially affecting the sales are evaluated upon experience.

[1] Unrecorded surplus (%) here refers to the proportion of unrecorded waste in relation to the total surplus.

Figure 2: This figure compares the actual outcome of quantity sold for a specific product, with two different forecasting models.



To assess the accuracy of the forecasting model, the model was tested on data from 2021, which was not included in the model's training data. The accuracy is measured as the mean absolute error of the forecast and expressed as a percentage of total sales for the same period. The results for five example products can be seen in **Figure 3**.

Figure 3: The accuracy of our forecasting model for five example products in one store during 2021, compared to the model currently employed by the stores, where the quantity sold is assumed to be the same as last year on the same date.

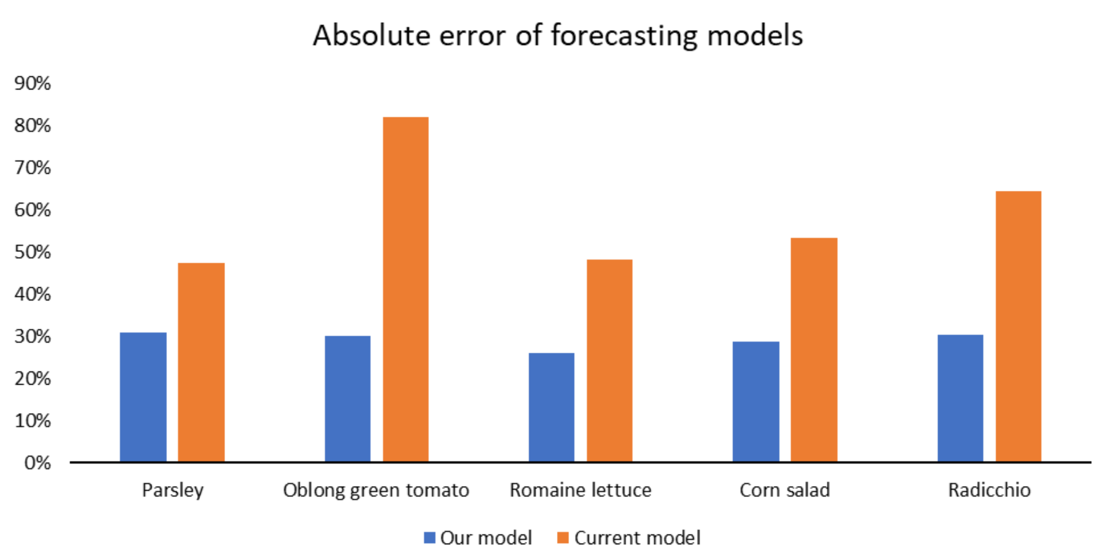


Table 3 displays the overall performance and reliability of our model compared to the model that is currently used by the stores. The table compares a sample of 15 products out of the 96. The mean average error is found to be approximately twice as large for the stores' current model compared to the new model in development.

Table 3: Comparison of a sample of 15 products from the suggested 96. Our selection criteria focused on choosing products with a substantial amount of data available. Specifically, we aimed to include products where the number of data points for our model and the current model were approximately equal. To assess the reliability of the models, we utilise the MAE/AVERGAE SALE measure. This metric is based on the quantities sold for each product and provides insight into the accuracy and performance of the forecasting models. As unit of measurement, kilogram (Kg) or Number of Units (NU) have been used.

		Our Model		Current Model	
Product no	Unit of measurement	MAE	Data points	MAE	Data points
Salad "trocadero / cappuccina"	kg	28.8%	355	53.3%	344
Green tomato	kg	30.1%	289	82.1%	301
Pack of 1.5 kg of golden apple	NU	50.0%	226	168.2%	270
Pack of 80 gr of parsley	NU	30.9%	357	47.4%	347
Lettuce "romana"	kg	26.1%	355	48.1%	343
Pack of 125 gr of argula	NU	23.9%	354	50.5%	343
Salad "gentilina"	kg	32.8%	141	73.9%	170
Red radicchio	kg	30.4%	354	64.5%	341
Black savoy cabbage	kg	36.3%	347	86.5%	321
Pack of 400 gr of salad "iceberg"	NU	30.5%	284	54.6%	303
Classic mixed salad	NU	41.9%	355	58.1%	344
Squash blossom	Nu	45.3%	344	76.4%	328
Yellow winter melon	kg	38.9%	354	61.5%	339
Pineapple	kg	52.0%	218	61.4%	199
Escarole	kg	42.2%	244	84.1%	288
AVERAGE		**36.0%**		**71.4%**	

Discussion and conclusions

Monitoring sales and waste data at retail stores is crucial to inform strategies to reduce food waste. In this study, we collected very detailed and informative data about sales, promotions and waste at three Italian retail stores, at the single product level for the food category of fruits and vegetables. One first evidence we found from these stores is the incidence of unrecorded food waste in the FFV product category. Previous evidence estimated the rate of unrecorded waste around 1/3 of total food waste (Eriksson et al., 2012; Cicatiello et al., 2020). Instead, the inventory gaps for FFV products at these stores reveal a much greater incidence of unrecorded food waste. This suggests that, especially in the FFV departments of retail stores, the procedures for waste monitoring shall still be improved.

Concerning the results of the forecasting software, they show that considerable improvements are possible in the information which is available to food category managers to place the orders. The overall performance of the new forecast model shows a substantial improvement with respect to the business-as-usual, reducing the error by approximately 50% compared to the current model in use. However, it is important to note that the forecasts generated by the model should not be directly considered as ordering suggestions. When placing orders, it may be advisable for the stores to incorporate a safety margin to prevent potential shortages. Additionally, they should consider the remaining stock from previous days to optimize their ordering decisions. Conducting a real test in an operational environment will be crucial to evaluate the extent to which the forecasts are truly trusted and utilised in the ordering process.

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Methods, tools, and theories to assess the propensity to introduce innovations in the agrifood sector: a literature review.

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KEYWORDS

Innovation, agrifood, sustainable development, determinant factors, implementation, assessment

INTRODUCTION

Companies must be able to create increasingly quick and disruptive solutions in response to the fundamental changes that are affecting the global scenario (e.g. the change that are affecting the market after the Covid-19 pandemic, the war in Ukraine or the climate change) in order to maintain competitiveness and sustainability. “Many small- and medium-size enterprises (SMEs), which represent the core engine of the economy of many countries, seem to no longer have a secure future unless they constantly innovate their products, processes, and business models” (Bertello et al., 2022; p.91). However, “integrating environmental, social and governance (ESG) factors to boost sustainability in business activities needs to rethink corporate purpose, redesign the management system, and allocate financial resources” (Cupertino et al., 2021; p.318), penalizing, above all shortly, firms’ profitability. Therefore, the need to innovate is closely related to the risks of innovation and companies, in particular SMEs, often live this condition as a barrier and not as an opportunity.

The food system is particularly affected by these challenges. Indeed, certain products' supply and demand have significantly changed in recent years, affecting both their availability and price. Additionally, since agriculture depends on the availability of natural resources, climate change can lead to unsuitable conditions for agricultural activities and cause losses in terms of productivity and revenues. Environmental end socio—economic aspects require an urgent transition toward more sustainable models, but these changes need innovation and several factors make it difficult (e.g the large number of small and medium-sized enterprises, the poor coordination among the actors of a supply chain, the lack of cooperation and knowledge). For this reason, the recent international political programs, strategies and agreement (e.g. RDPs 2014-22; EU-Green Deal; EU-Farm to Fork) are trying to support the agri-food companies creating around them a complex network of relationships and knowledge. The degree of companies’ openness to the external context and the ability to cooperate on research and innovation issues are crucial elements, to influence the technological dynamism of companies and their innovative performance and, more generally, the performance of the national innovation system.

Through the implementation of a systematic literature review, this study intends to investigate the following QR: “What are and how to measure the factors that affect the innovation adoption by agri-food entrepreneurs?”

The primary aim is to develop a tool that will be helpful to policymakers in designing political programs that reflect the true interests of businesses. At the same time, academics can be supported in defining new research insights, and businesses in understanding how to eradicate some barriers that avoid the implementation of innovations that represent a chance for increased competitiveness.

MATERIALS AND METHODS

A systematic literature review has become necessary to identify the methodologies used, in the last decade, to measure the phenomena underlying the innovation adoption in the framework of Italian agri-food system.

The bibliographical research was conducted using Scopus database by Elsevier. It contains peer-reviewed scientific output (journal articles, books, conference proceedings) and more than 70 million bibliographical citations, abstracts, and bibliometric data.

The keywords to be entered into Scopus were chosen using the focus group technique. Procedures from Silvestri et al. (2022) were used as a guide for the setting of the search strings (e.g., the selection of Boolean operators or the inclusion of the most popular synonyms for certain words). Therefore, the search strings used in Scopus have been: “Agricultural” OR “Agri-food” AND “Innovation” AND “Assessment” OR “Evaluation” OR “Measurement”. The research criteria were "Title, Keywords, Abstract". Finally, the following filters have been set:

- Year: from 2013 to 2023.
- Subject area: Environmental Sciences; Agricultural and Biological Sciences; Social Sciences; Economics, Econometrics and Finance; Business, Management and Accounting.
- Document type: articles and reviews.
- Publication stage: final.
- Country: Italy.
- Language: English.

The publications that were collected underwent a selection process before being used to carry out bibliometric, network and content analysis using as reference the review produced by Agnusdei and Coluccia (2022).

The bibliometric indices, which guarantee a quantitative approach, useful to increase the reliability of the results and minimize the subjective distortion of the literature reviews, have been studied adopting Bibliometrix R-Tool (Aria and Cuccurullo,2017). It is an R package that facilitates a more comprehensive bibliometric analysis, employing specific functions for both bibliometric and scientometric quantitative research, easily integrable with other relevant packages belonging to the R suite of software applications for data manipulation, calculation and graphic visualization (Crawley, 2007).

The VOS Viewer software was used for network analysis. In particular, it was use to analyze the keywords' co-occurrence, as it allows the display of results in graphic format and in an easy-to-interpret way (Van Eck and Waltman, 2008). In this study, some processing criteria were established in order to produce the most representative outcome: a Thesaurus file was made to group synonyms, a threshold value for occurrence was defined, and words with a low co-occurrence value were discarded.

After these steps, the last phase of content analysis will be developed to carry out a real examination of the collected documents, deepening the most salient themes to date and providing the basis for future research.

MAIN RESULTS

Scopus's bibliographic search produced 1185 results, which were filtered to find the ones that were most helpful in addressing the research topic. The first sorting phase was made by reading of titles, abstracts and keywords and it has produced a total number of 113 publications. The latter have been used to the bibliometric analysis.

The bibliometric analysis, implemented using the Bibliometrix in R package, has produced the main synthesis results, reported in Table 1. As defined by the application of filters on Scopus during the execution of the bibliographic survey, the selected publications refer to the decade from 2013 to 2023. There are 113 publications, of these 100 are articles and 13 reviews. The texts' sources are 54 but 21% of them have been selected by only two magazines: "Science of the Total Environment" and "British Food Journal". The annual percentage growth rate is 21.48%, in fact, in Table 2 it is possible to observe that the highest number of publications was selected among those produced in the year 2022 and, in any case, almost half of them (47.8%) belongs to the years between 2018 and 2021. Therefore, the most recent scientific production has been considered more suitable to answer the question of origin research and this was desirable, having as focus the innovation. Indeed, it is a theme that has attracted particular interest since the definition of the development objectives of the Europe 2020 Strategy, proposed by the European Commission in March 2010. The average age of the documents (3.16 years) confirms the relevance of the bibliography identified.

Table 1 - Main information about data (Source: Bibliometrix R Tools)

Timespan	2013 : 2023
Sources (Journals, Books, etc)	54
Documents	113
Annual Growth Rate %	21.48
Document Average Age	3.16
Average citations per doc	20.91
Average citations per year per doc	4.322
Keywords Plus (ID)	715
Author's Keywords (DE)	477
Authors	599
Author Appearances	670
Documents per Author	0.189
Co-Authors per Doc	5.93
Single-authored doc	4

Table 2 - Annual Scientific Production (Source: bIbliometrix R Tools)

Year	Articles
2013	1
2014	1
2015	4
2016	6
2017	8
2018	10
2019	16
2020	14
2021	14
2022	32
2023	7

Through the use of the VOSViewer program, a network analysis on co-occurrence has been built using the 477 keywords that the authors (DE) of the total publications defined. More in detail, the parameters "Co-occurence", "Author keywords", and "Full counting" are chosen. The minimum number of times each word appears has been set at 3. Thus, 17 terms have been recognized for processing by the co-occurrence network. It has since come to light that several of them were synonyms. Due to this, it was required to compile terms with similar meanings into a thesaurus file. 449 out of the original 477 keywords remain, and the number of words that fulfill the specified processing requirements has been reduced to 13 (Figure 1). Although meeting the processing criteria, the last two words of this list have recorded a low value (1 and 2 respectively) of co-occurrence, therefore they were subtracted to processing.

Figure 1 – List of keywords meeting processing criteria of co-occurrence network.

Selected	Keyword	Occurrences	Total link strength
☑	agri-food	25	26
☑	sustainability	24	19
☑	innovation	21	18
☑	circular economy	5	7
☑	digital transformation	14	6
☑	food security	4	4
☑	lca	5	4
☑	organic agriculture	5	4
☑	climate change	3	3
☑	network	4	3
☑	policy	5	3
☐	rural development	3	2
☐	social capital	3	1

Images 2 and 3 show the processing of co-occurrence calculations among selected keywords. The "Density Visualization" (Figure 2) highlights the 3 key words of the research: "agri-food", "sustainability" and "innovation". If "agri-food" and "innovation" are the keywords used in the Scopus string to carry out the search, then, it was likely that they appeared among the most cited, "sustainability" frames a new and important goal, now essential in innovation proposals. In the "Network Visualization" (Figure 3), however, the 3 search clusters identified by VOSViewer are evident, useful to highlight some sub-themes related to the main search query. In detail:

- The red cluster contains the key words most related to the environmental issue, so the solutions (for example, organic farming), the most felt problems (climate change and food security) and the issue of environmental impact assessment.
- The green cluster highlights the correlation between agricultural policy and some of the innovative solutions on which it is investing particularly, namely: cooperation and digital transformation (closely related to the concept of precision agriculture).
- The blue cluster belongs to the circular economy, a new idea of innovation in the agri-food sector that combines the objectives of sustainability, which research is trying to propose and achieve.

Finally, Overlay Visualization (Figure 4) allows us to observe the co-occurrence network by emphasizing the temporal aspect of research topics. Although the number of years is small, the incurring events (Covid-19 pandemic, war in Ukraine, and environmental disasters) matter on the research trend, justifying the increased interest in topics such as climate change, environmental impact, circular economy, and digital transformation. This key reading of the identified bibliography provides an additional framework useful in framing the path that scientific research is taking and drawing useful considerations with respect to the research question that this study proposes to answer.

Figure 2- Density Visualization on VOSviewer

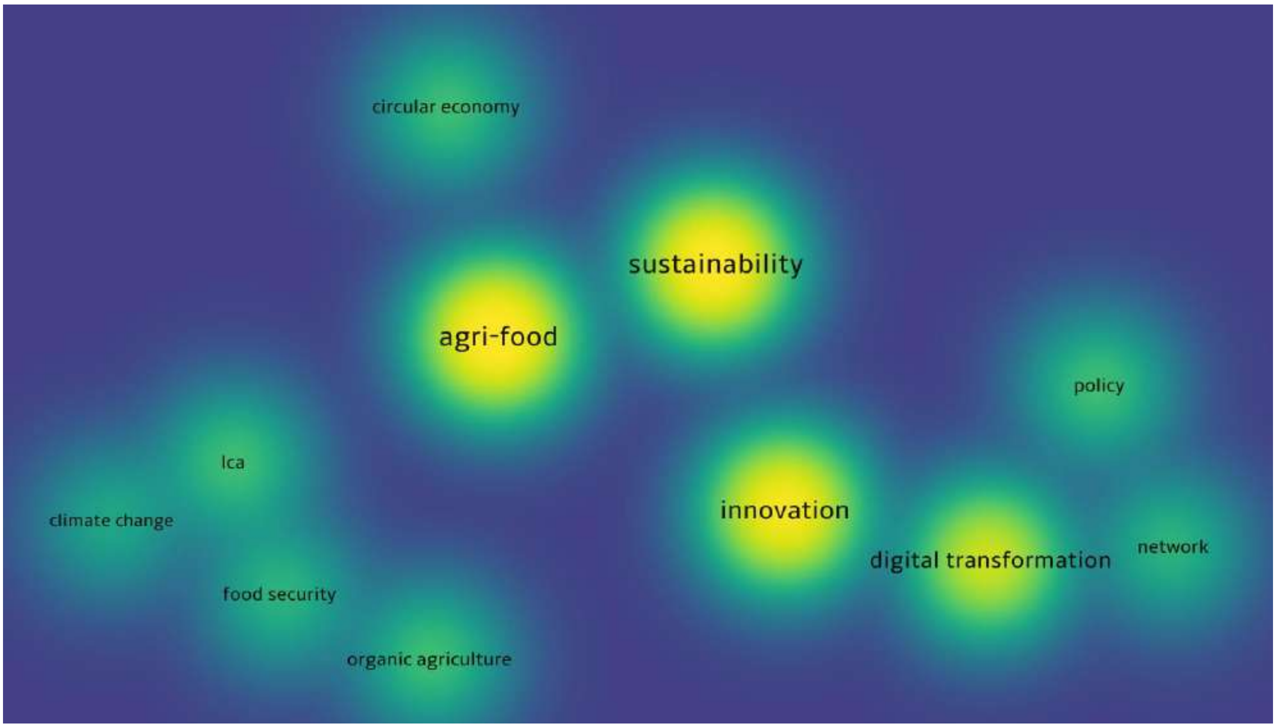


Figure 3 - Network Visualization on VOSviewer

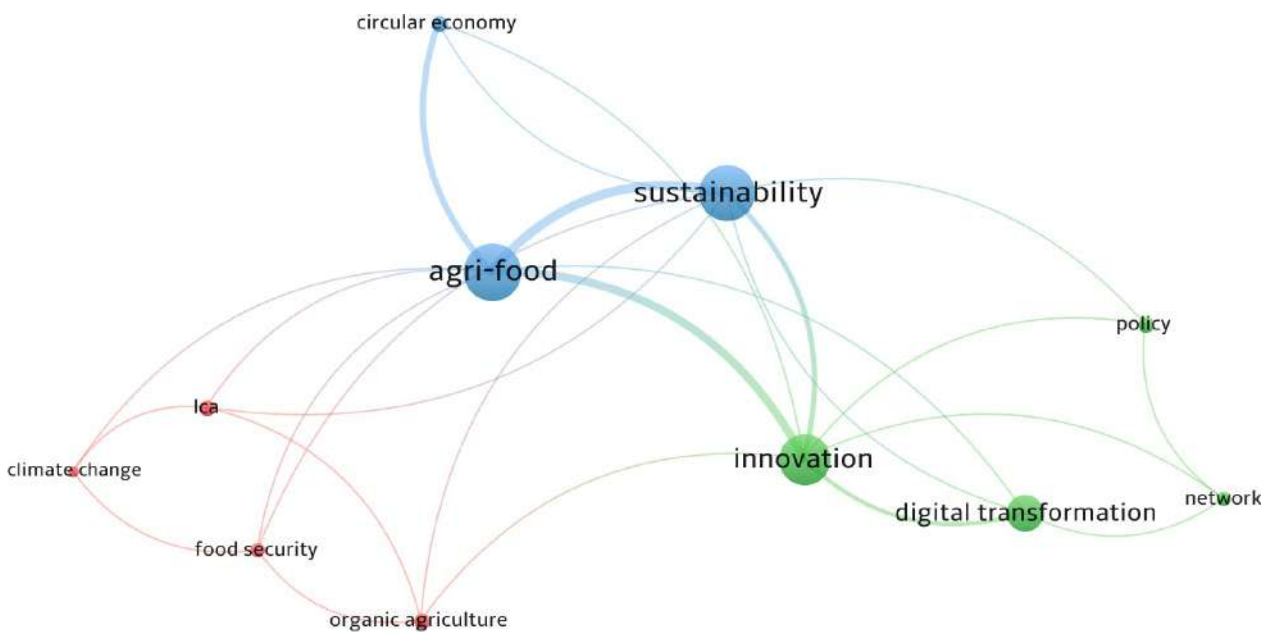
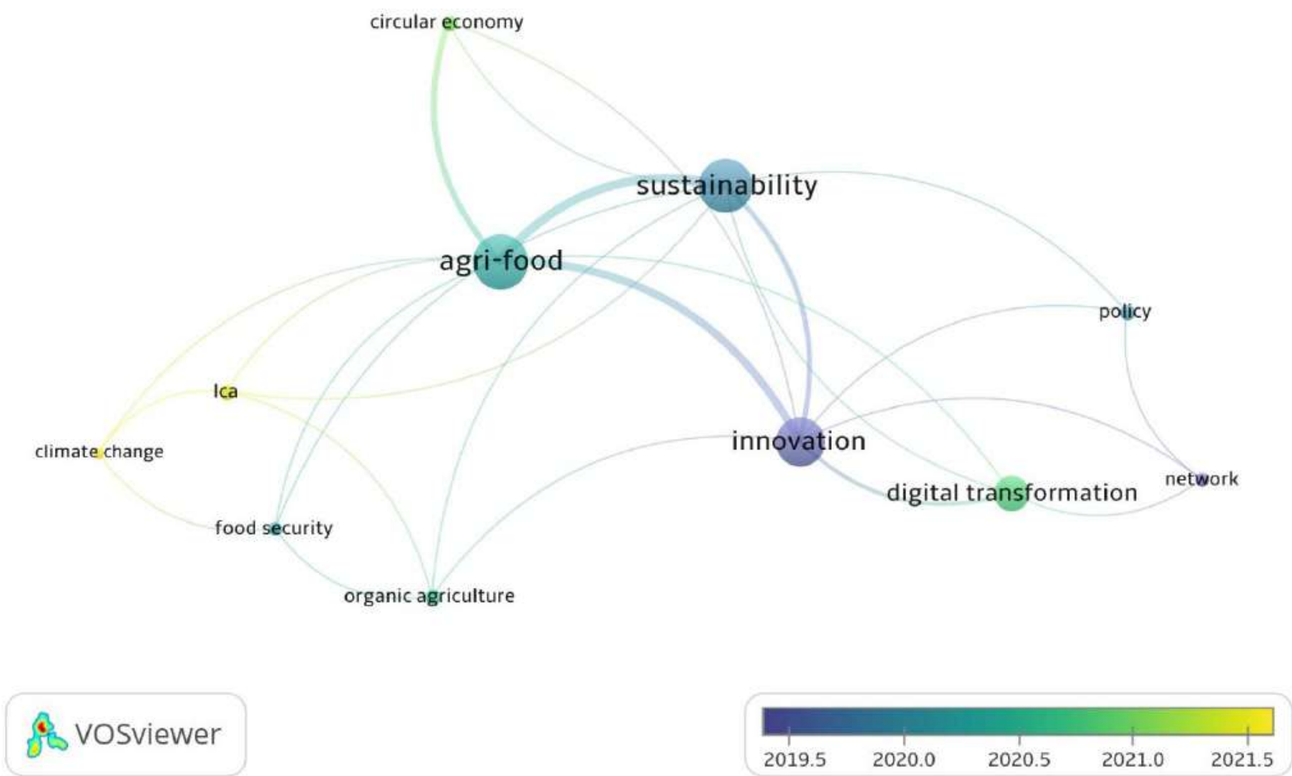


Figure 4 - Overlay Visualization on VOSViewer



The last phase of this study, which consists of content analysis, is in progress. Therefore, the 113 publications will be deepened and discussed. This step could widen and modify the results of synthesis until now exposed, providing a new and more complete key of reading of the collected literature.

CONCLUSION

The analysis of content is essential to arrive at meaningful conclusions about the initial research question. In fact, it will make it possible to understand how the research clusters identified in the network analysis have been developed by the authors to highlight the determinants that lead companies to innovate.

For example, the link between innovation and environment is so evident that it has generated an individual cluster, but it is interesting to understand how environmental issues are driving companies to adopt innovations, whose profitability and productivity goals are often at odds with social and environmental sustainability objectives. Moreover, publications that have examined the development of "networks" in the innovation process will receive special attention. In fact, this sector is so densely populated with micro, small, and medium-sized businesses that they will struggle to respond innovatively to difficulties if they continue to operate separately. Understanding what has been done and how much more needs to be done to promote this component is crucial since it serves as a catalyst for innovation.

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
Marina di Orosei (NU), 21-22 settembre 2023.
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AGRO-BIODIVERSITY ORIENTED FOOD SYSTEMS: EXPLORING THE POTENTIAL OF THE LENTILS VALUE CHAIN IN ITALY

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KEYWORDS
Agro-biodiversity; lentils; value chain; socio-ecological system; qualitative approach; thematic analysis.

1. INTRODUCTION

Agri-food systems worldwide are experiencing marked changes due to shifts in consumer preferences, rising input expenses, and growing concerns about food security and environmental threats like ongoing biodiversity loss and climate change (Varia *et al.*, 2021). In this context, agro-biodiversity has been recognized having a crucial role in increasing resilience of agricultural systems. According to the (FAO, 2019), agro-biodiversity is defined as the variety present among living organisms, encompassing both intra-species and inter-species diversity, utilized either directly or indirectly in food and agriculture. Drawing upon (Scaramuzzi *et al.*, 2021), we define agro-biodiversity-oriented food systems as systems centered around: (i) the preservation of underutilized landraces, (ii) the development of products derived from landraces showcasing agro-biodiversity and (iii) the enhancement, marketing, and promotion of agro-biodiversity products.

Researchers have demonstrated that agro-biodiversity oriented food systems can boost productivity, soil fertility, and contribute to the long-term sustainability of agriculture (Garcia-Yi, 2014; Meynard *et al.*, 2018) while supporting climate change mitigation and reducing the risk of pest and diseases (FAO, 2019; Hirata Sanches *et al.*, 2022). Recent EU strategies on climate and biodiversity have strongly supported this approach, explicitly endorsing the benefits of both crop diversification in general and the increased cultivation of legumes in particular (European Commission, 2022).

In this context, it is crucial to question whether farmers are the sole actors responsible for promoting agro-biodiversity within the industry. While studies exist on how market pressures influence agricultural diversity (Carpenter, 2010; Garcia-Yi, 2014; Isakson, 2011), other scholars argue that greater emphasis should be placed on exploring how value chain dynamics specifically contribute to agro-biodiversity conservation goals (Hellin *et al.*, 2010; Lockie and Carpenter, 2010).

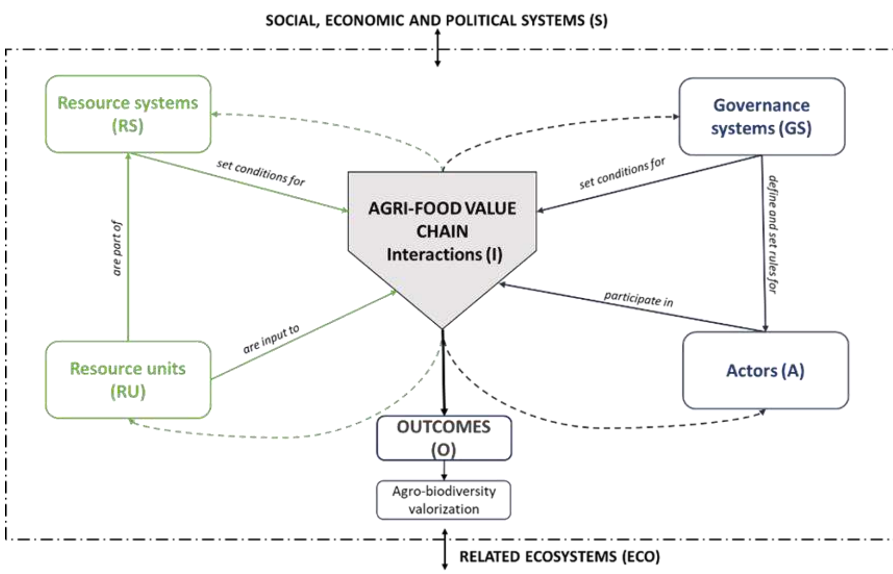
This study aims to identify key economic, social, environmental, and policy-related factors that define the decision-making process of farmers, processors, and retailers engaged in the lentils' value chain in Italy. Specifically, our analysis focuses on assessing the state of agro-biodiversity, identifying barriers and enablers affecting the promotion of biodiversity among different actors (Acciani *et al.*, 2020; Weituschat *et al.*, 2023).

2. CONCEPTUAL FRAMEWORK

We contribute to the understanding of agro-biodiversity-oriented food systems by following the socio-ecological system (SES) framework to define the context of analysis, the actors and resources involved in the system under investigation (Scaramuzzi *et al.*, 2021).

The SES framework was initially proposed by (Ostrom, 2007) as comprehensive conceptual framework for diagnosing interactions and outcomes in social-ecological systems. Integrating biodiversity within a SES framework allows for a better comprehension of the complexity of biodiversity conservation, its dynamics and interactions across various scales (Ban *et al.*, 2013; Martín-López and Montes, 2015; Mehring *et al.*, 2017).

Figure 1 – The Socio-ecological system (SES) framework of the study



Source: Own elaboration adapted from (McGinnis and Ostrom, 2014)

In this paper, the suggested SES is categorized into four components: the resource system, which refers to the Italian lentils' sector; resource units, which encompass the diversity of lentils and other legume crops; governance systems, which involve the management and oversight of the lentils' supply chain; and actors, which include farmers, processors, and retailers. On the other hand, the Social, Economic, and Political Setting (S) and Related ecosystems (ECO) are considered external factors that may arise as a result of the dynamic operation of the system (McGinnis and Ostrom, 2014) (Figure 1).

3. THE CASE STUDY

In response to a recent request for more applications based on real-life scenarios to gain deeper insights into sustainability and resilience in supply chains (Negri *et al.*, 2021), our study focused on the case study of the lentils' supply chain in Italy.

Lentils' production appears to be a good case study to explore the concept of agro-biodiversity in Italy given its large genetic variability of local regional or territorial varieties (Sonnante and Pignone, 2007). The cultivation of lentils in Italy centers around distinct varieties, such as green lentils (e.g., Eston and Laird, or Elsa and Gaia cultivars), red lentils (e.g., Crimson or Itaca cultivars), and Protected Geographic Indication (PGI) varieties like the PGI lentils of 'Castelluccio di Norcia' in Umbria, which holds a well-established market position, and the 'Altamura PGI lentils' in Apulia, which has experienced growing commercial popularity in recent times.

4. METHODOLOGY

In line with previous studies, the research outlined in this paper proposes a qualitative inductive approach to investigate social and behavioral phenomena specific to this value chain (Antosz *et al.*, 2022; McGarraghy *et al.*, 2022; Paoletti *et al.*, 2021; Taylor, 2003; Tubaro and Casilli, 2010).

4.1 Data collection

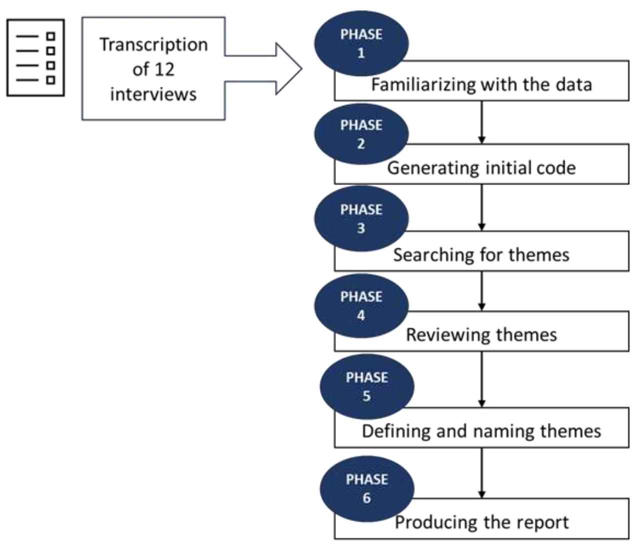
Data was collected through either face-to-face or online semi-structured interviews. Overall, 12 interviewees were conducted between November 2022 and January 2023 in the Italian language to three different value chain actors: 4 farmers, 4 processors, and 4 retailers, across different Italian regions.

In this type of research, it is common practice to develop a general guideline for the interviews, (Ghorbani *et al.*, 2015). First, the objective and context of the study are clearly outlined, and informed consent, including permission to audio-record, is obtained from each interviewee. Through open-ended questions, the study explores five main subjects: (i) type of crops/varieties produced/sold and related quantity, (ii) relations and contracts with suppliers and sellers, (iii) costs and prices, (iv) problems and expectations to diversify with more or new crop varieties, (v) perceived consumers' preferences.

4.2 Data analysis

The data analysis process is based on a six-phase inductive thematic analysis (Braun and Clarke, 2006) (Figure 2). Transcriptions from interviews have been imported into the NVivo software, allowing for the coding of typed interviews' transcripts.

Figure 2 – Phases of thematic analysis



Source: Own elaboration adapted from (Braun and Clarke, 2006)

The process begins by getting familiar with the data and identifying potential patterns. Initial codes are then assigned to the entire dataset. Next, these codes are organized into emergent themes, while the refinement phase ensures coherence and consistency within each theme. Overarching themes are named based on the primary aspects of the data. Finally, the findings are summarized and presented in an overall report for the case study (Figure 2).

5. RESULTS AND DISCUSSION

5.1 Main themes

In the coding process, 6 main general themes have been identified and named in relation to major recurrent topics: (i) biodiversity, (ii) economics, (iii) climate change, (iv) market, (v) policy and (vi) socio-cultural aspects (Table 1). Given the research focus on biodiversity, we also identified 2 additional targeted themes: (i) barriers and (ii) enablers towards biodiversity valorization.

Matrix coding was performed to analyze the co-occurrence or patterns of coding across multiple participants or sources. In Table 1, main themes have been displayed with numerical values representing the mean coverage of each theme across all participants.

Table 1 – Dictionary of themes and mean coverage

General themes	Definition	Mean coverage
I. Biodiversity	Two types of diversity: agrobiodiversity and product diversity.	5,67
II. Economics	Price and costs faced by all actors, and perceptions on recent price inflation.	3,08
III. Climate change	Climate change related events affecting Italian lentils' cultivation.	0,75
IV. Market	Contracts regulating the interactions between the actors, as well as mechanism of lentils' price setting in the market.	4,16
V. Policy	CAP policy measures affecting Italian lentils' cultivation.	0,5
VI. Socio-cultural aspects	Actors' perceptions on consumers' preferences, and collaboration among actors.	2,42
Targeted themes		
I. Barriers	Main barriers towards the valorization of lentils' biodiversity across all actors of the chain.	2,16
II. Enablers	Main enablers towards the valorization of lentils' biodiversity across all actors of the chain.	1,5

Source: Own elaboration

5.1.1 Theme I: Biodiversity

Biodiversity has been, further divided into two main nodes: (i) agro-biodiversity, which might be further sub-divided into intra-varietal diversity (within lentils) and inter-varietal diversity (within legume crops or between legumes and cereal crops), and (ii) product diversity (Table 2).

Table 2 – Matrix coding of nodes by actors_Biodiversity (mean values)

Nodes	Sub-nodes	Farmers	Processors	Retailers	Quotation
Agrobiodiversity		2,75	2,25	2,5	"Legumes didn't have the relevance they have now. We worked on a large project to re-evaluate legumes, for the inclusion of at least two varieties of the same legume. For example, we included black chickpeas to complete the range of classic chickpeas" (Retailer)
	Inter-varietal diversity	1	0,25	0,5	"We believe a lot in the use of legumes, in my opinion it is not so much a theme of variety of lentils, but it is lentil instead of beans, instead of chickpeas. It is not intra-variety" (Retailer)
	Intra-varietal diversity	1,75	2	2	"Some people use Le Puy, a French variety. Some use Laird, the big Canadian one. Then, some local varieties of Altamura lentil have been selected by the PGI consortium and these seem to be the most popular lentils" (Farmer)
Product diversity		0,25	0,75	1	"95% of lentils we buy goes into dry product. 5% goes into pre-cooked or already cooked product. If we were to also include lentil flour, therefore a derivative of lentils used to make pasta, it is probably not 95 but 92" (Processor)

Note: red= no evidence; yellow= weak evidence (mean value ≤1), green= strong evidence (mean value > 1)
Source: Own elaboration

Agro-biodiversity is extensively discussed by all participants involved in the value chain. Actors have discussed on diversity within the lentils' species (intra-varietal diversity) by providing a list of lentil varieties cultivated or purchased for production along the chain. However, the analysis of the text suggests that participants have also addressed the concept of inter-varietal diversity. Specifically, farmers and retailers seem to believe that focusing on the diversity of legumes is potentially more significant than introducing additional lentil varieties to the market, for establishing resilient and biodiversity-oriented systems (Table 2).

5.1.2 Themes II - VI: Economics, Market, Climate change, Policy, Socio-cultural aspects

Matrix coding was again performed to analyze the co-occurrence or patterns of the other codes across multiple participants (Table 3).

Table 3 – Matrix coding of nodes by actors_Other themes (mean values)

Theme	Nodes	Farmers	Processors	Retailers	Quotation
Economics	Costs	1,75	0	0	"The cost of diesel has increased, as all farm management costs and irrigation cost. Last year we certainly suffered from inflation. However, we saw it in all agricultural products made in Italy, not just lentils" (Processor)
	Price	1,25	0,25	0,25	
	Price inflation	1,75	1,5	1,25	
Market	Contracts & regulations	1,25	2,5	3,25	"We make an annual supply contract before sowing. We guarantee a price that is always the same and does not fluctuate according to the market, unless the market rises more than what expected in the contract. We set a price, if the market goes up beyond what offered as it happened this year, we follow the market, so the farmer doesn't lose out. But if the market goes down, we stay on the minimum guaranteed price" (Retailer)
	Price setting	1,5	1,25	0,75	
Climate change	Drought	0,5	0	0	"In recent years there have been anomalous situations related to temperatures. This year there have been low temperatures until the end of April not allowing the crop to grow and then the explosion of temperatures up to 40°C, which accelerated ripening" (Farmer)
	Extreme temperature	1	0,25	0	
	Heavy rains	0,25	0	0	
	Water scarcity	0,25	0	0	
Policy		1,25	0,25	0	"The new CAP will not favor lentils, just as other legumes. To get the eco-scheme 4, you need to follow crop rotation between cereals and legumes, and in legumes, as in forage crops, the use of pesticides is prohibited. Managing legumes without pesticides is very impractical and, in my opinion, this can only lead to the disappearance of this crop" (Farmer)
Socio-cultural aspects	Collaboration	1,25	0,5	0,5	"Up to now the consumer has always seen the lentil as a fairly basic product, and there has never been a specific request for the search of particular origins or particular varieties" (Retailer)
	Perceptions on consumers' preferences	0,25	1,5	2,25	

Note: red= no evidence; yellow= weak evidence (mean value ≤1), green= strong evidence (mean value > 1)
Source: Own elaboration

Regarding the economics-related aspects, price inflation is a significant concern for all actors of the chain, with rising costs of fuel, machinery, inputs, packaging materials, and retail food prices. On the market front, actors within this value chain largely operate through long-term contracts with suppliers and clients.

These contracts not only dictate the quality and quantity of the purchased product but also ensure a minimum guaranteed price for suppliers.

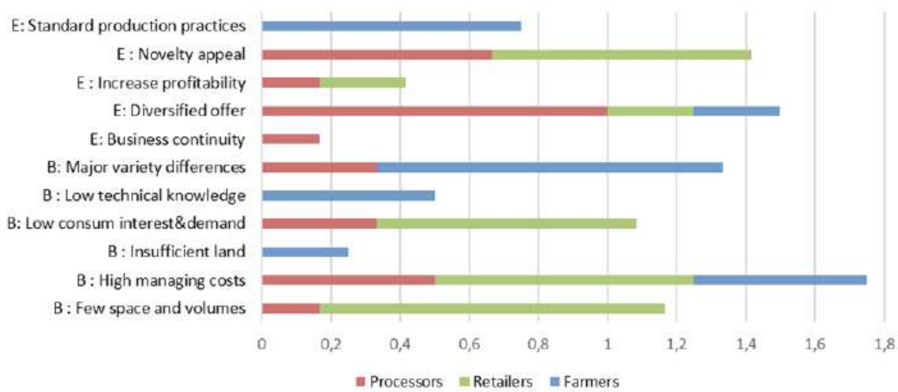
The study also delved into the subject of climate change, allowing to discuss whether lentil cultivation has been affected by any extreme weather events in recent years. Farmers, in particular, voiced their concerns about the impact of rising temperatures, especially high temperatures, on lentil farming. Furthermore, concerning recent or forthcoming biodiversity related policy, farmers believe that the introduction of eco-schemes may discourage lentil cultivation. This is primarily due to the prohibition of pesticide use, which is considered essential for effective weed control in this crop cultivation.

In conclusion, socio-cultural aspects indicate strong collaboration and trust among participants engaged in the PGI system such as consortium or cooperatives. Additionally, processors and retailers displayed heightened awareness of end consumers' preferences, indicating that consumers prioritize product differentiation based on attributes like colour, shape, and unique combinations of legumes and crops, rather than specific names of lentil varieties (Table 3).

5.2 Targeted themes: Barriers and enablers towards biodiversity

Given the focus of this study on biodiversity conservation, we also identified a set of factors – barriers and enablers – towards biodiversity promotion along the lentils' value chain (Figure 3).

Figure 3 – Barriers (B) and Enablers (E) across actors



Source: Own elaboration

Farmers seem to be primarily concerned about the barriers hindering the promotion of lentils' biodiversity, finding significant differences in performance and final yield, and high farming costs among lentil varieties. Limited land availability and insufficient technical knowledge also pose challenges to implementing crop diversification. However, farmers recognize that cultivating different lentil types does not necessarily require distinct farming practices; rather, the cultivation process remains relatively standard.

Similarly, retailers perceive more barriers than opportunities, facing challenges like high management costs, limited storage space, availability of specific lentil varieties in small volumes and lack of consumer interest for lentil differentiation. However, retailers do recognize that a high level of differentiation could increase novelty appeal, increase profitability, and generate greater consumer interest.

Lastly, processors identify both enablers and barriers. They recognize the potential to attract novelty-seeking consumers and ensure business continuity through a wide range of diversified lentil products and varieties along the year, especially when certain varieties are not available on the market at a given time. They also believe that having a broader selection of lentil varieties would increase profitability for farmers and other value chain actors. Yet, they are concerned about challenges in processing, increased management costs, and limited storage capacity due to substantial variations among lentil varieties. As retailers, they perceive lack of consumer interest and demand for differentiating lentil varieties in the market.

6. CONCLUSIONS

This study emphasizes the significance of agro-biodiversity in the lentils' value chain, highlighting diversity within lentils and among legumes. It stresses the importance of diversification with legumes for creating resilient and biodiversity-oriented systems rather than introducing new lentil varieties.

The research identifies barriers and enablers to biodiversity promotion among different actors, with farmers facing challenges related to costs and knowledge gaps, while retailers encounter storage limitations and low consumer interest. However, processors see opportunities in diversifying lentil products for business continuity and profitability.

The findings underscore the necessity of policies supporting agro-biodiversity preservation in legume cultivation along all value chain stages. These policies should include financial support, technical assistance, capacity-building programs, and increased collaboration among policymakers and stakeholders. Implementing these measures could contribute to the development of sustainable and resilient agro-biodiversity-oriented systems, ensuring both food security and environmental sustainability.

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Climate and environment: The directions of innovation studying Italian Operational Groups

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Keywords
AKIS, Operational Groups, Innovation ecosystem, Environmental innovation, sustainable agriculture, Emissions

Introduction

Agriculture featured prominently at the UN Climate Change Conference COP27 in 2022, since agriculture, food, and land use contribute for about 25% of greenhouse gas (GHG) emissions worldwide according to the Intergovernmental Panel on Climate Change (IPCC). Innovation can pave the way towards mitigating the climate impact of agriculture, as well as fostering the diffusion of mitigation options in sectors providing inputs, such as the energy sector. The place of agriculture in innovation policy has perhaps been overlooked, and only recently can one find research works studying the distinctive features of the innovation process in agricultural firms and the knowledge exchange flows it entertains with other sectors (Bjerke and Johansson, 2022). In regard to knowledge flows, the European Union has taken the challenges to establish an Agricultural and Knowledge Innovation System (AKIS) and has assigned it a central role in the future economic development after the global crisis. Supporting the adoption of innovations through AKISs has been one of the main issues addressed by the European Union's structural policies for the development of farms and rural areas in terms of competitiveness and sustainability (Mirra *et al.*, 2020). Therefore, in order to achieve the main policy goals for a resilient, intelligent, and sustainable agriculture, innovation has, evermore, a central role for the future European strategy.

Hence, the literature argues the importance of radical technological and organizational solutions to addressing a sustainable transition in agriculture. According to Brunori *et al.* (2013), such a transition is favoured by innovation policies which foster new approaches and methods of intervention, such as the implementation and definition of network models, characterized by the linkages and cooperation among actors.

In this framework, partnerships are demand-driven and follow a bottom-up approach, increasing the awareness of the value of local knowledge and of producer participation. Indeed, this model foster knowledge production, resource sharing and information dissemination in rural areas. Furthermore, it generates spaces for the experimentation and the transformation of local knowledge into resource development (Brunori *et al.*, 2013). The extent of collaboration among several actors is a key determinant innovation (Minarelli *et al*., 2015).

Therefore, the Rural Development Policy (RDP) promotes innovation in agriculture, forestry and rural areas, by funding the establishment of Operational Groups (OGs). These multi-actor partnerships aim to identify innovative solutions to solve problems or exploit new technological opportunities.

Innovation projects are financed by the 2014-2020 RDPs, as provided in Measure 16 for cooperation, through sub-measure 16.1 "Support for the establishment and management of EIP operational groups on agricultural productivity and sustainability". Indeed, the first Priority (P1) of rural development programming 2014-2020 has been to promoting knowledge transfer and innovation in agriculture and in rural areas. Its application cuts across other European priorities regarding rural development, confirming the key contribution of innovation to sustainable growth.

The study aims at understanding, in detail, how the RDP is fostering innovation. In particular, the focus is directed toward defining the analysis of entrepreneurs 'innovative outcomes, regarding innovations aimed at mitigating the carbon and environmental footprints of agricultural production.

To this purpose, a content analysis of objectives of successful applications of OGs (Measure 16.1.1) has been made, along with a statistical analysis, in order to define the categories of innovations actually supported through European funds.

Data and research methodology

The study has been performed in two main steps: a quantitative and a qualitative analysis on the Operational Groups (OG) constituted in Italy during the CAP 2014-2020. Innovarurale provides publicly available data about the OGs. In some cases, data have been completed by searching on the OG's dedicated websites.

Data on OG projects have been collected searching in the Innovarurale webpage by keywords ("Climate and climate change", "Energy management", "Management of water resources", "Waste management") and themes ("Climate change", "Pollution and climate-altering emissions", "Energy", "Renewable energy", "Carbon footprint"). Overall, 43 projects corresponding to these search criteria are found out of nearly 700. For each project, we have collected data about the OG composition (number of partners; involvement of a public university or research center; involvement of individuals), project theme, duration, budget (total budget, co-funding share), region, and the project outcomes. The following outcomes have been considered: type of innovation (product; process; method), type of publication disseminating the project outcomes (for academics; for practitioners), and targeted environmental benefit (mitigation of climate-altering emissions; mitigation of other pollutants; energy saving; water saving; reduction of plastics).

Summary statistics of the data are computed in order to assess the main features of the projects. Moreover, to achieve deeper information, a content analysis is implemented to identify qualitative data on the main goals and strategies of OGs. Content analysis is used to find and conceptualise the underlying issue amongst the documents (Allan, 2003). The European Commission has provided guidelines to Member States and their regions for a homogeneous scheme for the textual categories.

Thus, the main goals are reported by following a general format (European Commission, 2014). Therefore, the analysis is surely a relevant tool in order to cluster OGs patterns and highlight the main goals of the several projects. Thereafter, the study may request further data to saturate the theoretical sampling to develop in favour of the reliability and validity of the qualitative research.

Discussion of results

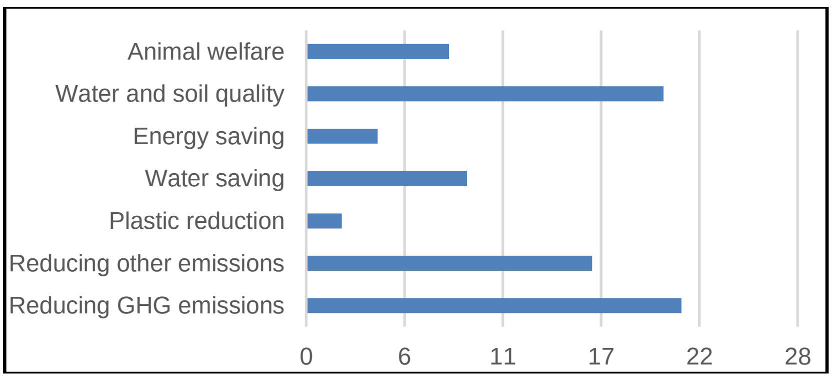
The data analysis shows that OG projects, regarding environmentally related innovation, are mostly carried out in the North of Italy, with Emilia-Romagna alone housing 29 projects. Only 5 projects are developed in the Centre regions, while none in the South, as Figure 1 shows.

Figure 1- Operational Groups on environmentally related innovation in Italy

Source: Our elaboration

Concerning the goals of the various projects, the bar-graph in Figure 2 demonstrates the most frequent ones. The principal targets are “emissions of pollutants” and “green-house gases” involved in 14 projects mostly from the zootechny sector. These projects concern mainly the reduction in green-house gases emissions as well as emissions of ammonia and methane.

Figure 2 - Main OGs goals on climate change in Italy



Source: Our Elaboration

The analysis is validated also in the content analysis. Thus, the frequency of words, which provides information on the saliency of OG goals, involves mainly "Sustainable"; "Emissions"; "Production"; "Management" and "Reduction" as it was expected. The analysis has categorized innovations into three types: process, product, and methods, concerning non-technical innovations (see also Wisdom et al., 2014).

Figure 3 - Importance of words in the document

Source: Our Elaboration

OG projects mainly target process innovations (18), or innovations in methods (18), more rarely product innovations (7). Universities and public research centres are often partners in the groups; in some groups, universities collaborate with other research bodies (e.g., CNR, CMCC) in addition to firms. This is in line with the innovation system framework according to Edquist (1997).

Notwithstanding the engagements of several public research actors, project outcomes are mainly disseminated through non-academic or practitioners 'journals, presumably due to the lengthy academic peer-review processes. The performance of quantitative and qualitative analyses, which in parallel explore the OG projects, is relevant to ensure the validity of the research. Furthermore, the analysis paves the way for further studies in this field about the role of OG and innovation in rural areas.

Main conclusions

The connection between agricultural sector and EU rural areas through the development of human capital and research, along with strengthening the support for innovation, are identified by the European Commission as central aspects of the strategy to achieve the goals of sustainability and social welfare. The new CAP 2023-2027 has further enhanced synergies with research and innovation policy.

Numerous innovation policy instruments have been put in place to foster cooperation between the actors of the "innovation ecosystem" characterized by dynamic interactions (Autio e Thomas, 2014).

The experience in the 2014-2020 programming period has shown a positive impact of measures to support knowledge and innovation systems in the so-called AKIS (Agricultural Knowledge and Innovation System). That has been beneficial for knowledge dissemination and advisory measures as for measures to cooperation, through the funding of EIP-AGRI.

In the current RDP programming period 2023-2027, the AKIS model has become even more central, for instance through intervention SRG 01 "Support to Operational Groups - EIP-AGRI". AKIS has been claimed as the approach to follow for the implementation of the strategic objectives related to stable knowledge flows and adoption of innovations (Coldiretti, 2023). The data collected highlight the crucial role of innovation and dissemination of knowledge through the networks of actors also for the OGs projects.

The quantitative evidence about the selected projects sheds light on two gaps: lacking involvement of Southern OGs in green innovative activities; and a relatively minor focus on the renewable energy-agriculture interactions. The latter evidence is consistent with a relatively large distance between agriculture and renewable energy generation techniques in the technological space, which prevent agricultural firms from contributing to significant advances in energy research, while their role in the abatement of GHG can be essential. There are perhaps more opportunities to bridge the territorial gap, which may signal a lacking involvement of Southern universities and research institutes, or a broader weakness in networking by Southern agricultural producers. Still, cross-regional difference go beyond a North-South gap, as one region (Emilia-Romagna) stands out in terms of OG involvement in green agricultural innovation. A future step in the analysis may therefore involve comparing calls for OG projects across regions, with the aim of identifying regional specificities in the innovation policy strategies.

The present study is one of the first addressed to OG in Italy. It aims to analyse the innovative outcomes of a sample of Italian agricultural entrepreneurs on environmental and climate issues. The analysis performed in this work could be the starting point for future research assessing the factors that can negatively or positively influence the adoption of "green" innovation in agricultural firms outside of OGs. In particular, we plan to compute a "value for money" indicator to measure the environmental benefits per Euro spent in the projects. These issues, which was important in the RDP 2014-2020 programming, will be crucial in the current RDP 2023-2027.

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THE CONTRIBUTION OF ECONOMICS TO AGROECOLOGY: A SCOPING REVIEW

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ABSTRACT
In the last years, agroecology has gained prominence as one of the innovative approaches that could positively contribute to achieving sustainable food systems. As a transdisciplinary science, agroecology could benefit from the contribution of the economic toolbox. This study aims to give an overview of how the agricultural economics discipline have contributed to this field of study. A scoping review was conducted by using the PRISMA methodology and its extensions for scoping reviews. After the identification, screening and selection stages, a total of 196 papers were included in our review, both from Scopus and Web of Sciences databases, according to eligibility criteria. The selected body of literature provides an overview of the key topics investigated, the main methodological approaches applied, and the main results achieved by scholars.

KEYWORDS: agroecology, agricultural economics, sustainable food system, socio-technical transition, transdisciplinary.

INTRODUCTION
Agroecology is increasingly seen as a holistic and multidimensional approach (Méndez et al., 2013; Gliessman, 2018) to achieve sustainable food systems (HLPE, 2019). Although there are several definitions in literature, agroecology is widely considered a transdisciplinary science that includes elements from several disciplines (Dalgaard et al., 2003), increasingly focusing on the transformation of the whole agri-food system (Wezel and David, 2020) to enhance food security and nutrition (HLPE, 2019). Compared to other approaches concerning the transition toward more sustainable food systems, the literature on agroecology has still several gaps preventing a full understanding of its potential (D'Annolfo et al., 2017).

For example, it is still disputed whether the agroecological transition of food systems can deal with ongoing food security and nutrition challenges (Bezner Kerr et al., 2021). Furthermore, the impacts of agroecology on society at large are little explored (Gonzalez de Molina, 2013). Understanding socio-economic and political factors is necessary to identify drivers and barriers to foster the agroecological transition (Bellamy and Ioris, 2017; Giraldo and Rosset, 2018).

Against this backdrop, the role of agricultural economics discipline can be relevant (Fresco et al., 2021), and the present research falls in this domain. More specifically, this study aims to provide an overview of how the economics discipline have approached and contributed to the literature concerning the agroecology.

Seeking to systematize this body of literature, the research will focus on different relevant economic dimensions explored (e.g., farm management, provision of ecosystem services, extension and advisory services, governance of supply chains, consumer preferences, agricultural policies, and other relevant socio-political issues and environmental outcomes of agroecology). To reach this objective a scoping review was performed to systematically map the research done in the field of agroecology by using the toolbox and tools from the agricultural economics domain. In detail, the literature review aims to reply the following research questions:

1. What are the main economic topics analysed?
2. What are the main methodological approaches applied?
3. What are the main results achieved?

Finally, the literature review aims to find-out the research gaps that should be filled-in.

MATERIALS AND METHODS

The scoping review is the ideal tool to characterize scientific literature on a given topic, determining the amount and type of extant studies. Scoping reviews are useful to bring out underinvestigated areas of inquiry and to eventually suggest the formulation of specific research questions (Colquhoun et al., 2014; Munn et al., 2018).

The review protocol was drafted using the PRISMA methodology and its extensions for scoping reviews (PRISMA-ScR). We designed a searching protocol incorporating inclusion criteria and keywords for the application in two different databases, Scopus and Web of Science (WoS). We performed a query based on the Boolean combination of the following keywords: “agroecol*”, “agro-ecol*” and “econom*” set in the fields "article title, abstract, and keywords".

These keywords were chosen with the intention of identifying those studies that had as their focus on agroecology and the economic dimension at different level of analysis (from plot or farm’s scale to the whole food system). To get variants of the provided search terms, asterisk (*) at the end of the keyword was added. Databases search was conducted on 18 January 2023. After the search procedure a total of 5,436 entries were retrieved from the two databases (Table 1).

Table 1 - Databases search queries

Databases	Search query	No. of records
Scopus	TITLE-ABS-KEY ([agroecol*OR agro-ecol*] AND econom*)	3,410
WoS	((TI=((agroecol* OR agro-ecol*) AND econom*) OR AB= ((agroecol* OR agro-ecol*) AND econom*) OR AK= ((agroecol* OR agro-ecol*) AND econom*))	2,026
	Total	**5,436**

On each database, automatic filters for identifying eligible articles were applied in accordance with the following criteria: published in the period 2013-2023 by believing that scientists' interest in this topic had increased following the International Symposium on Agroecology for Food Security and Nutrition held by FAO in Rome in 2014. To be sure obtaining high quality publication we included scientific articles published in peer-reviewed journals (Larson & Chung, 2012), written in English being generally perceived as the universal language of science (Morrison et al., 2012) and considering the inconsistency of empirical evidence showing that the exclusion of non-English language articles in reviews generates biases (Balshem et al., 2013; Hartling et al., 2017). The identification stage was further narrowed according to subject areas where it was almost certain to find articles falling under the domain of agricultural economics (Table 2 & Table 3).

Table 2 - Identification criteria

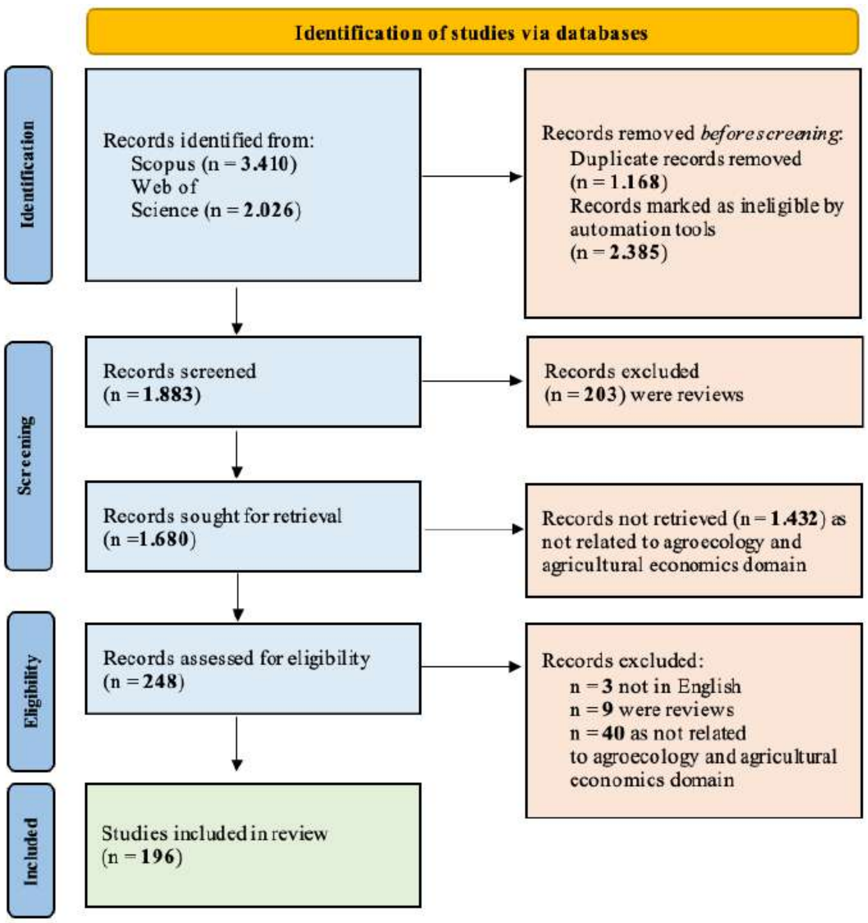
Database	Automatic filters	No. of records
Scopus	• Document type: articles, review, short survey • Subject area: AGRI, BUSI, DECI, EART,ECON, ENVI, MULTI, SOCI, VETE • Language: English • Publication year: from 2013 to 2023	2,903 2,789 2,482 **1,772**
Web of Science	• Document type: article, review • Subject area: AGRICULTURAL SCINCES, BIOLOGY & BIOCHEMSTRY, ECONOMICS & BUSINESS, ENGINEERING, ENVIRONMENT/ECOLOGY, MULTIDUSCIPLINARY, PLANT & ANIMAL SCINCE, SOCIAL SCIENCES, GENERAL, GEOSCIENCES • Language: English • Publication year: from 2013 to 2023	1,951 1,919 1,732 **1,279**
	Total	**3,051**

Table 3 - Inclusion/exclusion criteria

Inclusion criteria	Exclusion criteria
1. Peer-review studies 2. Document type: article, review, short survey 3. Subject areas 4. Only English language 5. Published between 2013-2023 6. Focused on agroecology 7. Fell within agricultural economics domain	1. Not peer-review (e.g. proceedings) 2. Were not articles, reviews or short papers 3. Not within selected subject areas 4. Not in English or only abstract in English 5. Outside of target dates for publications 6. Not focused on agroecology or the word agroecology referred to other themes 7. Not included within the domain of the agricultural economics

The studies identified by applying the automatic filters in each database (n = 1,772 in Scopus; n = 1,279 in WoS; n = 3,051 in total) were imported into excel for the de-duplication process. After the elimination of duplicates (n = 1,168) the remaining abstracts (n = 1,883) were reviewed by two of the authors. The screening stage was performed by reading of "article title, abstract, and keywords" to ascertain if papers focus on agroecology and have significant agricultural economics content (Fresco et al., 2021). When we were unable to deduce all the aforementioned information from the title or abstract, we included the paper for further examination via full-text reading. In addition, during the screening stage, we choose to eliminate the reviews (n = 203) from our database after ascertaining that their scope was different by our review objective. At the end of the screening stage, 248 articles were recorded. After, a full-text assessment for the eligibility, 196 articles were included in the scoping review. Figure 1 shows the entire selection process.

Figure 1 - PRISMA-ScR flow diagram, representing the stepwise process of record identification, de-duplication and abstract screening, full-text assessment for the scoping review



RESULTS

Through an iterative process based on the reading and analysis of full-text articles, a detailed categorization was carried out. At this stage, through the detection of the main differences and the key elements in common, the studies were combined to refine the categorization. The main research topics were identified according to the stated general objective of the selected studies. Within each main research topic, were identified based on the stated specific objective. After such analysis, 8 main research topics were identified (see Table 4) and then further categorized in sub-topics.

Table 4 - Number of studies for each main topic

ID	MAIN TOPICS	N.
#1	AGROECOLOGICAL TRANSITION	**44**
#2	ASSESSMENT OF PRODUCTION SYSTEMS	**52**
#3	FOOD SECURITY AND FOOD SOVEREIGNTY	**7**
#4	MARKET STUDIES	**23**
#5	POLITICAL DIMENSION	**41**
#6	RESEARCH AND EDUCATION AGENDA	**16**
#7	RURAL AND URBAN DEVELOPMENT	**9**
#8	MISCELLANEOUS STUDIES	**4**
	TOTAL	**196**

It follows a brief discussion of each category of the selected studies, seeking to synthetize the main findings and to emphasize the similarities among articles falling under each main topic.

The category "AGROECOLOGICAL TRANSITIONS" contains publications that approach the topic of agroecological transition by exploring case studies from both the Global North and South. Many studies examine the transition dynamics and trajectories by considering interactions between multiple levels, from field to farm, sectoral and territorial agri-food system, and socio-technical landscape, addressing the different challenges and pressures to change. Some of them propose comprehensive theoretical frameworks for studying transition pathways. Other works focus specifically on the multiple drivers and/or barriers to transition, on the crucial resources to foster the change, and on stakeholders' involvement and relations, mainly adopting a multi-actor perspective. Another group of studies explores the factors affecting decision-making processes, to understand farmers' decisions to adopt agroecological practices, often identifying socio-economic trade-offs.

The studies under the category "ASSESSMENT OF PRODUCTION SYSTEMS" focus on the assessment of productions systems in terms of sustainability performance of the agroecological paradigm at various scales of analysis (from plot scale and farm scale to entire agri-food system). Some articles covered sub-topics concerning the diversification of faming systems (e.g. crop-livestock integration, livestock farming systems, crop diversification). Other studies aimed at prototyping of new farm management systems based on agroecological principle. An array of articles focused on the impacts of agroecological transition at farm and territorial scale. Few studies performed an analysis of agroecology in terms of transitioning to organic farming, while others performed a comparison between conventional farming vs. agroecological farming or the impact of adopting several others agroecological practices in conventional farms (e.g. biocontrol, organic fertilization, biostimulants).

The articles under the category "FOOD SECURITY AND FOOD SOVEREIGNTY" explore the relationship between agroecology and the issues of food security and food sovereignty. Specifically, food sovereignty is seen as an ideal aspiration widely shared by several socio-cultural and political movements, both in the South and in the North of the world, and understood as the right of people who produce, distribute, and consume food to also control the mechanisms and policies of food production and distribution. Overall, these studies provide empirical evidences that the contribution of agroecology to food security and food sovereignty is twofold. On the one hand, agroecology contribute in building sustainable agri-food systems strongly rooted in local knowledge, culture, and food production and consumption practices to adequately meet the nutrition needs of local communities. On the other hand, agroecology includes a social and political dimension of governing agri-food systems that can synergistically support the struggle movements for food sovereignty to break down social and political barriers towards the transition.

The "MARKET STUDIES" investigate different market issues strictly related to the transition process of agri-food systems towards agroecology. Some of these studies analysed the role of labelling and identified some strong limitations of this specific tool for supporting and fostering agroecological products on the market. Other studies focused on the role of consumers and highlighted that the transition process towards agroecological food systems needs to shift from farm-level solutions to the interactions within the entire value chain, from production to consumption, with emphasis on the role of consumers' collective action as a powerful force for driving the transition process. Another group of studies emphasized the strategic role of "alternative food networks" to support peasant economy and foster the agroecological transition. These networks are understood as specific market organizations based on the partnership and social cooperation between small-scale farmers and consumers at local level, with the aim to re-connect production and consumption using practices, which are sustainable in economic, social and environmental terms.

The studies concerning the "POLITICAL DIMENSION" focus on the analysis of the economic and social impacts of public policies supporting the agroecological transition, and other studies aimed at suggesting guidelines for design and implementation public policies. Also, studies that emphasized the role of grassroots action and social movements in making agroecology a dominant topic in political discourse.

The category "RESEARCH AND EDUCATION AGENDA" embraces those studies that address concerns on the research and education programmes dealing with agroecology. Some articles faced different innovative approaches to research in order to grasp the complexity of the theme (e.g. transdisciplinary and action orientation methods) or the educational initiatives such as training courses on the topic of agroecology. Finally, other studies highlighted the gaps in the literature.

The papers under the research topic "RURAL AND URBAN DEVELOPMENT" analyse the agroecology through the lens of urban and rural development. Authors consider agroecology, implemented through urban and peri-urban agriculture, as a strategy able to address challenges related to food security, health issues, biodiversity loss, and resource depletion, all of which are gravely affecting the linkage between the rural and urban environment.

The category named "MISCELLANEOUS STUDIES" includes heterogeneous studies that explored specific dimensions of agroecology including social justice, ethical consumerism, and valorisation of local historical knowledge. In general, these studies highlight the opportunity to build a more comprehensive and shared conceptualization of agroecology.

CONCLUSIONS

The scoping review reached the aim to gain insights on how the economics discipline have contributed to the field of study on agroecology. The selected body of literature (196 papers) was classified into 8 main research topics and then further categorized in several sub-topics, providing an overview of the main methodological approaches applied, the results achieved by scholars, and the research and policy implications. The 8 main research topics identified were as follow: 1) agroecological transition, 2) assessment of production systems, 3) food security and food sovereignty, 4) market studies, 5) political dimension, 6) research and education agenda, 7) rural and urban development, 8) miscellaneous studies. This review pointed-out how multidisciplinary and transdisciplinary approach to research is essential to face the complexity of the sustainable transitioning of the agri-food system. Aware of the limitations of this study, it is an attempt to inspire future research on underinvestigated areas, highlighted by the present study.

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Cost-effectiveness assessment of biosecurity practices focusing on Italian intensive pig farms

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KEYWORDS
Cost-effectiveness, biosecurity, pig farms, economic analysis.

BACKGROUND

High standards of animal welfare and biosecurity are essential to improve animal health and significantly reduce the use of antibiotics in livestock production, maintaining optimal animal performances, particularly in the pig sector (Ryan, 2019) (Niemi *et al.*, 2016).

Biosecurity is the set of measures designed to reduce the risk of entry and/or spread of an infectious disease in farms. It concerns both the farm management and the farm structures (Huber *et al.*, 2022).

The EU Regulation 2016/429 indicates biosecurity as one of the main prevention tools, to anticipate the introduction, development and spread of transmissible animal diseases from and within an animal population. In accordance with this Regulation, operators are primarily responsible for adopting adequate biosecurity measures regarding the species and categories of kept animals and products under their control.

In Italy, data on the application of biosecurity measures on farms are collected through specific checklists by veterinarians of the National Health Service (NHS) during official farm inspections, and by farm veterinarians, to verify farm biosecurity conditions and, compliance with regulations, and to design farm biosecurity plans. Biosecurity checklists are different for aims, animal species, and livestock categories. In this paper we will focus on the intensive Italian pig farms sector.

The U-Gent biosecurity checklist is an internationally recognized reference in this field, which allows to perform an evaluation of the different aspects of biosecurity based on a risk analysis for the main infectious diseases.

The U-Gent checklist designed for swine, is a questionnaire including 109 questions with sections for external and internal biosecurity, and for different types of pig farms (farrow, weaners, fattening, mixed). The answer to every question is ranked in quantitative scale scored between zero (when this measure is not implemented at all or the least optimal answer is given) to one (when the measure is fully implemented). Depending on the importance of a particular biosecurity measure, the score of each question is multiplied by a weighting factor.

STUDY OBJECTIVES

The goal of biosecurity is to prevent transmission routes, break the infectious cycle and focus on generic measures rather than disease specific commonalities.

Biosecurity, at company level, is based on two essential pillars: external biosecurity and internal biosecurity. By external biosecurity we mean the set of measures aimed at limiting the risk of introducing new agents of infection and/or disease. The severity of the restrictions and measures necessary to maintain an adequate level of biosecurity may vary according to the type of business, the health level required, the surrounding epidemiological status as well as the regulatory framework.

Internal biosecurity, on the other hand, aims to limit the circulation of disease agents within the farm. In this case, it includes all those restrictions and precautions necessary to reduce the spread of morbid conditions among the different groups of animals, between the different production categories and between the different company structures.

The management of internal biosecurity, compared to the external one, is complex and heterogeneous since it requires the evaluation of numerous factors, such as:

- adequate knowledge of the corporate health status
- analysis of the company from the point of view of the structure, position and strategy
- evaluation of the margins for structural-management improvement and of the cost/benefit ratio of the improvement intervention.

The advantages referable to good biosecurity practices in farms are attributable to a better state of health for the animal, greater production, reduction in the use of drugs, etc (Kuster *et al.*, 2015).

Likewise adopting biosecurity measures at the farm level leads to higher management costs and investments that drives to reduce profits and reductions in these investments (Berends *et al.*, 2021).

In this context fits the European HE Project BIOSECURE, whose goal is to improve the ability of decision makers in livestock farming to understand, prioritize, and implement evidence based, cost-effective, and sustainable biosecurity management systems in multiple animal species and of different production types. One of the aims of the Project is to carry out a cost-effectiveness evaluation of biosecurity practices in intensive European pig farms.

Pig farming is a highly topical sector in relation to the economic burden incurred by the spread of animal diseases, use of antibiotics (AMU) and the related phenomenon of antimicrobial resistance (AMR)[1], and the application of biosecurity practices beyond to good animal welfare practices, are crucial to improve the economic sustainability of these activities.

In this framework thus described a multi-year PhD research project is included, the aim of which is to evaluate the costs and benefits of monitoring and improving animal welfare and biosecurity in pig farms.

In this study some results achieved by the PhD project will be reported, focusing on the cost-effectiveness assessment of internal biosecurity practices focalizing on Italian intensive pig farms.

The Ph.D. project includes an assessment of the costs to be supported to increase the farms' biosecurity scoring according to the U-Gent checklist: it considers improvements in management, equipment, farm facilities, and other elements contributing to internal and external biosecurity, as well as the effects of these improvements on animal-based measures. The benefits are examined in terms of reductions in animal health costs and production losses related to health and welfare problems, improvements in farm efficiency, production performance and product quality, including the possibility of accessing new markets (e.g., products obtained without using antibiotics), and reduction of health risks for agricultural workers.

[1] Antimicrobial resistance (AMR) is the ability of microorganisms to resist antimicrobial treatments. The incorrect use or abuse of antibiotics is considered the cause of the growth and spread of microorganisms resistant to their action, with consequent loss of efficacy of therapies and serious risks for public health. (World Health Organization, 2015)

METHODOLOGY

The methodology applied for the research project is structured in some relevant steps:

i) the collection and analysis of a systematic review of the literature and bibliographic materials related to biosecurity and animal welfare in the swine sector, nationally and internationally
ii) the development of a questionnaire to be submitted to veterinarians, breeders and zootechnicians to identify define the costs and evaluate the economic impacts of the biosecurity measures indicated by the U-Gent checklist, to arrive at a list of costs for external and internal biosecurity, subsequently validated by interested parties
iii) The next step will be to correlate biosecurity costs with checklist question scores
iv) Subsequently, the criteria for identifying the costs to be incurred for lowering the biosafety risk level of a pig farm will be defined and the costs to be incurred for lowering the biosafety risk level of a pig farm will be assessed
v) The penultimate step will be to define the criteria for identifying the benefits for pig farms deriving from the lowering of the risk level for biosecurity
vi) Finally, an evaluation of the benefits for pig farms of lowering the biosecurity risk level and an evaluation of the cost-effectiveness of lowering the biosecurity risk level in pig farms from the farm point of view.

RESULTS

In this study will be reported the first results of the second point of the methodology described above related to the internal biosecurity.

13 interviews were produced so far: 3 zootechnicians, 2 breeders, and 8 veterinarians were interviewed (Table 1) to collect technical and economic information on the application of biosecurity measures in pig farms.

Table 1 – Sociodemographic characteristics of interviewees

ID	Occupation	Sex	Basic information	Age	Years of experience (nr of years)	Region	Number of animals under control
1	Vet	M	Practitioner	40	15 years, 10 years for Ministry of Health	Lombardy	20.000 sows
2	Vet	M	Practitioner	-	21	Emilia-Romagna	15,500 pigs in full cycle and 13,000 pigs in another farm
3	Vet	M	ASL Vet	62	31	Emilia-Romagna	-
4	Vet	M	Company Vet	-	-	Lombardia e Veneto	10.000 sows, 100,000 weaned and 100,000 finishing
5	Vet	M	Company Vet	-	36	Lombardy	a farm of 1.00 sows e one from 12,000 antibiotic-free sows
6	Vet	M	Academic	-	-	Veneto	90-120 animals, experimental breeding For finishing
7	Vet	M	ASL Vet	32	1 and half	Emilia-Romagna	.
8	Vet	M	Academic	-	-	Veneto	90-120 animals, experimental breeding for finishing

9	Zootechnician	M	Agricultural expert	-	18 with sows	-	1800 sow farm and site two, piglets and weaning open cycle
10	Zootechnician	M	Veterinary technician	40	10 with supply chain companies	-	120,000 fattening pigs and 7,000 pigs from weaning
11	Zootechnician	F	Ph.D. Student	26	1	Veneto	90-110 pigs for finishing
12	Breeder	M	Site 1-2-3	57	32	Emilia-Romagna	15.500 swines
13	Breeder	F	Site 1 - 2	54	24	Lombardy	2.500 sows, 70,000 piglets a year

The professional activities of the interviewees were located mainly in the Veneto, Emilia-Romagna and Lombardy regions. On average, respondents have almost 20 years of experience in pig farms.

Questions were different according to the professional role of the respondent veterinarians, in particular:

- veterinarians were asked questions from a practical-technical point of view with respect to compliance with the regulations in force
- zootechnicians were subjected to questions regarding operational activities within the farms
- breeders were asked questions about farm management and costs.

This allowed us to classify the costs of internal biosecurity: operating cost (work hours), consumption of materials, cost for facilities and equipment (structural), staff training, external services, organizational costs, and implementation of good practices (Table 2). All the areas of internal biosecurity imply both operational and structural costs, and almost all but the nursery unit have material costs. The biosecurity measures between compartment, working lines and the use of equipment is the only area where costs from all categories are incurred.

Table 2 – Cost category of internal biosecurity

COST CATEGORY	Operating	Material	Structural	Training	Services	Organizational	Good Practices
Disease management	V	V	V	V	-	-	-
Farrowing and suckling period	V	V	V	V	-	V	-
Nursery unit	V	-	V	-	-	-	-
Finishing unit	V	V	V	-	-	-	-
Measures between compartments, working lines and use of equipment	V	V	V	V	V	V	V
Cleaning and disinfection	V	V	V	V	-	-	-

At this point, a matrix was created (Table 3) which summarizes the costs associated with the macro areas of internal biosecurity.

From an economic point of view, all the cost can be categorized according to the classical distinction among fixed and variable cost. Structural costs are also fixed costs: e.g., sickbay, the cool for rooms for carcasses eventually rented, the disinfection area and structures complying with the legislation in force, costs incurred for structural adjustment. Training costs are often refresher courses on biosecurity carried out every 3/4 years by farm operators, therefore they are fixed costs which shall be divided into macro areas. Laboratory analyses are mostly performed only in the event of an infectious disease outbreak, rather than as a routine diagnostic screening. Costs for the disposal of carcasses and for the disposal of sanitary materials were also considered.

Most of the variable costs belong to the category of sanitary materials, therefore vaccines, protective devices, scalpels, syringes, needles, swabs, and products such as additives and supplements (if added to the farm after the purchase of the feed), detergents and disinfectants. Finally, the workload needed for cleaning and disinfections, washing animals, and other biosecurity procedures was considered.

Table 3 – Matrix of internal biosecurity costs

	Structures	Training	Lab. Analysis	Consultancy	External operators	Sanitary materials	Equipment	Products	Labor
Disease management	Infirmary box Cold room	Biosecurity course	Serology	Company veterinarian or az. pharmaceutical for vaccination protocol Supplement nutritionist Vet ASL: score at the slaughterhouse Company Vet: samples for serology Company vet for euthanasia with drugs	Disposal of carcasses	Vaccines	DPI Felling equipment (pistol, knife…)	Additives/supplements	Administration of vaccines Killing and moving carcasses
Farrowing and suckling period	Washing area	Biosecurity course	-	-	-	DPI Scalpel	Basin Castration box Sow washing equipment	Cleaners Disinfectants for vet equipment	Sow washing
Nursery unit	Adequacy of the structures								
Finishing unit	Adequacy of the structures							Detergents Disinfectants	Cleaning and disinfection of the housing area after each cycle

Measures between compartments, working lines and use of equipment	Adequacy of the structures	Biosecurity course		Quality Consultant for drafting a hygienic operating procedure	Sanitary material disposal	Syringes Needles	Professional clothing Boots Trays Equipment set for managing animals of different ages	Detergents Disinfectants Disinfectants for footwear tray	Cleaning and disinfection of panels for moving pigs at the end of the cycle
Cleaning and disinfection	Adequacy of the structures	Biosecurity course	Swab analysis			Surface swabs DPI	Trays Boot washing machine	Disinfectants for footwear tray Detergents Disinfectants	Performing swabs Cleaning and disinfection of the housing area after each cycle Cleaning and disinfection of aisles and loading areas

Through the interviews, a list of variable costs for internal biosecurity measures has been created and it resulted that the highest costs are incurred for professional clothing, around €6,800 per year, and those incurred for cleaning and disinfecting environments around € 4,000 per year, while the cheapest ones are related to the purchase of needles, €1.00 per 100 animals (Table 4). Evaluation of fixed costs is ongoing (Table 5).

Table 4 – Internal biosecurity variable costs

VARIABLE COSTS	Costs	Unit of measure
Cost of personnel for vaccinations (labor and materials)	143,00 €	1 vaccination/100 swine
Cost of scores	200,00 €	1 score to slaughter
Cost of a cold room for carcasses	1.000,00 €	Annual rental
Cost of disposal of carcasses	9,00 €	1 carcass disposal for average weight
Cost of killing sick animals (materials)	35,00 €	1 slaughter by euthanasia
Cost of equipment for washing sows before farrowing	20,00 €	
Cost of detergents for washing animals	16,00 €	100 swine
Cost of disinfectant for veterinary equipment	2,50 €	100 swine
Cost of retractor for piglet castration	115,00 €	
PPE cost	2,50 €	lt/100 swine
Cost for professional clothing	6.800,00 €	Per year
Hand cleaner cost?	220,00 €	Per year
Cost of a tray = €20; Tray capacity = 12-20 litres; 1 tray/sector	20,00 €	1
Cost of boots (availability of a pair of boots/sector/employee working in that sector; included in the overall cost of workwear (C91)?)	70,00 €	1
Average cost of a set of equipment for managing animals of different ages (by sector)	200,00 €	Average
Costs for equipment cleaners and disinfectants for animals	160,00 €	Per year per 100 sows
Cost of syringes (Availability of syringes in an adequate number for the age groups present on the farm. How many syringes per sow, per litter, per number of growing or fattening pigs present?)	50,00 €	100 swine
Cost of needles (Availability of needles in an adequate number for the age groups present in the farm. How many needles per sow, per litter, per number of growing or fattening pigs present?)	1,00 €	100 swine
Cost of a tampon	120,00 €	10 tampons
Cost for the analysis of a swab	22,00 €	
Costs for cleaners and disinfectants for buildings	320,00 €	Per year per 100 sows
Cost of footwear disinfection trays (1 tray per house)	20,00 €	1
Disinfectant cost for trays	10,00 €	Per L

Table 5 – List of internal biosecurity fixed costs

FIXED COSTS
Cost of a sick bay
Cost of a biosafety training course
Structural costs for washing sows before farrowing
Costs of AI/AO in weaning
Cost of an adequate sanitary barrier
Costs of the AI/AO for the fattening sector
Costs of the AI/AO: Fixed costs incurred by the farmer (losses) during the sanitation gap?
Cost for the presence of a changing room for changing clothes between the different sectors

CONCLUSIONS

Studies investigating the economic aspect of improving animal welfare and biosecurity are still quite rare and are generally based on the analysis of small herd samples. In this presentation, the results of 13 interviews were reported which led to a list of variable costs for internal biosecurity measures in intensive pig farms.

The results induce to consider that much of the costs for optimal implementation of biosecurity in pig farms are related to the improvement of farm structures. The characteristics of the Italian pig sector, where small individual producers, often close to the retirement age, with obsolete farm structures still play a very relevant role, do not allow expectations of significant changes in the short term. Therefore, the general improvement of the biosecurity at the national level is related to a generational renewal of pig farmers, accompanied by substantial incentives to investments from the agricultural policy.

This study is part of a multi-year PhD research project and is part of the ongoing European HE Project BIOSECURE, therefore no conclusive results have been reported.

The next steps of this research are the definition of the structural costs for internal biosecurity, the total costs for external biosecurity and the economic benefits for farmers.

The next steps for this research are the definition of the structural costs for internal biosecurity, the total costs for external biosecurity, and the economic benefits for farmers.

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FACTORS INFLUENCING THE ADOPTION OF BLOCKCHAIN TECHNOLOGY BASED SOLUTIONS IN THE WINE AND OLIVE OIL INDUSTRY: EVIDENCE FROM ITALIAN CASES STUDY

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Keywords: Absorptive capacity, Innovation, Digitalization, Wine industry, Olive oil industry, BCT.

Introduction

The agro-food supply chain is today facing several challenges related to the lack of transparency and effective traceability systems to ensure food safety and avoid food waste, information asymmetry, product adulteration, and overcome the difficulty of implementing the principles of sustainability (Vern *et al*., 2023; Yadav *et al*., 2022). All this has brought businesses to redefine their organizational models by identifying effective solutions and strategies to face these challenges also through the adoption of more responsible behaviors (Thrassou *et al*., 2018). Digital technologies are undoubtedly playing a pivotal role today, by supporting businesses in this transformation process to make the supply chain more transparent and ensure effective traceability systems (Compagnucci *et al*., 2022; Lezoche *et al*., 2020). Among the digital technologies, the Blockchain (BCT) is the most promising solution, because it looks like a tool that can guarantee, through a decentralized system adopted for recording and storing information permanently, a greater integrity as well as security and trust among supply chain partners (Wamba *et al.*, 2020; Kramer *et al*., 2021). Over the last few years, the BCT had been applied to strategic sectors of Made in Italy, including the wine and olive oil industry, thus exploiting the marked propensity for innovation of many operators in the two sectors. It has been applied owing to the need to make the supply chain increasingly transparent and fight the perennial problem of food fraud (Alkhudary *et al*., 2022; Galati *et al*., 2021). With regard to the latter issue, and according to the Italian Central Inspectorate for fraud repression and quality protection of the agri-food products (ICQRF) data (ICQRF, 2022) in 2022, €23.3 million worth of wine and €1.99 million worth of olive oil was seized for food fraud, representing, overall, 77% of the value of all agri-foods seized.

In the wine sector and in the olive-oil industry in particular, very few studies analyzed the potential applications of blockchain technology, enablers, benefits and barriers. Tiscini *et al*. (2020) found that the BCT implementation significantly enhance the winery's sustainability in terms of food safety and quality, supply chain disintermediation, trust and anti-corruption. Moreover, as Silvestri and colleagues (2023) state, BCT becomes a source of competitive advantage for companies, if supported by specific skills in digital technologies that help to understand how technologies work and interpret the analytics derived from BCT applications. Indeed, as emerged in some studies focused on the main barriers of the adoption of this emerging technology, the unfamiliarity with the BCT, the lack of understanding of how the BC work and a lack of experience with this technology makes its use more difficult (Helliar *et al*., 2020; Galati *et al*., 2021). In light of this, , understanding the process of adoption of the BCT, what the main applications in the two strategic sectors are and how the capabilities affect the adoption process could be of interest for academics and practitioners.

This study aims to analyse the main influencing factors affecting the adoption of BCT-based solutions in two of the most prominent Made in Italy sectors by considering the Absorptive Capacity Theory (ACAP). The ACAP was defined by Cohen and Levinthal (1990, p. 128) as the ability of a firm to recognize the value of new and external information, assimilate it, and apply it to commercial ends. In other words, it is a dynamic capability that allows companies to reconfigure their organizational model by exploiting relevant external knowledge so as to obtain a competitive advantage. To achieve this aim, an analysis of six case studies of Italian wineries and olive oil companies was performed.

Materials and Methods

To address our research aim we adopted a qualitative empirical research based on a multiple cases study. A qualitative approach, as the case study, is appropriate when analyzing an emerging phenomenon in its uniqueness, as part of a particular scenario and of its interactions in order to define the boundaries of the phenomenon in the context in which it develops (Patton, 1985; Yin 1984; Yin, 2003). Specifically, we focused on an exploratory case study to understand how a contemporary phenomenon takes place and, in particular, how the process of implementing a technological innovation, as the BCT, is managed and organized (De Massis and Kotlar, 2014). This exploratory empirical approach, as stated by De Massis and co-authors (2015), contrasts with the statistical empirical research used for confirmatory objectives, in which it is well known the reason why a phenomenon occurs and what the contingent variables affecting the phenomenon itself are. Taking into account that one of the main obstacles of qualitative approaches is linked to the inability to generalize the results, the triangulation technique was used, by referring to multiple sources of information and removing any biases generated by the researchers' subjectivity (Teegavarapu *et al.*, 2008). Therefore, we relied on primary and secondary data sources by using the triangulation of the data (Eisenhardt and Graebner, 2007). In our study, we selected six firms as our case studies; four of them operate in the wine industry and two in the olive-oil sector in Italy. As regards the interviews, an interview contains qualitative and quantitative information; the interviews were conducted by taking into account the theoretical approach adopted. Interviews were managed online, from January to June 2023, involving organizational managers of the wineries and olive-oil companies, recorded and transcribed verbatim. Then, archival data from press releases, articles in specialized magazines, articles on the web, speeches with experts, etc., were used as secondary sources for data triangulation. The Gioia methodology (Gioia *et al*., 2013) has been finally exploited for qualitative data analysis and to satisfy the rigorous standards of trustworthy research (De Massis and Kotlar, 2014).

Results

The findings show that businesses, in both sectors, use the BCT for different purposes, from a simple marketing tool to communicate and promote the firm and its products (storytelling), to technologies that guarantee a transparent and safer traceability system. In particular, this technology is in the majority of cases adopted as a tool for data verifiability by registering some characteristics of data or documents, so that they are visible and verifiable by other actors (mainly consumers). The common approach does not fully exploit the potential of more effective and efficient coordination among the different supply chain players through a data sharing process and smart contracts. In one case study, the BCT is used to trace the product, not just within the business, but along the entire supply chain through the adoption of screw caps equipped with microchips that allow continuous monitoring of the product, thus being able to guarantee its quality and authenticity. In few cases, the BCT is integrated with other technologies, such as precision agriculture tools, failing to fully exploit the potential combination of these technologies to improve supervision and to manage agriculture effectively (Nigam *et al*., 2022).

In all cases studies, the adoption of BCT has been possible thanks to the ability of entrepreneurs or managers to operate units to recognize the potential of this emerging technology, and to the support of start-ups and service companies, located in Italy and abroad, with which companies have created strategic partnerships. This result confirms that the companies analysed in this study have the ability to filter and acquire external information, but to date they have not had the full ability to autonomously transform the acquired knowledge. This balance between Potential Absorptive Capacity" (PACAP), developed internally, and "Realized Absorptive Capacity (RACAP), developed in part externally, emerges in other experiences in the wine business (Galati *et al.*, 2021; Spadoni *et al.,* 2019).

The results show that to date businesses in both sectors have only marginally exploited the potential offered by the BCT, due to lack of expertise, the high costs and the difficulty in involving other supply chain players. New research is needed to corroborate our findings and develop concrete solutions to remove the main barriers to the BCT adoption. Future research should focus on a larger sample of case studies in Italy by comparing North and South wineries and comparing the results with EU firms. This study and its results may be reproduced in the future by other research in different SMEs

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SOCIETÀ ITALIANA DI ECONOMIA AGRARIA

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NATURAL WINE AND CONSUMERS' AWARENESS

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PAROLE CHIAVE
Wine, natural wine, international consumers, logos, marketing, survey.

INTRODUCTION

"Natural" wine was firstly mentioned in the 80s, pushed by the advent of Slow Food's philosophy and the look for a healthier lifestyle from the global consumers, embodying the need for a comeback of a more natural winemaking and the pureness of the origins.

At the very beginning of the Twenty First Century, many "natural" wine associations arose, promoting a low intervention agriculture, the respect for a sound raw material and the necessity to lower the amount of spread chemical compounds - either in the cellar and in the vineyard. "Natural" wine style finds basis by an absence concept: absence (or reduction) of added sulfites, absence of inoculated yeasts in favour of spontaneous ones (or directly retrieved from the cellar environment), absence of chemicals and additives; evidently, whenever it comes to removing something, the know-how must increase. It is possible to state that "natural" wine represents the last step of an imaginary ladder, starting from the so-called conventional wine, ranging from the supermarket ones to the most renown brands, moving on to the organic wine - which implies a soil conversion and a lower threshold of sulfur dioxide (precisely 50 mg/l less than the conventional addition), eventually reaching the biodynamic style, that takes into account the relationship among the soil, the weather, the human factor and the vineyard. Nevertheless, the European Union has ruled against "natural" wines because of the misleading nature of the claim towards people and more conventional wine types, which appears to bring the final consumer on a wrong track, by interpreting the term "natural" as a synonym of "higher quality" (Wine News, 2020). Currently, the only regulated winemaking practices are the conventional and the organic ones and there seems to be no space for "natural" wines in such a broad market. A universally accepted definition of naturalness does not exist, and thus, the naturalness of a food or beverage is still a rather vague concept (Roman et al. 2017; Rozin 2006). Nonetheless, the peculiarity of being a niche sector makes "natural" wines' strength.

As the "naturals" entered the Chinese market in 2017, a constant growth in production and consumption was observed, especially touching millennials and Gen-Z's consumers. The findings indicate that consumers are willing to pay a premium price for "natural" wine, and this choice is positively affected by the importance attributed to information on the ingredient content, production method and sensory characteristics included on the wine label (Galati et al, 2019). A similar growing phenomenon, mainly regarding the productive stages, is currently developing in the southern hemisphere, involving innovation-forward countries such as the New Zealand. The huge contribution of youngsters and their innovative thoughts is pushing the market towards a new direction, fighting for the enhancement of the peculiarities of different terroirs against the flattening of taste that seems to threaten the current wine market.

However, it must be noted that a high level of confusion concerning the terms used to indicate all the existing wine categories (conventional, organic, biodynamic, natural) is still present, both on consumers' side (Vecchio, 2021) and the mass communication one. It is very easy to get false or incomplete information about the topic – with a special mention for the online literature, given that many times the terms “natural” and “organic” are used as synonyms or perceived as so. Specifically meaningful for the purpose of the research is to understand the relationship between "natural” wine concept and the existing logos and claims, to highlight the importance of a recognized regulation certified by a signature one, hence the need to focus on this ever-expanding niche sector in terms of consumers’ perception and awareness. The analysis of the terminology used to describe this wine style according to a wide panel of international respondents constitutes a corollary of the research, together with a resume of what a “natural” wine and the corresponding winemaking should look like, based on the various wine associations’ point of view about the topic.

The experimental analysis at the base of the research consists of an online questionnaire called “Regulation or regulated? Natural wine wave”. Drafted on Google Forms, the questionnaire was sent to a broad target by means of different social media and through the University of Turin email network service. We aimed this poll to catch on thanks to a word-of-mouth way of spreading, starting from professors, students of different departments and colleagues, up to reaching whoever was interested in answering. The hundreds of results collected were possible because of the structure of the latter, which was addressed to a wide audience, starting from 18 years old and above, without asking for any preliminary knowledge about wine and oenology. It was online from March 5th, 2022, to the very beginning of 2023 and drawn up both in Italian and English. An objective interpretation of the data will eventually help raise awareness about “natural” wine, as well as helping producers and consumers find a safe space to work, drink and recognize themselves under a universally acknowledged perspective. Consumers’ tastes keep evolving and, as Jacques Dupont states, “it is necessary to open the doors to new wine styles”.

MATERIALS AND METHODS

The questionnaire is divided into three main parts for a total of 29 questions: 15 referring to the First Part, 13 related to the Second Part and a last one as a conclusion of the Third Part.

The First Part of the research aims to investigate consumers’ knowledge and interest towards wine and “natural” wine thanks to general and totally anonymous questions about gender, age, income and other personal queries. The goal is to reach both wine experts and nonexperts, accustomed consumers and occasional wine drinkers, wine sector workers as well as other professionals. The Second Part of the research focuses on consumers’ knowledge about wine and “natural” wine certifications. We provided our audience with a series of questions based on logos recognition and interpretation. These questions allowed the understanding of two crucial aspects: the first one refers to the identification of the logo, whereas the second tries to study if people would expect - or know - to find those claims on a “natural” wine bottle. In this case, the data interpretation takes place according to a different perspective: the aim is to evaluate the level of confusion that characterizes a broad market in which only the most renowned logos play the biggest role, while some others are almost unknown, even from a huge slice of wine sector workers. The last part of the questionnaire constitutes a corollary of the research focusing on a list of proposals forwarded by the respondents to substitute or implement the term “natural”, which appears to lead most consumers towards a misconception of what a “natural” wine truly is. The list is made up of eight alternative suggestions and a blank spot to let people write freely as well as leave personal comments and critiques about the topic.

MAIN RESULTS

A first type of analysis was performed just by looking at the percentage values resulting from the answers of the whole survey, without implying any statistical method. A sample of 319 respondents took part in the questionnaire, showing an abundance of answers by the male audience (57.1%), mainly from three age ranges: 18-24, 25-34 and 55-64 years old. Moving on to the nationality, 245 people were Italian, whereas the remaining 74 have been previously sorted between EU citizens (22) and non-EU citizens (52). Less than 10% of the respondents claimed a low interest towards wine and oenology, affirming to drink either on the weekends or during special occasions only; on the other hand, 42.6% of people stated to be almost daily wine drinkers. Going forward through the questionnaire, the queries related to the budget underline the difference between the average expense for a conventional wine bottle and the one for a "natural" wine, starting from less than 5€ to more than 25€. The second question was forerun by the definition given by Wikipedia of what a "natural" wine should be; this kind of naive explanation was purposefully chosen to provoke the audience, mainly because of a lack of online literature concerning the topic and since, generally, most of the internet users are prone to click on such links to get some information about unknown topics. Around 9 people out of 10 seemed to be aware of the existing differences between organic and "natural" wine, as well as biodynamic and "natural" wine, despite 20.7% have approached "natural" wines only unconsciously. In the second slot of questions, the most renowned logos were Triple "A", Organic wine and Vignaioli Indipendenti. Predictably, VinNatur and Vin Méthode Nature resulted - on average - as unknown as paired to the concept of "natural" wine, as well as Naturland. SQNPI, Associazione "Suolo e Salute", Demeter, Vins S.A.I.N.S and Renaissance des Appellations left most of the respondents feeling perplexed, leading them to believe that there is no correlation among them and the topic of the research.

Finally, the third and last part of the questionnaire let us understand what people's thoughts and comments on "natural" wines and the corresponding philosophy are. We provided the respondents with a list of eight proposal on how to substitute the claim "natural", in addition to a blank field. This opportunity left the anonymous respondents free to express their feelings and thoughts regarding this wine style, as well as comments and - not always - constructive criticism, ranging from "hippie piss" and "natural wine shouldn't be regulated" to many innovative and more rational suggestions. Despite that, the average consumer's imagination regarding natural wines often shifted to negative attributes, such as being acidic, unsuitable for storage and expensive (Fabbrizzi, 2021).

In the second place, a statistical analysis was carried out after retrieving all the data collected - eventually downloaded in an Excel file and sorted applying different filters - and focuses on the existence of a possible correlation between five selected variables (Gender, Age, Nationality, Education level, Wage) and two expenditure levels – both deriving from the First Part of the survey: the first one referring to the average expense for a wine bottle and the second concerning a "natural" one. The statistical method applied is based on the univariate Chi-square test and its corresponding P-value, used to assess the association among the variables and the willingness to spend from less than 5€ to more than 25€. The price range was purposefully chosen to mirror the average prices of conventional and "natural" wine bottles from several reference wine shops, without considering premium wines from any of the categories. For all the analysis, the alpha level was set at 5% (0.05), meaning that getting a P-value lower than alpha states the significance of the result. The following step consisted of observing all the percentages extracted by the tables and resumed in the column chart, highlighting the differences among them according to each variable combination. The crucial step of the whole procedure was possible thanks to the online program Epitools, which allowed a deeper analysis of the results by crossing the five variables with the two questions related to the wine price, one by one. Eventually, half of the results showed a high level of significance (<5%), concerning three out of five variables: Age, Nationality and Wage.

CONCLUDING REMARKS

In conclusion, despite the limited number of people involved, the most challenging aspect of carrying out a study on "natural" wine has been a deep lack of literature to get reliable information from. Just think of how the concepts of organic, biodynamic and "natural" wine overlap on most of the links, journals and articles available, as well as the multiple confusing pictures and tables grouping the three concepts all together.

The present research finds its strength in raising unbiased awareness about the topic, relating on empirical observations, reputable sources, extensive conversations and seminars with the main representatives of all existing wine styles, without forgetting to emit wine enthusiasts' opinions. This embodies a first step to shed some light on a still debated and misunderstood topic, with profound attention and critical sense. We strongly believe that "natural" wine's strengths and opportunities get ahead of the multiple misunderstanding, critiques and menaces that strive to intimidate such and ancient wine style – nowadays perceived as brand new. Wine, whichever category it falls into, will never truly be "natural". Mankind has domesticated the vine thousands of years ago, by modifying the soil, improving different techniques and mastering the sciences. Humans stand at the base of the whole process as much as the plant itself. Every wine style, as well as its producers and supporters, deserve respect and understanding. Before even speaking of merely good or bad wines, it is all about oenologically correct or mistaken ones. Regardless of the colour palette, the type of fermentation, the often-unconventional aromatic array or the (desired) sediment presence, "nowadays" wines derive from the never-ending evolution of the Georgian, Etruscan, Greek and Roman beverages. Despite many respondents claiming the absence of necessity to regulate and certify "natural" wine, it is crucial to remember that technological improvement looks to the future as much as to the past, adapting to a volatile culture and language.

Eventually, settling for an "in quotation marks" definition, will not discourage all the producers and consumers that strongly support "natural" wines and the spot that they have earned in the current market. "Natural" wine exists and needs to be safeguarded from whoever rides the wave unconsciously, dragging the mass towards a misrepresented direction. Wine is joy, conviviality and history. It embodies science, consciousness and knowledge. In such a diverse, colourful and lively field it is appropriate and necessary to find a positioning, dimension and regulation for "natural" wine, once and for all without quotation marks.

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Comparative assessment of the land footprint and regulating ecosystem services embodied in the Italian's consumption of vegetable oils: an environmental trade-off analysis among substitute goods.

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Keywords

Land-Use Change, land footprint, global trade, vegetable oil, biodiversity, ecosystem services

INTRODUCTION

Agricultural-driven global land-use change (GLUC) represents one of the main drivers of climate change, biodiversity loss, and natural ecosystem fragmentation. Since the XXI century, around 75% of GLUC dynamics consisted of deforestation driven by the expansion of agriculture and forest plantations to produce wood and non-wood commodities aimed at global trade (Curtis *et al*., 2018). In this context, by outsourcing their internal demand for agricultural products, consuming countries are displacing local land use (LU) to producing countries (Weinzettel *et al*., 2012). As a result, international trade has been identified as one of the main indirect drivers of global environmental resource degradation and the exceeding of the Planetary Boundaries (Pendrill *et al*., 2019; Sala *et al*., 2020). Up to 70% of global socio-environmental impacts stem from the international demand for goods and services (Wiedmann *et al*. 2018) and, although not physically traded, biodiversity and ecosystem services are embodied in global trade flows.

The European Union (EU) plays a leading role in the global trade and consumption of products linked to the loss of high-carbon stock and biodiversity-rich ecosystems. Moreover, since 1990, the EU has become one of the largest importers of Forest Risk Commodities (FRCs) - i.e., commodities that might cause deforestation - at the per capita level. Among the main FRCs, soybeans and oil palm fruits, i.e., primary crops supplying the global vegetable oil market, play a pivotal role, representing at least 20% of the total embodied deforestation in the XXI century (Pendrill *et al*., 2019).

Since 1960, the vegetable oil sector, mainly associated with the consumption of foodstuff, bioenergy, and oleochemicals, has been one of the main drivers of spatially explicit environmental impacts, becoming the third agricultural commodity group in terms of global LU and the first in terms of LU increase over time. Palm oil (+98%), rapeseed oil (+96%), soybean oil (+95%), and sunflower oil (+90%) showed the main increase in production, together ensuring 87% of the global supply of vegetable oils in 2020 (Faostat, 2021).

Given its prominent position within the global trade of FRCs, the EU has developed specific policies, including a recent Regulation on deforestation-free products (EUDR, 2023) that will enter into force in 2024. By imposing a mandatory due diligence for all the operators placing FRCs – including palm oil and soybean-based ones - within the EU market without acting in reducing the domestic demand for vegetable oils, the EUDR will likely not only constrain the EU imports of palm oil and soybean-based products but also impact the market of alternative products. Thus, the EUDR could cause consumption trade-offs among different oils and associated environmental impacts in terms of LU change, and natural ecosystem degradation. Consequently, the quantitative assessment of the sustainability trade-offs among alternative vegetable oil can support decision-makers to meet future EU consumption needs, while also minimizing the embodied environmental impacts.

Within the EU, Italy plays a central role in the trade and consumption of the four leading vegetable oils – e.g., ranking first in palm oil apparent consumption (Faostat, 2023) - and thus it is expected to be affected by EUDR regarding both the domestic downstream production of processed products and their final domestic consumption.

OBJECTIVES

Despite a growing body of literature assessing global agricultural trade as a distant driver of ecosystem degradation (Henders, et al., 2015; Chaudary et al., 2016; Liu et al., 2018, Pendrill et al., 2019; Hoang et al., 2022; Molotoks et al., 2022; Sun et al., 2023), by also modelling Land Footprint (LF) (Kastner et al., 2014; Bruckner et al., 2019; Liu et al., 2021;Vanham et al., 2023), studies addressing land-use telecoupling to detect trade-offs among consumption alternatives are still lacking.

Estimating ecological conservation trade-offs associated with the EU demand for FRCs substitute products represents the main novelty of this study and aims to contribute filling current research gaps within this domain.

In doing so, the three main specific research objectives (RO) are:

RO1) To model the EU27 and Italian LF embodied in the apparent consumption of four main vegetable oils per producing country.

RO2) To analyse the trade network behind the LF assessed under RO1.

RO3) To quantify the ecosystem services (i.e., climate and water regulation, and terrestrial biodiversity conservation) embodied in the LF assessed under RO1 to perform an environmental trade-off analysis of the future Italian consumption patterns of targeted oils.

METHODOLOGY

Data on production and trade, as well as the conversion coefficients were retrieved from a bulk download of the Faostat database for the 2000-2020 period and processed in JupyterLab 3.5.0 with version 1.5.1 of the PANDAS library in Python 3.

Regarding the LF modelling, besides primary products and the corresponding four vegetable oils, we also considered all the first-level co-products reported within the commodity trees in Faostat. For example, while the oil palm kernels are produced from the crashing of the kernels of the oil palm fruits, the oil cakes are residues obtained after oil is removed from the oilseeds. Oil cakes are mainly used as a component of animal feeds.

As for RO1, a physical accounting approach was used (De Laurentis *et al*., 2022) to quantify the agricultural area needed to produce the primary crops embedded in oils and oil cakes imported into the EU. Physical accounting models for assessing commodity supply chains consist of two main stages (Bruckner *et al*., 2015): 1) the analysis of primary production and processing at the country level and 2) the bilateral trade analysis. The first stage consists in the attribution of LU (e.g., hectares of croplands) to a primary product or processed commodity in the country of production through specific conversion coefficients (see Eq. 1, and Eq. 2 in the Annex). The second stage focuses on tracking products measured in physical inputs from the country of production to the one of apparent consumption.

Since the main limitation of bilateral trade analysis is the low capacity to detect the different positions and functions of the nodes (i.e., trade partners) within the trade network (Sun *et al*., 2023), a network analysis (RO2) allows identifying major regional re-export hubs and to avoid misleading results in the footprint analysis.

Finally, for the trade-off analysis of ecosystem services impacted by the production of the four primary products in their countries of origin (RO3), estimations were based on overlaying the spatially explicit information of high-resolution (i.e., 10-km^2 grid cells) integrated global biodiversity, carbon, and water quality regulation maps (Jung *et al*., 2021) with maps of the country's crops agricultural areas (Yu, *et al*., 2020). An ecosystem service conservation score - i.e., a value ranging between 1 (max) and 100 (min), indicating the potential for conserving biodiversity, carbon retention and water quality - has been estimated building on Yu, *et al*., (2020) and Jung *et al*., (2021) for terrestrial areas that are already in competition with oil crops production.

Our analysis ultimately aims to highlight potential mismatches between agricultural GLUC (i.e., increased production area) driven by the future demand for vegetable oil and global ecosystem services conservation.

RESULTS

Between 2000 and 2020, the LF embodied in the EU27 apparent consumption of targeted products totalled 340.8 Million hectares (Mha), 41.6% represented by soybeans, about 50% by rapeseed and sunflower together and 7% by palm oil (Table 1).

Table 1 - LF embodied in the apparent EU27 consumption of the four targeted vegetable oils (Mha and % on total) between 2000 and 2020.

Primary crop eq.	LF (Mha)	% on Total
Soybeans	140.8	41.6%
Rapeseed	91.3	26.3%
Sunflower seed	84.2	24.9%

Primary crop eq.	LF (Mha)	% on Total
Oil palm fruits	24.5	7.1%
Total	**340.8**	**100.0%**

While the share of rapeseed and palm oil has increased over the period, for soybeans, after reaching 54.1% of the total apparent consumption in 2002, it has constantly decreased. The share of sunflower seeds has remained stable over the period (Figure 1).

EU27 Land Footprint of apparent consumption (2000-2020)

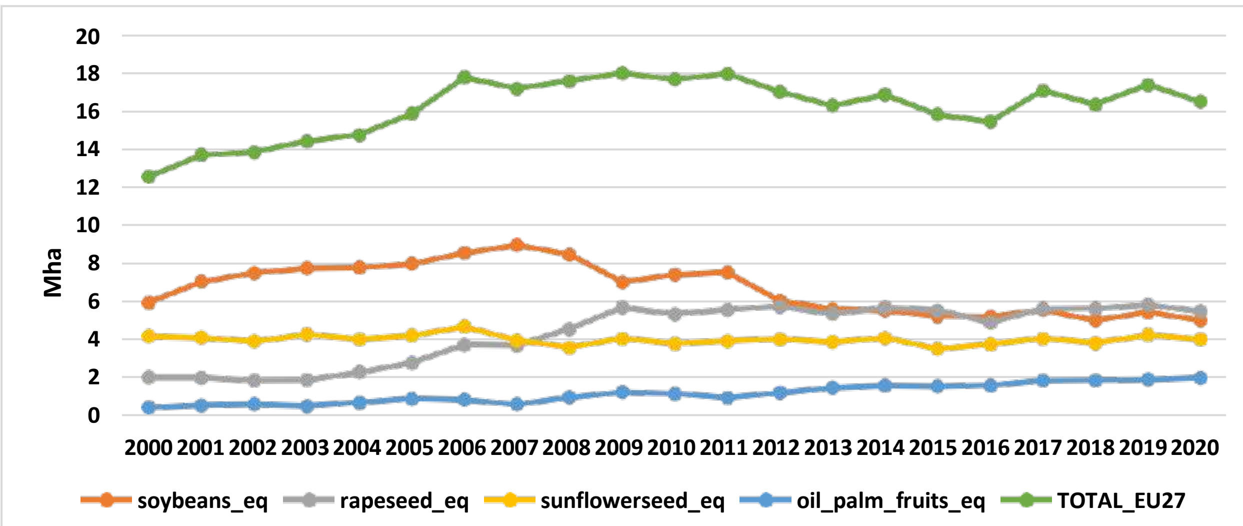

Figure 1: Temporal trends of the EU27 LF (Mha) for soybeans eq (orange line), rapeseed eq. (grey line), sunflower seed eq. (yellow line), oil palm fruits eq. (blue line), total apparent consumption (green line).

Italy's share of LF over total EU LF has been relevant for oil palm fruits eq. (21.3%), for which Italy has ranked first (5.2Mha) within the EU, sunflower seed eq. (13.9%), ranking second (11.7Mha) after Spain, and soybeans eq. (13.2%) raking third (18.6Mha) after France and Spain. For rapeseed eq. Italy's share of LF has been significantly lower (3.8%), with 3.5Mha (sixth in the ranking) consumed over the period. However, Italian citizens, on average, contributed less compared to other EU countries in terms of per-capita apparent consumption, ranking 18th, 14th, 12th, and 5th respectively for rapeseed eq., soybeans eq., sunflower seed eq., and oil palm fruits eq.

The number of the leading producing countries involved in EU imports (Table 2) vary significantly according to the type of primary crop. Soybeans and oil palm fruits show a high degree of concentration, with about 77% of EU's apparent consumption originating from just two extra-EU countries (respectively

Brazil and Argentina, and Indonesia and Malaysia), while sunflower seeds and even more rapeseeds show a lower concentration degree and involve a higher number of producing countries, mainly within the EU27.

Table 2: Producing countries sourcing at least 1% of EU27 apparent consumption for soybeans, sunflower seed, rapeseed, oil palm fruits (% on total apparent consumption) between 2000 and 2020.

Soybeans	Sunflower seeds	Rapeseeds	Oil palm fruits
BRA (44.9%)	UKR (24.6%)	FRA (17.3%)	IDN (46.5%)
ARG (32.0%)	ROM (11.9%)	DEU (16.7%)	MYS (31.0%)
USA (9.9%)	SPA (10.8%)	POL (10.4%)	PNG (7.2%)
PRY (4.9%)	FRA (9.5%)	AUS (10.4%)	GTM (3.8%)
IND (1.5%)	ARG (8.6%)	UKR (8.0%)	HND (3.8%)
CAN (1.4%)	HUN (8.2%)	CZE (5.0%)	COL (3.1%)
UKR (1.3%)	BGR (7.8%)	CAN (4.6%)	THA (1.0%)
	RUS (7.3%)	ROM (3.9%)	ECU (1.0%)
	MDA (2.2%)	RUS (3.4%)	
	ITA (1.8%)	HUN (3.0%)	
	SVK (1.2%)	GBR (2.3%)	
		LTU (1.8%)	
		SVK (1.7%)	
		DEN (1.6%)	
		BGR (1.5%)	
		SWE (1%)	

Countries names follow Alpha-3 codes ISO 3166-1

Compared to the EU, the Italian’s outsourcing patterns are different for soybeans due to the leading role played by Argentina (52.4%) instead of Brazil (21.8%), and the higher share of domestic soybeans (6.3%). Differences can also be observed for rapeseeds with a higher contribution of Canada (20.4%) and Russia (12.8%) and a lower from Germany (10.9%), Australia (3.5%), and Poland (1.6%). For sunflower seeds Italy strongly depends on Ukraine (34.5%) and Russia (19.3%) as well as on domestic production (14.9%), while dependence from Spain (0.5%) and France (1.7%) was much lower. Finally for oil palm fruits, Indonesia has a dominating role (64.2%) with other partners showing a lower share.

Detailed trade network analysis reveals that EU member states have different trade profiles for each of the traded commodities. For instance, regarding the import of primary crops processed domestically, the top three EU trade intermediaries (i.e., countries re-exporting some of their annual imports) for soybeans are The Netherlands, Belgium and Germany, while for Italy they are Slovenia, Canada and Austria.

Our analysis for RO3 shows the extent to which current LU for oil crops as well as future potential LUC activities at the country level can generate trade-offs with the conservation of natural ecosystems and ecosystem services delivery. For instance, on average, Paraguay (scoring 36.5) shows the highest potential trade-off between regulating ecosystem service conservation and soybeans production, followed by Canada (38.1), Brazil (39.1), Ukraine (44.2), the United States of America (48.7), Argentina (50.9), and India (61.7). Based on these findings, soybeans eq. imports from India and Argentina embed, on average, a lower environmental risk when considering biodiversity conservation, carbon retention, and water regulation, and future LUC within these countries could be less impactful.
We also detected lower environmental impacts of the Italian consumption of soybeans eq. if compared to the EU average one, mainly because of a lower dependence of Italian consumption on Brazil and a larger on Argentina, despite a limited role played by India and a larger contribution of Paraguay and domestically sourced (Italy scoring 36.6) soybeans.

CONCLUSIONS

Our analysis shows different trade patterns associated with key vegetable oils and highlights implications in terms of LU effects and associated environmental impacts, as well as different roles and responsibilities by the EU27 and Italy. Consequently, it can provide a better understanding of the role played by the EU within the telecoupling framework for LU dynamics, with specific reference to deforestation.

Despite our efforts, we are aware that our research has some limitations. These are mainly linked to a top-down analysis based on spatial data availability limited only to specific years. Furthermore, the results linked to RO3 are strictly scale-dependent. A future implementation (i.e., by updating trade data) of this study could provide peculiar results if considering the impact determined by the ongoing Ukraine crisis on the oilseed global market.

Notwithstanding the above-reported limitations, we believe that our study can help moving forward the existing research on FRCs and support future policy development and implementation. For example, by linking the EU consumption of alternative primary products to specific ecological conservation values of productive lands located within and outside the EU, our research can support bridging different policy measures within the European Green Deal: those aimed to protect and restore biodiversity within domestic agricultural ecosystems - e.g., the EU nature restoration law (EC, 2022) and the EU Biodiversity Strategy (EU, 2020) -, and those aimed at halting natural ecosystem degradation embodied in global value chains (e.g., EUDR). Indeed, strengthening these policies' connection is critical to avoid controversial ecological effects, such as, an increase of environmental conservation indices in the EU and a corresponding decrease of the same indices within the largest producing and trading countries of agricultural commodities.

Moreover, our results emphasize possible trade-offs among two ambitious United Nations Sustainable Development Goals (SDGs) (UN, 2015), namely, achieving food security for an increasing global population (SDG 2) and curbing land degradation (SDG 15) or, more generally, balancing the delivery of provisioning and regulating ecosystem services at different scales. Indeed, in the context of globalization of food and agricultural trade, by assessing trade-offs between socioeconomic benefits (e.g., pushing for the expansion of high-yield crops such as oil palms) and the ecological costs (i.e., the ecosystem services forgone due to oil-crop production) our analysis can help identifying both mismatches and synergies between the implementation of global nutrition and ecological conservation policies.

ANNEX

Oil and oil cakes were converted into primary crop equivalents (PCEs) through:

$$\mathbf{PCE_{i,j} = Qi / P_{i,j} * V_{i,j}} \quad \textbf{[Eq. 1]}$$

Where:

$PCE_{i,j}$ is the volume of the j^{th} primary crop equivalent needed to produce the i^{th} processed product (tonnes).
Q_i is the volume of the i^{th} processed product (tonnes).
$P_{i,j}$ is the extraction rate, i.e. fraction of the volume of the processed i^{th} product needed to obtain the corresponding j^{th} primary crop equivalent (unitless).
$V_{i,j}$ is the economic value fraction (i.e. value share) of the ith processed product over the total economic value of all co-products that can be obtained from the j^{th} primary crop (unitless).

According to Cuypers (2013), this approach, based on economic assumptions[1], is functional to allocate primary crops into the complex production of jointly produced commodities and to avoid double counting. While values share represents global averages, country dependent extraction rates were used.

Then, PCEs are converted in LF through country-specific time-varying yields (t/ha of primary crop).

$$\mathbf{LF_{i,t} = PCE_{i,t} / Y_{sm,i,t}} \quad \textbf{[Eq. 2]}$$

Where:
$\mathbf{LF_{i,t}}$ is the annual (t) hectares of agricultural lands (ha);
$\mathbf{PCE_{,i,t}}$ is the annual (t) production/import of primary crop equivalent (tonnes);
$\mathbf{Y_{sm,i,t}}$ is the annual (t) smoothed yield (t/ha);

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WOMEN'S EATING BEHAVIOR THROUGH A FOOD-RELATED LIFESTYLE MODEL

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Keywords: food-related lifestyle; consumer behavior; women; cluster analysis

Introduction

Food-related lifestyle can be considered as "the system of cognitive categories, scripts, and related associations that relate a set of products to a set of values" (Brunsø and Grunert, 1998) that is expressed through desires for self-actualization and representation and can certainly be considered an important component through which to describe women's roles (Lombardo *et al.*, 2019).

Currently, the contemporary woman is no longer in the position of having to express her social identity through eating behavior, and this is a consequence of the evolution of her role within the family and work. Thus, the authors hypothesize that women's lifestyles are no longer linked to gender stereotypes, and thus to eating behavior as a representation of their identity, due to the increasing importance of social involvement of the female role.

In the late 1990s, a deductive model of food-related lifestyle was created (Brunsø and Grunert, 1998), considers lifestyle as a cognitive mediator between life values (Brunsø *et al.*, 2021), and allows for the description of eating behavior based on self-reported consumption preferences (Saba *et al.*, 2019).

Starting from the general hypothesis that eating habits and food lifestyles are correlated and can converge in a survey aimed at understanding the behavioral characteristics of female consumers (Lanfranchi *et al.*, 2016), the goal is to test whether there is a relationship between the degree of food involvement and the types of foods consumed, allowing us to describe the lifestyle of the surveyed sample based on self-reported preferences.

Because the food-related lifestyle instrument has not been used previously to conduct a gender survey, this study is new in terms of using a convenience sample of Italian women as the population of interest (Flaherty *et al.*, 2020).

Materials and methods

An anonymous, structured questionnaire was administered to a convenience sample of 399 Italian women via Google Forms. The questionnaire, disseminated through major social networks, aimed to collect data on food consumption attitudes and the type of food consumed. To identify food consumption attitudes, items proposed by Brunsø et al. (2021) measuring three basic dimensions of food-related lifestyle were used, while the types of foods consumed are measured through items proposed by the same authors.

Socio-demographic characteristics were collected considering the following characteristics: age group; level of education; number of household members; presence of minors (<18 years) in the household.

The study first conducted two separate exploratory factor analyses (EFAs) on the data blocks to summarize separately the different information on the involvement of food consumption and the type of food consumed by the examined sample to identify the main factors within each block. Varimax rotation was used to facilitate the understanding of the EFA results and optimize the variance of the sum of square loadings (Kaiser, 1960) and the Kaiser-Meyer-Olkin (KMO) test to assess model fit (Kaiser and Rice, 1974).

Finally, to identify homogeneous groups of consumers, a cluster analysis was conducted using the k-means technique on factor scores derived from EFAs (Steinley, 2006).

Results

The first EFA was conducted on items related to consumer involvement in food consumption. Three different factors emerged: eco-friendly feeling, food innovation and food satisfaction.

Regarding the goodness of fit of the model, the KMO test values were found to be highly significant, thus indicating that the variables contain a high amount of common information that justifies factor analysis.

The second EFA was performed on items related to the type of food consumed. Accordingly, the following four factors were identified: veggy-based diet; sugar and fat-based diet; likes drinks; and carnivorous based-diet. Regarding the goodness of fit of the model, the KMO test values were average, indicating that the variables contain a fair amount of common information that justifies factor analysis.

The results of applying cluster analysis to the seven factors led to the identification of four following homogeneous clusters (Table 1): greediness consumers; healthy-diet consumers; curious consumers; uninvolved consumers.

In terms of socio-demographic characteristics, only age seems to be significant (Table 2), that is, there seems to be variability in dietary lifestyle among the age groups.

Table 1 - Results of cluster analysis using the k-means method

	Cluster 1 (Greediness consumers)	Cluster 2 (Healthy-diet consumers)	Cluster 3 (Curious consumers)	Cluster 4 (Uninvolved consumers)	p-value
Eco-friendly feeling	–0.0587	0.9495	–0.3049	–0.7210	0.000***
Food innovation	–0.9339	0.1426	0.9030	–0.6265	0.000***
Food satisfaction	0.9463	–0.0066	0.3306	–1.337	0.040*
Veggy-based diet	–0.4076	0.6360	–0.1133	–0.2756	0.000***
Sugar and fat-based diet	0.5230	–0.3195	0.1007	–0.2170	0.002**
Likes drinks	–0.2365	–0.3416	0.5833	–0.1869	0.584
Carnivorous based-diet	0.0911	–0.4104	0.2735	0.0468	0.000***

Note: * p≤0.05; ** p≤0.01; *** p≤0.001.

Table 2 - Results of the chi-square test by age

Age (years)	**Cluster 1 (Greediness consumers)**	**Cluster 2 (Healthy-diet consumers)**	**Cluster 3 (Curious consumers)**	**Cluster 4 (Uninvolved consumers)**	**Total**
18–24	15	20	25	18	78
	18.99%	18.18%	20.16%	20.93%	19.55%
25–28	32	21	32	17	102
	40.51%	19.09%	25.81%	19.77%	25.56%
29–43	23	27	35	21	106
	29.11%	24.55%	**28.23%**	24.42%	26.57%
44–64	9	42	32	30	113
	11.39%	**38.18%**	25.81%	**34.88%**	28.32%
Total	79	110	124	86	399
	100.00%	100.00%	100.00%	100.00%	100.00%

Note: Pearson chi-square = 24.0570 (p-value <0.004).

Conclusions

As the primary food purchasers, who are responsible for meal planning, creating the shopping list, and purchasing supplies for the family, women are frequently situated at the vanguard of food-related decision-making processes.

Considering the significant influence women have on food choices and preferences in contemporary society, the present study sought to investigate the eating lifestyle of Italian women by determining the degree of association between involvement and eating habits.

The main findings of this study indicate that there is a direct correlation between the level of involvement and the eating habits of women. The results of the factor analysis reveal the extreme significance of environmental sensitivity, a strong propensity for food innovation, and the relevance of appetite in influencing food choices that are not necessarily always healthful.

The cluster analysis generated four distinct groups, validating the three patterns derived from the factor analysis and adding a wholly disinterested category that appears to have little propensity toward food-related preferences, interests, or lifestyles.

Based on food lifestyle theory, the results of this study contribute to the body of knowledge regarding marketing to women, as they provide additional insights into the role women play in directing the diets of family members and influencing societal food preferences.

Furthermore, there are social implications associated with female food consumers. Our study demonstrates that in addition to the large number of women engaged in sustainable food consumption and interested in a balanced diet, there are segments of female consumers who are attracted to harmful foods or who are completely uninterested in what they consume.

This study also contributes to our understanding of anthropological theories based on the relationship between sustenance and gender. Specifically, the results of the survey support a revision of general gender theories regarding the consumption of dietary categories.

This research may have implications for public health nutrition programs that could be developed to enhance the health of women.

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UNDERSTANDING THE DETERMINANTS OF SUSTAINABILITY STRATEGIES IN THE BEEF VALUE CHAIN

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KEYWORDS
Sustainability practices, certifications, beef value chain, negative binomial regression

INTRODUCTION

The beef sector faces severe sustainability challenges. The environmental ones relate to the fact that beef cattle have a higher carbon footprint, water footprint and land footprint than any other livestock system and grain cultivation (Gerber et al., 2015). Beef is considered to be a forest-risk commodity, together with leather, cocoa and soya, meaning that its production is deeply damaging forest ecosystem services provision (Camargo et al., 2019). Specifically, beef production is a major driver of deforestation in Brazil (zu Ermgassen et al., 2020), and it jeopardizes the protection of indigenous rights (Nepstad et al., 2014). Companies operating along the beef value chain are adopting an increasing number of strategies to tackle such problems, including the development of indicators and frameworks designed to assess the progress and the improvement of communication between actors of the chain and with other stakeholders (Maia de Souza et al., 2017). Marques Vieira and Traill (2008) carried out an analysis of the relationship among actors operating along the beef value chain and found that beef processors are more stimulated by domestic retailers than by EU importers to optimize and improve production. Broom (2021) developed a comprehensive codification system and methodology to assess firm sustainability and identified three pillars of beef value chain sustainability: human health, animal welfare and environmental impacts.

Stakeholder pressures, economic performance, and firm's behavioural characteristics such as risk-aversion and consumer behaviour have been recognized among the determinants for the implementation of sustainability strategies in various sectors (Darnall et al., 2010; Dauvergne, 2017; Mayer & Gereffi, 2010; Thorlakson et al., 2018). However, there is still little evidence on the firm characteristics and value chain positions that influence the adoption of sustainability practices and certifications by beef firms. Therefore, the research questions are the following:

RQ1. Which are the firm characteristics shaping the pattern of sustainability practices adoption within the beef value chain?

RQ2. Which are the firm characteristics shaping the pattern of sustainability third-party certifications adoption within the beef value chain?

THEORETICAL FRAMEWORK AND RESEARCH HYPOTHESES

The choice of relevant firm characteristics affecting sustainability strategies adoption was based on the previous literature, which has adopted different approaches to frame the analysis of the determinants of corporate sustainability performance. The main stream of literature is based on Stakeholder theory, which was first developed by Freeman (2010) and suggests that the adoption of sustainability strategies by firms is driven by pressures exerted by various stakeholders along the supply chain (Agle et al., 1999; Artiach et al., 2010; Darnall et al., 2010; Delmas & Toffel, 2004; Khaled et al., 2021; Schaltegger et al., 2019). More recent studies integrated the stakeholder view with Resource Dependence theory (Lourenço & Branco, 2013; Wolf, 2014), which states that firms are dependent on the external environment for their survival and success, and are constrained by resource availability (Hillman et al., 2009; Pfeffer & Salancik, 2003). Stakeholder theory has also been complemented by Global Value Chain theory (Bager & Lambin, 2020; Thorlakson et al., 2018) to explain the extent of sustainability commitment by firms. GVC theory suggests that firms are subject to the power exerted by other value chain participants, and that the leading actors along the chain are likely to drive others to imitate them in committing to sustainability or to require them to adopt practices or certifications (Gereffi, 1994). Nonetheless, research about the impact of value chain positions on corporate sustainability performance is still scarce (Groves et al., 2011; Hahn & Kühnen, 2013), therefore our analysis aims at integrating elements from Global Value Chain theory to Stakeholder theory and Resource Dependence theory, in order to provide a comprehensive understanding of the impact of company characteristics on sustainability strategies adoption.

Based on the integration of Stakeholder theory, Global Value Chain theory and Resource Dependence theory, our research hypotheses are the following:

H1. The larger the firm size, the higher the probability of adopting sustainability practices and certifications.

H2. Public companies are more likely to adopt sustainability practices and certifications.

H3. Consumer engagement positively influence the adoption of sustainability practices and certifications.

H4. Being a business-to-consumer company has a positive effect over the adoption of sustainability practices and certifications, with respect to being business-to-business.

H5. Among the beef value chain positions, certain positions have a positive on the adoption of sustainability strategies adoption.

H6. Firms' risk-aversion positively impacts the adoption of sustainability practices and certifications.

DATA AND RESEACH METHODOLOGY

The data employed in the analysis were collected from firms' websites and sustainability reports in order to create an original dataset.

A sample of firms operating in the beef GVC was extracted from the Orbis database. After cleaning the dataset from companies with no website, irrelevant companies and doubles, we obtained a refined sample of 303 firms. For each company, we extracted firm size, public listing, group dimension, and location of firms headquarter from Orbis. Also, we collected other company characteristics through a content analysis carried out on firms' websites and sustainability reports, including value chain positions, market type, business type, risk-aversion and consumer engagement. Data about the sustainability performance of firms were also collected through the content analysis. Based on the list of environmental impacts identified by Broom (2021), we created a list of 23 environmental and 14 socio-economic practices and of six sustainability certifications and coded them as binary variables. The total number of sustainability practices adopted by each company resulted in the Practice Index, whereas the Certification Index corresponds to the total number of sustainability certifications adopted by each company in the sample.

The empirical model employed to test the effects of company characteristics over sustainability strategies adoption was adapted from Bager and Lambin (2020), and is shown by equation (1).

$$y_i = \beta_0 + \sum_{r=1}^{4} \beta_r firm_{size_{ri}} + \sum_{r=5}^{6} \beta_r M_{ri} + \beta_7 group\_dim_i + \beta_8 PL_i + \beta_9 CE_i + \beta_{10} B2B_i + \beta_{11} B2C_i + \sum_{r=12}^{16} \beta_r VC_{ri} + \beta_{17} RA_i + \beta_{18} GDP_i + \varepsilon_i \quad (1)$$

The dependent variables are the Practice Index and the Certification Index, alternatively. The explanatory variables are firm size ($firm\_size_{ri}$), market type (M_{ri}), group dimension ($group\_dim_i$), public listing (PL_i), consumer engagement (CE_i), business type ($B2B_i$, $B2C_i$), value chain positions (VC_{ri}), and risk-aversion (RA_i). In the set of dummies indicating market type and firm size, the reference categories were chosen to be local market and medium firm size, which were excluded from the model to avoid multicollinearity. The GDP per capita of the firm headquarters location country (GDP_i), retrieved from the World Bank, was included as a control variable.

We fit a negative binomial regression model, because the dependent variables are nonnegative count variables and their means are lower than their standard deviations (Hilbe, 2011).

RESULTS

The sample is described by the summary statistics in Table 1. The results of the descriptive analysis show that more than one third of firms in the sample do not adopt any sustainability practice, about another third adopts between one and three practices, and the remaining third adopts four or more. More than two thirds of the sample do not adopt any certification, about 18% adopt only one and about 4% of companies adopt two or three standards. The environmental practices which are most likely to be adopted by companies are animal welfare programmes, energy efficiency targets and waste reduction policies. Among the socio-economic ones, traceability, health and safety and training for employees are the most common among beef companies. The organic certification and the ISO 14001 are the most popular standards in our sample.

Table 1: Summary statistics

Dependent Variables	*Description*	*Mean*	*Std. dev.*	*Min.*	*Max.*
Practice Index	Number of sustainability practices adopted by each firm	2.35	4.11	0	21
Certification Index	Number of sustainability certifications adopted by each firm	1.48	2.08	0	11
Explanatory Variables	*Description*	*Mean*	*Std. dev.*	*Min.*	*Max.*
Company size ($Size_r$)	XS: Firm has a turnover ≤ € 2 million	0.03	0.18	0	1
	S: Firm has a turnover > € 2 million and ≤ € 10 million	0.21	0.41	0	1

	M: Firm has a turnover > € 10 million and ≤ € 50 million	0.45	0.50	0	1
	L: Firm has a turnover > € 50 million and ≤ € 200 million	0.20	0.40	0	1
	XL: Firm has a turnover > € 200 million	0.11	0.31	0	1
Market type (M_r)	Local: Firm operates in one country	0.67	0.47	0	1
	Regional: Firm operates in more than one country within the same continent	0.21	0.41	0	1
	Global: Firm operates in at least two countries in two different continents	0.26	0.44	0	1
Group dimension (*Group_dim*)	Number of companies in the corporate group (thousands)	237.98	3,889.37	0	67,711
Public listing (*PL*)	Company is publicly owned	0.03	0.18	0	1
Consumer engagement (*CE*)	The firm is active on three or more social medias	1.32	1.64	0	6
Business type (*B2B*)	Firm is business-facing	0.82	0.39	0	1
Business type (*B2C*)	Firm is consumer-facing	0.53	0.50	0	1
Feed manufacturer (VC_1)	Firm is growing feed	0.11	0.31	0	1
Breeder (VC_2)	Firm is breeding cattle	0.15	0.35	0	1
Trader (VC_3)	Firm is trading live animals	0.02	0.16	0	1
Manufacturer (VC_4)	Firm is processing meat	0.74	0.44	0	1
Butcher shop (VC_5)	Firm runs one or more shops	0.19	0.40	0	1
Risk-aversion (*RA*)	Firm mentions risk as part of the sustainability activity	0.10	0.29	0	1
GDP per capita (*GDP*)	GDP per capita of country where firm is located (thousands of US$)	36,929.7	17,908.2	1,137.3	100,172.1

Sources: Authors' own content analysis, Orbis, World Bank.

The results of the regression analysis are shown in Table 2. Results about value chain positions suggest that cattle breeders and beef manufacturers have a positive impact on the adoption of sustainability practices, whereas butcher shops negatively impact the Practice Index, possibly due to an interaction effect with small or extra small firm size. Manufacturers also positively impact sustainability certification adoption, which is negatively affected by trading companies. These results suggest that the beef value chain is producer-driven, meaning that the leading actors along the chain are producers and manufacturers (Gereffi, 1994; Lee et al., 2012). Very large firms (with a turnover higher than € 200 million) positively and strongly influence the adoption of both sustainability practices and standards, large firms (with a turnover between € 50 and € 200 million) are linked to a higher Certification Index and small firms to a lower Practice Index. The results about firm size are coherent with the previous literature, stating that larger firms are more likely to have a better overall sustainability performance than smaller firms (Drempetic et al., 2020). Both risk-aversion and consumer engagement exert a positive influence on the two indexes, which is in line with the previous literature (Bager & Lambin, 2020; ElShafei, 2020).

Table 2: Negative binomial regression coefficients

	***Practice Index* (1)**	***Certification Index* (2)**
Intercept	-1.580*** (0.508)	-0.978*** (0.338)
Feed manufacturer	0.344 (0.386)	0.140 (0.249)
Breeder	0.945*** (0.233)	0.068 (0.141)
Trader	-0.120 (0.437)	-0.867** (0.380)
Manufacturer	0.913*** (0.312)	0.495** (0.200)
Butcher Shop	-1.038*** (0.215)	0.230 (0.180)
XS	-0.118 (0.578)	0.104 (0.366)
S	-0.625** (0.294)	-0.284 (0.218)
L	0.211 (0.271)	0.627*** (0.175)
XL	0.726** (0.295)	1.206*** (0.338)
Regional	-0.223 (0.273)	0.244 (0.154)
Global	0.010 (0.238)	0.086 (0.163)
Group dimension	-0.119 (0.160)	-0.484 (1.021)
B2B	0.300 (0.265)	-0.108 (0.186)
B2C	-0.167 (0.240)	-0.189 (0.157)
Public listing	0.303	0.318

	(0.425)	(0.303)
RA	1.253***	0.473**
	(0.236)	(0.186)
CE	0.181***	0.183***
	(0.049)	(0.037)
GDP (.000)	0.017**	0.007*
	(0.006)	(0.004)
Observations	303	303
Log Likelihood	-501.407	-441.519
Wald Chi^2 (df)	162.53 (8)	201.42 (8)
Pseudo R^2	0.099	0.125

Notes: Robust standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01.

In conclusion, the results of this research can provide both policymakers and companies with information about how the beef sector addresses environmental and socio-economic issues, and inform their policy choices. Overall results should stimulate policy-makers to implement stronger regulation to give beef firms incentives to act more sustainably. The result about the positive relation between firm size and sustainability strategies adoption suggests that there is the need for policy-makers to focus on small- and medium-sized enterprises. Another potential implication is that awareness campaigns could be organized in order to inform firms about risks related to environmental degradation with the aim of promoting sustainable strategies adoption by leveraging the firms' risk-aversion. One limitation of this study is that both the sample selection from Orbis and the data collection from company websites may result in an underrepresentation of small and extra-small firms. Also, data collection about sustainability efforts was carried out on voluntary disclosures by firms, which may result in an overreporting of practices adoption and in a potential risk of greenwashing. An interesting research direction could be to build a more proper measure to assess this risk.

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UNDERSTANDING HOW TWIN TRANSITION MATERIALIZES IN AGRIFOOD: AN EXPLORATORY STUDY.

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PAROLE CHIAVE
Twin transition, agrifood, digital transition, green transition, exploratory study

INTRODUCTION AND OBJECTIVES OF THE STUDY

Twin transition represents a concept put forward by the European Commission (EC) to simultaneously achieve the objectives of two main pillars of the EC agenda: the green and the digital transitions. The underlying idea is that the green and the digital transitions should mutually reinforce each other as they clearly generate synergies. On the one hand, the green transition aims to combat climate change and environmental degradation, while on the other hand, the digital transition aims to harness digital technologies for sustainability and prosperity (Muench *et al.*, 2022). This appears particularly relevant for the agrifood sector, as it accounts for 10% of the European Union's (EU) greenhouse gas emissions; therefore, supporting a transition towards sustainable agriculture and food systems is pivotal to achieve the European Green Deal's objectives (Muench *et al.*, 2022), by mitigating the consequences of climate change and environmental degradation. Concurrently, digital technologies are increasingly penetrating the processes and operational logics of firms in many sectors, including the agrifood industry. Digital technologies are of paramount importance for the competitiveness of the European agrifood economy because they allow efficiency gains and at the same time support more sustainable business models. However, the two transitions have been mostly considered separately, while it appears that uniting them to mutually reinforce each other might unlock the full potential of the twin transition. In order to determine how twin transition in agrifood is understood in academia, a search on Scopus database was carried out in March 2023 to identify relevant research that could allow us to better understand and frame this concept. However, to our knowledge, there is only one published paper that specifically discussed twin transition in agrifood (Brunori, 2022) using the term "twin transition". Therefore, to address this gap, our research team has developed a two-step research design: first the literature search was widened by using the terms "green transition" and "digital transition" instead of the term "twin transition" together with agrifood (and its derivatives). Considering that only 59 papers were retrieved, we moved from a deductive to an inductive approach by creating a survey directed to Small and Medium Enterprises (SMEs) in three North East Italian regions. The aim was to determine whether and how twin transition materializes across Small and Medium Enterprises (SMEs) in the agrifood sector and contribute to the nascent literature in the field.

LITERATURE REVIEW

Twin transition is increasingly becoming a buzzword in European policy circles. Twin transition consists in the matching of the green and digital transitions together to accelerate necessary changes in societies and economies. In order to better grasp this concept, our research team has attempted to carry out a systematic literature review on "twin transition" and agrifood (and its derivatives). Despite of the growing importance of the term in the economic and political community, the scientific literature does not refer much yet to this concept: we retrieved only one paper in the Scopus database (Brunori, 2022) that would refer to "twin transition" in agriculture. This finding could be interpreted in two ways: 1) scholars are still not aware of the expression "twin transition", so they use the terms green and digital transitions; 2) green transition and digital transition are analyzed as two different silos and not considered as a unique process. However, much research has been addressing the two macro transitions that underlie twin transition: the green and digital transitions.

The green transition addresses the climate crisis and the loss of biodiversity, whose consequences represent a global threat. In order to support the transition towards environmentally sustainable lifestyles and economies, it appears pivotal to shift production and consumption patterns to live within the planetary boundaries, while being fair and inclusive for all. The digital transition represents an ongoing process that is changing societies and economies. The new technologies, such as robotics, Artificial Intelligence, automated mobility or digitally-enabled biotechnologies are crossing digital, physical and biological spheres (Muench *et al.*, 2022). While both transitions contribute to transforming societies and economies, they have different dynamics: achieving the green transition stems from the need to reach the aims of climate neutrality and sustainability, but it requires political and societal push to be realized. On the other hand, the digital transition is already ongoing and pervasive; therefore, it might be used as a tool to facilitate the green transition. Moreover, digital transformation entails altering existing process, routine, and resources. Technology adoption is just an enabler of transformation: a real transformation also requires new competences and a new culture to be exploited (Checchinato, 2021).

To better grasp the concept of twin transition in agrifood – and given the limitations due to the lack of the use of this specific term in academia - we carried out a systematic literature review on Scopus database together with a team of computer scientists. Our team used a search string that would encompass derivatives of the word "digital" OR "green" AND transition AND "business model" AND "agrifood". 59 papers were identified and clustered through BERTopic – a clustering pipeline used to cluster different topics. 3 main clusters were identified:

- Cluster 1: more than 60% focus on firms within food systems for sustainability transitions (systemic approaches; firms within ecosystems);
- Cluster 2: more than 9% focus on circular economy but from the perspective of reuse of waste for energy (e.g. biogas and biomass etc.);
- Cluster 3: more than 26% would focus on digital transformation.

Across these papers, two (Abbate *et al.*, 2023; Viola and Mendes, 2023) would talk about twin transition (uniting digital and green transitions) without mentioning the term; accordingly, it appeared necessary to better define twin transition in agrifood. Therefore, our team has modified the research design to move from a deductive to an inductive approach, by creating a survey across 566 agrifood companies in the Triveneto to capture the implementation of green and digital activities bottom-up, and to draw implications for the nascent field of twin transition in agrifood.

METHODOLOGY

One of the first steps of the twin transition process is related to the use and the adoption of both digital technologies and green processes or activities. To explore these aspects, we developed a survey aimed to map the use of digital tools as well as activities enabling the green transition across 566 agrifood companies in three regions in North East Italy: Veneto, Friuli Venezia Giulia and Trentino Alto Adige. The sample includes SMEs belonging to all ATECO codes (10.1 to 10.8, excluding beverages) and with a number of employees ranging from 10 to 250.

This mapping exercise can let us understand if and whether agrifood companies are embracing the two transitions at the same time.

The online questionnaire was constituted mainly by closed-ended questions to gather information on SMEs strategies in terms of digitalization and sustainability. Survey was pre-tested among some companies between 1-15 April 2023 to determine if questions were clear and relevant for respondents. Based on the feedback, the updated version of the survey opened on April 19th, and it is still ongoing at the time of the writing (June 2023). Questions would explore the use of different types of technologies (e.g. management technologies such as supply chain management, cloud services, etc.; technologies for automation/robotics in production and logistics; technologies for communication and market transactions such as e-commerce, digital marketing, etc.; visualization and simulation technologies such as augmented reality; technologies for data analysis such as data analytics, machine learning etc.) in each SME.

In terms of capturing efforts towards the green transition, questions would address the use of sustainable packaging, monitoring tools for sustainable supply chains; reuse of food waste; use of renewable energy; systems for energy efficiency; systems for water efficiency; systems to reduce greenhouse emissions.

One second objective was to understand if the companies are ready to complete the transition, thus if human resources with the right skills and competences to support the implementation of both the digital and sustainable transformations are available.

PRELIMINARY RESULTS

At the time of the writing (June 2023) the survey is still circulating among companies: we just collected 95 responses, so the elaboration of results is preliminary.

Technologies and sustainability activities

The most used technologies among respondents are management technologies (69.4%), followed by automation/robotics technologies (49.4%), technologies for communication and transactions (35.7%), technologies for data analysis and predictive activities (22.1%). Only one respondent (1%) uses visualization and simulation technologies. 13.6% of companies have not adopted any technology.

Not surprisingly, the most adopted technologies are mainly related to production, and this appears consistent with the typical entrepreneurial mindset and the production orientation of many Italian SMEs. Still low is the implementation of data analysis and predictive activities. Further investigation should focus on these findings, to understand if the reason is related to the lack of competencies or to the lack of vision.

Implemented activities enabling sustainable transition across respondents:

- 75.3% of respondents reuse food waste;
- 65.6% use renewable energy;
- 63.4% use eco compatible packaging;
- 48.4% use energy efficiency systems;
- 38.7% employ monitoring tools for sustainable supply chains;
- 24.7% use systems for water efficiency;
- 24.7% use systems to reduce greenhouse emissions.

The two most used technologies - management technologies and automation/robotics technologies, are jointly used by 43.1% of respondents.

If we add the third most used technology - communication and market transaction technologies - we observe that only 15.7% of respondents use the three of them. This finding could be a signal of the companies' orientation: the effort to be efficient from the production side is not reflected in the effort to better serve the market, using technologies to reach customers. In fact, the last type of technology is mainly adopted for marketing reasons and SMEs are usually not able to exploit the benefits of digital marketing due to their lack of human resources and competences.

Use of technologies and implementation of activities enabling the sustainable transition

To understand if SMEs implemented sustainable activities and adopted digital technologies, Table 1 reports the percentage of green activities developed by companies adopting one, two or three of the main digital technologies, as well as sustainable activities implemented regardless of technology adoption.

Table 1 – Sustainable activities and technologies: percentage of SMEs

Sustainable activities	SMEs using mgmt. technology (%) 69.4%	SMEs using mgmt. AND automation technologies (%) 43.1%	SMEs using mgmt. AND automation technologies AND communication (%) 15.7%	Total sample
Sustainable packaging	60.6%	68.2%	73.3%	63.4%
Monitoring tools for sustainable supply chains	40.9%	48.7%	46.6%	38.7%
Reuse of food waste	78.7%	80.4%	73.3%	75.3%
Use of renewable energy	72.7%	78%	80%	65.6%
Systems for energy efficiency	56%	68.2%	73.3%	48.4%
Systems for water efficiency	31.8%	34.1%	20%	24.7%
Systems to reduce greenhouse emissions	27.2%	34.1%	20%	24.7%

Source: authors' elaboration

It seems interesting to notice that the use of one or more technologies positively affects different sustainability activities, in particular: sustainable packaging, monitoring tools, use of renewable energy, and systems for energy efficiency. While the co-occurrence of digital and green activities does not mean that companies are completely aware of the twin transition, it might still allow us to understand what sectors/activities implemented support more the shift towards it.

For example, energy (use of renewable energy and systems for energy efficiency) appears the most affected by the use of technologies: as more technologies are used, more systems for energy efficiency activities and use of renewable energy are implemented.

This finding is interesting because the energy sector is the largest emitter of greenhouse gases in the EU, and low-cost renewable energy technologies made the energy sector the keystone supporting the transition towards a climate-neutral Europe (Muench *et al.*, 2022). Accordingly, this appears to be a promising preliminary result to unlock the potential of twin transition.

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THE CURRENT STATE OF THE INSECT INDUSTRY WITHIN THE CONTEXT OF A CIRCULAR BIOECONOMY

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Keywords: circular economy; waste management; bioconversion; food; feed; social acceptance

Introduction

The overexploitation of natural resources is pushing the agribusiness industry to find sustainable alternatives based on circular economy principles. In this regard, the current food production paradigm will have to undergo a fundamental transformation in which it will be necessary to re-evaluate the way food is produced, correcting inefficiencies, reducing food waste through proper management, and promoting sustainable diets using alternative protein sources (Henry *et al.*, 2015).

Within this scenario, the introduction of insects into production cycles would not only enable them to further the principles of sustainability, due to their low capital requirements, but also play an important role in closed-loop production processes. In fact, due to their high conversion rate, they act as effective bioconverters of organic substrates, which would enable the agribusiness industry to improve waste and waste management. For example, some larvae grow on waste substrates and through these bioconversion processes, they can produce high value-added (upcycling) materials that can be reintroduced into production cycles, allowing the industry to reduce internal (economic) and external (environmental) costs.

However, to complete the transition of this niche innovation to full deployment in agribusiness and livestock systems, there are many hurdles to overcome. In this regard there is the need to achieve high and reliable production volumes, to offer fair and competitive market prices, to resolve legislative hurdles such as permitting the use of organic waste or by-products from the agribusiness industry, and the expansion of the system to accommodate new players and technologies that enable the usability of the innovation.

Through a systematic literature review and co-occurrence analysis, the study aims to create a categorization of qualitative data to generate a comprehensive conceptual framework of the current state that describes the theoretical outlines of the field in the context of a circular bioeconomy and comments on its shortcomings.

Methodological framework

To investigate the literature and identify some of the factors that influence the implementation of circularity in insect-based production systems, a literature meta synthesis was conducted in two different steps: a systematic literature review and an analysis of co-occurrences among the terms most frequently emerging from the titles and abstracts of the papers included in the systematic review.

The analysis was firstly based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) method, which includes the well-defined steps of a systematic review, including eligibility criteria and relevant sources of information, exploration of strategies, selection process, results, and data synthesis (Ortiz-Martínez *et al.*, 2019).

As the database's search option was "title, abstract, keywords" the investigation included all possible combinations and variations of the following keywords: "circular economy" AND "insect*", while Boolean operators and wildcards were employed in accordance with the purpose of this study.

In the second stage, the authors performed co-occurrence analysis on the data from the articles included in the systematic literature review to gain a comprehensive understanding of the state of insect farming in the context of the circular economy. Indeed, this method is useful for interpreting data and maximizing learning from qualitative studies to report generalizable results.

This analysis was applied through VOSviewer software, version 1.6.19. Identification of term co-occurrences was based on textual data extracted from the titles and abstracts, using a full count procedure that included only terms with at least five co-occurrences. Next, the software selected the most relevant terms, from which the authors performed further skimming by removing redundant terms.

The identification of these keywords evolved with the creation of three easily identifiable clusters due to the correlation between them.

Results

During the screening phase, pertinent literature was chosen by restricting the search to the following subject areas: agricultural and biological sciences; environmental sciences; energy; social sciences; business, management, and accounting; multidisciplinary; and economics, econometrics, and finance.

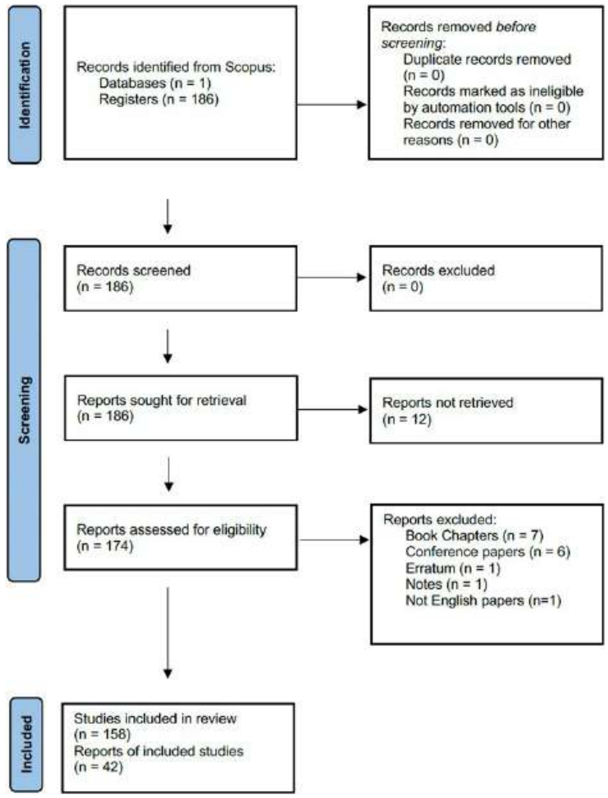
To assure greater research rigor and quality only peer-reviewed journal articles were included, thus avoiding grey literature.

In addition, no time constraints were imposed, and all peer-reviewed literature available to date on the topics was searched. The search was also limited to English-language articles and reviews. Therefore, seven book chapters, eight conference papers, one erratum, one note, and one non-English language paper were disqualified during the screening phase.

The remaining documents were then subjected to a comprehensive evaluation based on their titles and abstracts. In addition, a thorough examination of the text's content was conducted to eradicate texts that did not satisfy the review's eligibility criteria or were not directly pertinent to the subject of insect circular economy.

After eliminating papers that were irrelevant to the investigation, a sample of 42 papers was chosen (Figure 1). The results of the literature review indicate that all papers were published within the last seven years indicating that this field of study is still in its infancy.

Figure 1 - PRISMA flowchart



To identify critical elements in the titles and abstracts of the chosen studies, a comprehensive analysis was conducted. The co-occurrence of these terms, which resulted in the construction of three distinct clusters, is depicted in Figure 2. Each cluster, which is represented by a distinct color, highlights the most prominent themes discussed in the literature. The aggregated terms within each cluster emphasize the primary research topics and summarize the studies that were analyzed.

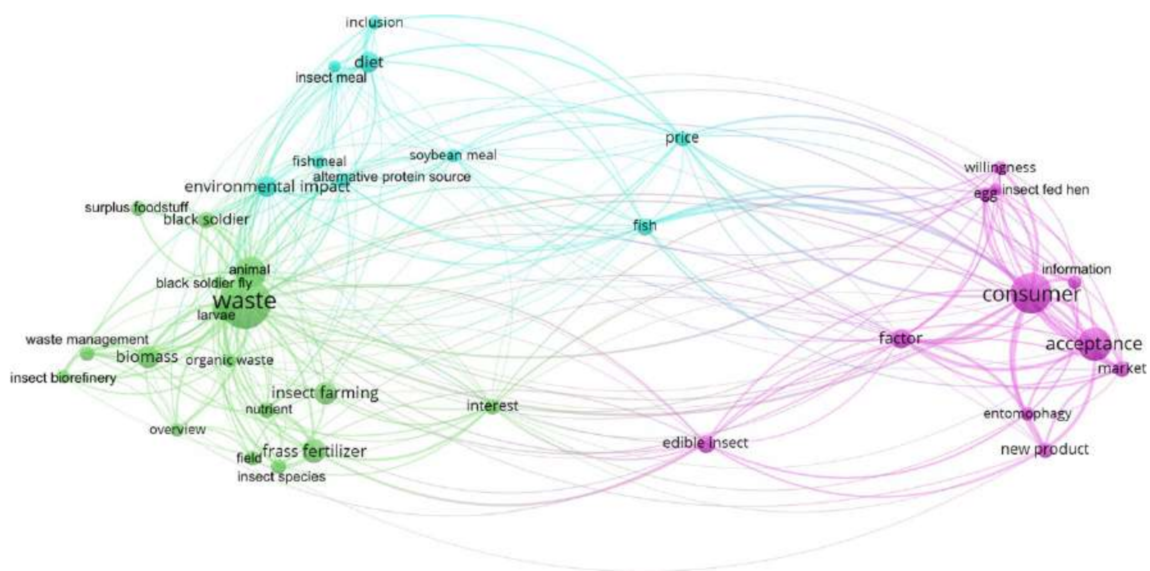
Therefore, we identified three emergent clusters based on the co-occurrence of key elements in the titles and abstracts of the articles:

(a) Bioconversion processes (green cluster): whose terms can be traced back to bioconversion processes carried out by insects on waste organic substrates;

(b) Feed industry (blue cluster): whose terms related to the inclusion of sustainable alternative food sources for intensively farmed animals emerge;

(c) Food industry (purple cluster): whose terms can be traced back to the theme of social acceptability about the consumption of edible insects.

Figure 2 - Co-occurrence map



Discussion and Conclusion

The insect breeding industry is emerging as a viable option in various sectors, including food production, animal feed, waste management, and biomedical research. It allows to achieve different goals in the economic and environmental fields and there are multiple strengths related to new ways of meeting food needs, due to their nutritional value, as well to the development of sustainable agricultural practices, waste management (Chia *et al.*, 2019), and production of alternative food protein sources, biofertilizers, and bioenergy (Beesigamukama, 2019).

According to the findings, insect-generated bioconversion is an emerging tool for a circular bioeconomy based on a process whereby several tonnes of food waste can be efficiently converted into high-value products (upcycling) from a given amount of relatively low-value biomass (Van huis *et al.*, 2021).

However, although the sector involved in the cultivation and propagation of insects is expected to grow significantly with the establishment of industrial-scale breeding facilities, it still represents a niche for innovation and efforts to develop closed innovation models are still many (Chia *et al.*, 2019).

In fact, empirical evidence suggests that their large-scale application is hindered by technical, economic, logistical, and legal barriers that prevent their full deployment, even though the results presented thus far seem to indicate that insects have great potential to contribute to the development of circular business models (Dagevos and Taufik, 2023).

Our results show that the sector currently faces many obstacles, such as the high price of insect meal and production processes due to the lack of appropriate technologies, the large quantity required by feed producers to cover feed needs, the development of sanitation standards to prevent livestock diseases and contamination during rearing, processing, and marketing processes (Reverberi, 2021), legislative constraints related to the use of insect meal as livestock feed (Van Raamsdonk *et al.*, 2017), their habitat, the food substrates in which they are raised, and the possibility of ecosystem imbalances (Berggren *et al.*, 2019).

In addition to the above findings, the authors raise questions about the level of circularity achievable in the insect breeding industry. While it has been estimated that negative externalities are significantly reduced compared to traditional production, they are not eliminated. Furthermore, legislative constraints in different countries limit the rearing of insects on all organic substrates, resulting in the underutilization of organic waste and a lack of encouragement for proper waste management. Additionally, their use in animal feed is currently limited to being additives rather than complete diet replacements. Moreover, the lack of widespread insect breeding centers poses a logistical challenge for the entire supply chain, making closed-loop production processes economically unsustainable. In this regard, while the potential for circularity exists in the insect breeding industry, empirical evidence suggests that its application on a large scale is impeded by technical, economic, and logistical obstacles.

Finally, as the concept of closed-loop systems necessitates increasingly active consumers through co-design processes (Clark *et al*., 2020), the results indicate that the social acceptability of entomophagy is an essential aspect of the transition to a circular economy (Dagevos and Taufik, 2023).
However, even though the concept of circularity as a potential driver for consumer acceptance and adoption of insect consumption has been widely discussed and identified in numerous articles, these topics remain scientifically unexplored.

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Monitoring technical and economic indicator in dairy sheep farm to improve farm economic sustainability

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PAROLE CHIAVE
Partial indicators, Simplified economic balance, Economic sustainability, Farm management

Introduction

In these recent year the issue of economic sustainability of dairy sheep farm increased in relevance. For farmer and technicians is important to monitor over time partial indicators that support farm managerial choices. These indicators are especially diffused in dairy cattle farms and were recently reviewed and applied by Atzori et al. (2021). The most important and common partial indicator are: Feed Efficiency (FE) (Pepin, 2009; Bach, 2020), calculated by milk yield divided Dry Matter Intake (DMI); feed cost expressed per liter of milk delivered (Ondarza, 2017) (€/l) calculated as the total feed cost divided by the amount of milk delivered; Income Equal Feed Cost (IEFC) (Pepin, 2009) calculated by feed cost per milking animal divided by milk price per liter, that shows how much milk yield is needed pay feed cost; Income Over Feed Cost (IOFC), which is calculated as milk revenues minus feed cost expressed per animal unit or per herd per day. IOFC also depends from milk quality, reproduction and herd management (Atzori et al. 2013) and is negatively related with environmental impacts and carbon footprint (Serra et al., 2013). Within the Italian National Program for Regrowth and Resilience (PNRR), the project AgriTech (involves 28 Universities, 5 research centres e 18 companies) has the aims of improving productivity, sustainability, resilience and economic competitiveness of the Italian agrifood sector trough the enhancement of the ecological and digital transition.
This work is included within the activities of the Spoke Unit 5 “Sustainable production and mitigation of the environmental impact in livestock systems” and in particular within the task 5.2.6 aimed at focusing the development of Bio-economic models to assess the impact of climate change/adaptation measures on the socio-economic sustainability of livestock farms. The task is participated by research groups of the University of Tuscia (Viterbo), Pisa, Sassari and Catania with joined activities and shared objectives. The activities will focus on socio-economic analysis of climate change/adaptation measured especially in terms of impacts on socio-economic sustainability at farm level. This will consist of development and implementation of bio-economic and business models, which will help to simulate different scenarios with alternative adaptation strategies for the dairy sheep and cattle sector. The developed models will take into account the characteristics, production and management options of farms, and will calculate technical, environmental, economic indicators aimed at increasing farm efficiency and pathways to circular economy.
The aim of this work was to present a practical example of use of technical and economic partial indicators in dairy sheep farms to be included in the economic balance used at farm level as decision

support of managerial choices. A specific focus on technical and economic indicators currently used in dairy sheep farming has been recently advanced based on previous works on dairy cattle.

Materials and methods

Four dairy sheep farms (A,B,C and D) located in northern Sardinia were monitored in the month of March 2023 and an example of technical and economic indicators currently used by farmers and technicians has been reported. Available land was equal to 123, 78, 167 and 44 hectares and 532, 345, 742 and 186 ewes (primiparous + pluriparous) for farm A, B C and D, respectively. The entire farms land was grazed by milking ewes in all farms and only farm D did not deliver feed by unifeed to the flock. Farms have been selected on the farmer's interest to economic management and the availability to gather data on daily basis. Data collection was performed as following: The farmer enters, daily, in an excel spreadsheet the number of milking ewes, liters of milk delivered, kg of DM delivered and feed cost per milking ewe, without considering pasture feed consumption. The costs and composition of rations and self-produced feed prices are considered of reference to the current year and were constantly updated , milk price is 2 €/l. All partial indicators (Table 1) are calculated on daily basis only for milking ewes.

Table 1. Calculation of average daily partial indicators.

Indicator	Formula
Average daily milk yield (ADMY), l/d	Milk delivered (l) /number of milking ewes
Estimated DMI*, kg/d	-0.545+0.095 x liveweight^0.75+0.65 x ADMY
Pasture DMI, kg/d	Estimated DMI (kg) – DM delivered (kg)
Feed efficiency (FE), l/kg	AMDY(l)/estimated DMI (kg)
FE without pasture, l/kg	AMDY(l)/ DM delivered (kg)
Milk revenue, €/d	ADMY (l) x milk price (€/l)
Pasture cost, €/d	Pasture DMI (kg) x pasture cost* (€/kg of DM)
Total feed cost, €/d	Pasture cost (€/d) + Feed cost without pasture (€/d)
IOFC, €/d	Milk revenue (€/d) – Total feed cost (€/d)
IEFC, l/d	Total Feed Cost (€/d)/Milk price (€/l)

*(Pulina et al., 2013) liveweight was assumed 48 kg for all the farms;
** Pasture cost was considered 0.20 €/kg of DM

Furthermore, data from farm C were collected for structuring a simplified economic balance that could combine technical and economic indicators. Data collected on farm included: i) Revenues from milk sales; ii) Revenues from slaughter animals; iii) Total feed cost; v) Health and reproduction cost; iv) Total energy and fuel cost; v) Other costs related to worker, maintenance, detergents or other purchased materials. Through these, EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) can be calculated by subtracting the internal costs from total revenues. EBITDA and the other expenses were calculated per liter of milk delivered, thus dividing the total amount of revenues by total liters of milk delivered in March.

Results

Preliminary results of indicators collected at farm levels were presented for farms A, B, C and D. Estimated DMI and pasture DMI were represented in (Table 2).

Table 2. Average dry matter intake in the farms, March 2023.

	Farm A	Farm B	Farm C	Farm D	Average
Extimated DMI, kg/d per milking ewe	2.16	2.75	2.10	2.29	2.32
DM delivered, kg/d per milking ewe	1.5	1.8	1.5	0.8	1.40
Pasture DMI, kg/d per milking ewe	0.66	0.95	0.60	1.49	0.92

On the 4 farms ADMY was on average equal to 2.1 l/d, in particular farm B and D had an higher milk yield (2.8 and 2.2 l/d respectively) than farm A and C, being1.6 and 1.8 l/d, respectively. FE without pasture in farm A, B, C and D was 1.10, 1.33, 0.93, 2.43 respectively. Whereas FE values (considering pasture intake) were 0.69, 0.87, 0.67, and 0.74, for farm A, B, C and D, respectively. It indicated that on the FE calculation, pasture DMI impacts for 43%. Regarding feed costs on farm A, B, C and D, per milking ewes were: i) without pasture 0.80, 0.70, 0.74, 0.39 €/d; ii) considering pasture 0.94, 0.89, 0.84, 0.79 €/d respectively. Thus average pasture cost was about 28% of total feed cost per milking ewes. Regarding IOFC, in farm A, B, C and D was 2.22, 4.51, 2.65, 3.73 €/d respectively. Farm B and D had an higher IOFC than A and C, due to the higher milk yield and an higher FE (Figure 1).

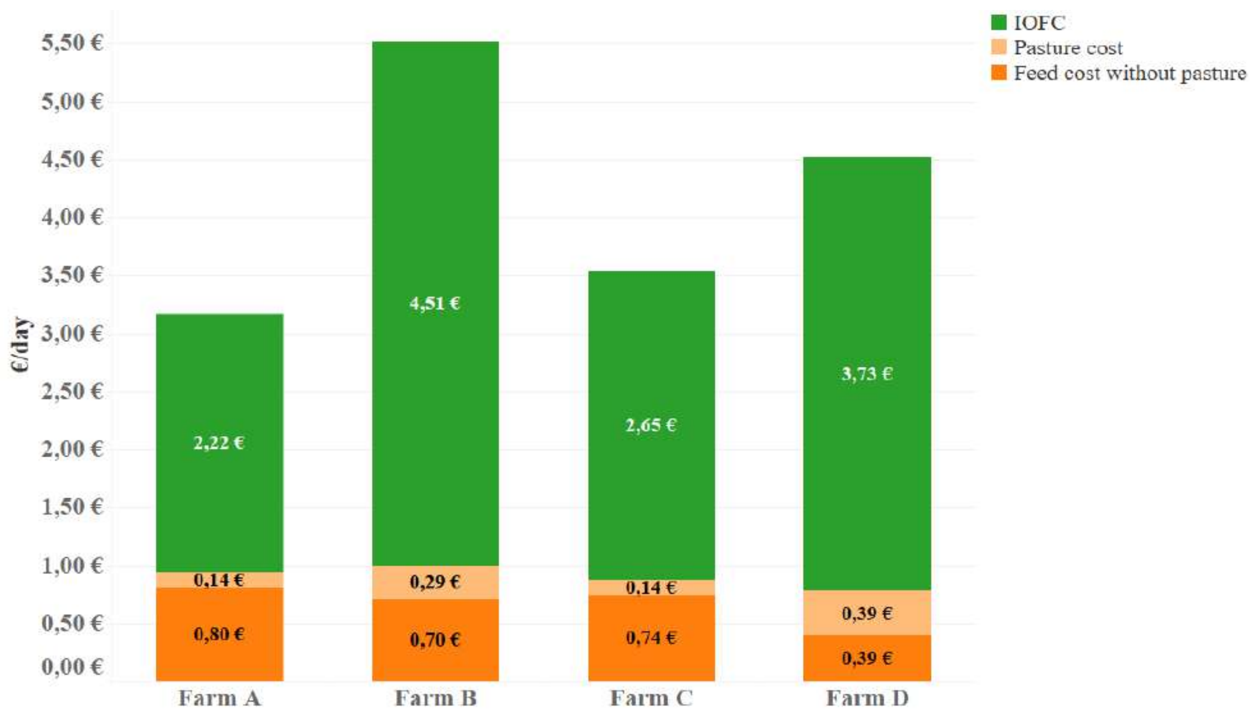
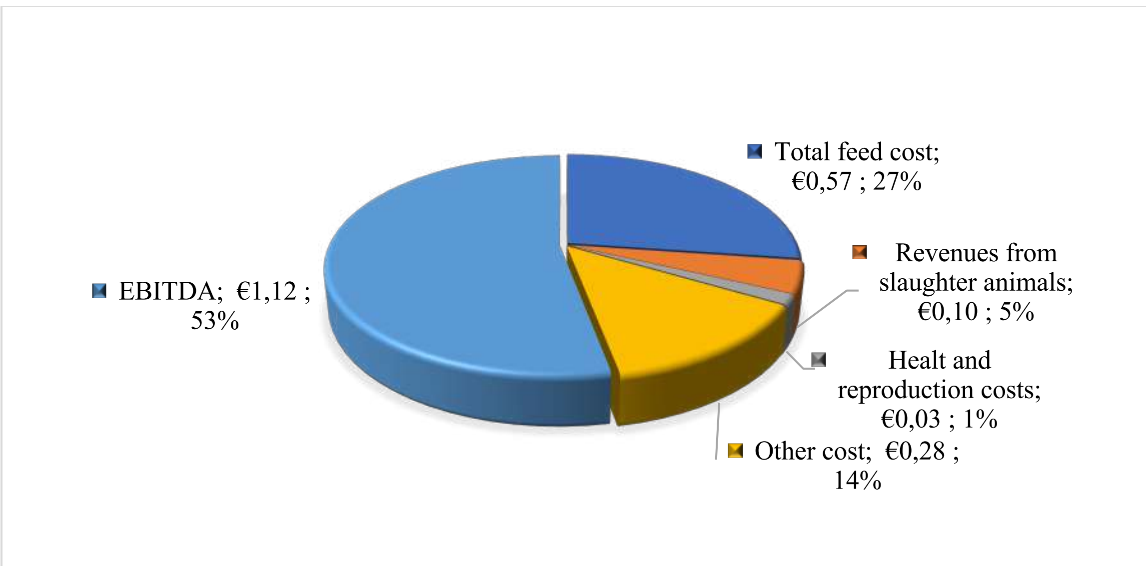


Figure 1. Feed cost without pasture, pasture cost, IOFC in all four farm monitored in March 2023.

Pooled daily data over the whole month for each farm a variation of ±0.1 in FE corresponded to 0.77, 0.46, 0.22, 1.12 €/d per milking ewe in the farm A, B, C, D respectively. In these farm a daily variation of ±0.1 point of FE corresponds to a daily variation of ±0.64 €/d of IOFC per milking ewe on average. The IEFC for farm A, B, C, D was 0.47, 0.44, 0.43, 0.34 l/d; in farm D it was lower than other farms because of the lower feed cost.

In farm C, where the simplified economic balance was calculated, in March the total milk delivered was 21,106 liters, also the total revenues from milk and slaughter animal were 42,211.00 € and 2,116.00 €, respectively. Total feed cost were about 12,102,00 €, health and reproduction cost were 667 €, energy and fuel were 3,100.00 € and other cost were 6,000.00 €. EBITDA was 23,558.00 € and was about 53% of total revenues and impact 0.57 €/l (Figure 2). The higher cost was represented by feed cost contributing to 55% of the total costs.

Figure 2.Simplified economic balance expressed per liter of milk delivered from farm C, March 2023.



Conclusions

Partial indicators can be one of the keys for performance monitoring and to increase farm economic sustainability. This approach could be in fact a practical way to support short and medium term business choices of the farmer. On this study emerged that pasture cost have to be included include in all calculation because it contributes to 28% on feed cost and 43% on FE. Also FE is one of the most important partial indicators, considering that the variation of ±0.1 point of FE corresponds to a monthly variation of 1,920.00 € every hundred milking ewes.

The approach of a simplified economic balance in farm C can be pointed out a an example to be used in other farms and foster benchmark analysis in order to identify the most common problem and inefficient areas of farm management. These data can also be useful to improve adequate territorial planning to increase the regional system resilience. This approach can also be suggested to cooperatives and farmers for milk price negotiation especially in case of low milk price. Another next step in this work will be to make easier data collection (including other animal categories data) with simple tools for sharing data a territorial level.

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Consumers' awareness of animal welfare issue and livestock innovations: a PLS-SEM approach

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KEYWORDS
Animal Welfare, Consumers, PLS-SEM, WTP.

INTRODUCTION

The increasing consumer interest in Farm Animal Welfare (FAW) is prompting more and more individuals to opt for products that emphasize ethical farming practices and brands that associate themselves with respect for FAW. This extends not only to food products like eggs and meat but also to non-food items such as cosmetics. In the case of agricultural products, information regarding FAW is typically conveyed to consumers via specific labels or brands, serving to fill the informational gap about the production processes of certain goods in the food market. However, when consumers buy products tagged with animal welfare labels, their understanding of the sustainability practices associated with them may not always be accurate. Moreover, consumer knowledge about farming practices involving animals may be substantially limited in terms of both fundamental and more complex aspects. In cattle farming, for example, certain practices such as animal grazing are well known and considered highly important by consumers: the existence of a premium price associated with these practices is widely confirmed in literature (Mazzocchi and Sali, 2022). The same applies in the choice of poultry products, with consumers showing a marked preference for options such as free-range eggs, pasture-raised animals, or antibiotic-free products (Slack and Sharma, 2022).

However, it is crucial to note that a substantial portion of consumers does not fully understand a significant number of farming practices. Aspects such as the lifespan of a dairy cow under intensive farming, the use of artificial insemination, or even the life cycle of a productive cow are areas where consumer knowledge often falls short. Studies show that although dairy cows can live up to 20 years, their lifespan is considerably shortened under modern farming conditions (Dallago et al., 2021), resulting in a decrease in the longevity of dairy cows in most countries characterized by high individual milk production (Dallago et al., 2021). Several aspects of animal farming are not widely communicated or understood, leading to a lack of awareness among consumers about the specific details and processes involved in the production of animal-derived products.

In traditional intensive farming, the practice of separating the calf from its mother immediately after birth is common. This is justified on several grounds, including increased profits, better control over the calf's milk intake, enhanced calf health monitoring, and reduced stress for both the cow and the calf (Meagher et al., 2019). Additionally, the immediate separation of the calf from its mother aims to prevent direct colostrum intake and potential contact with infected faeces from the adult cow. It is also necessary to eradicate certain diseases, such as paratuberculosis. However, the impact of this practice on both the calf and the cow's health is still a matter of debate. Direct suckling of colostrum and milk by the calf has been shown to be protective against mastitis, and prolonged cow-calf contact promotes the development of normal social behaviour in the calf and higher weight gains (Meagher et al., 2019). From an environmental sustainability perspective, the management of cow-calf separation requires further investigation, as there are multiple aspects to consider. With prolonged cow-calf contact, the quantity of milk sold is lower, which inevitably leads to increased emissions and waste per unit of product. Furthermore, prolonged cow-calf contact has been associated with faster growth in animals, which can lead to reduced health issues, a lower age at first calving, and increased milk production (Mogensen et al., 2022). Management practices that involve increased cow-calf contact are indeed well-received by consumers, as reported in a recent study (Sirovica et al., 2022). Among the available strategies to address management issues and milk losses associated with cow-calf separation in intensive farming, one approach could be using nurse cows. Nurse cows are healthy cows that are not milked and are solely dedicated to nursing a group of calves (Broucek et al., 2020). This practice allows for continued calf-mother interaction while minimizing the potential negative impacts on milk production and management challenges in intensive farming systems.

An examination of intensive farming systems in Italy reveals a noteworthy evolution in the sector: over the past 50 years, individual milk production has more than doubled, but this growth has been coupled with a reduction in lactation length — falling from 334 days in 2010 to 324 days by 2020 (AIA, 2022). A trend towards maximizing animal productivity has emerged, favouring the presence of primarily first-lactation cows within farming operations. While slightly less productive than multiparous cows, these animals present fewer health complications. However, this strategy necessitates a higher turnover of young livestock, such as heifers and young cows, to replace culled adult cows. The implications of this approach extend beyond increased production costs associated with the upkeep of a larger cohort of non-productive animals, as it also exacerbates the environmental footprint of milk production within these facilities (De Vries, 2020).

In light of these observations, the present study seeks to elucidate the effects of consumer's understanding and perceptions of FAW on WTP for innovative practices within cattle farming. The investigation will explore the correlation between consumers' comprehension and perceptions of FAW and their readiness to endorse novel livestock farming techniques financially. Specifically, this research aims to shed light on the influence of consumers' environmental and ethical attitudes, their perceptions of animal welfare, and their knowledge concerning FAW on their WTP for animal products sourced from cattle farming.

METHODOLOGY

Partial Least Squares Structural Equation Modeling (PLS-SEM) is a technique that enjoys widespread utilization in many published works, particularly within the spheres of management and marketing. One of the primary merits of PLS-SEM lies in its capacity to estimate complex models involving multiple constructs, variables, and paths, circumventing the need for rigid data distribution assumptions. This aspect of flexibility proves instrumental when handling non-experimental data, which often exhibits divergence from ideal distribution assumptions inherent in real-world scenarios. In this study, we employ the Partial Least Squares (PLS) methodology due to the relatively small sample size constraints and the indeterminate nature of data distribution arising from survey-based data collection.

Our hypothesis posits a positive correlation between three latent factors: ethical-environmental consumer attitudes, perception of animal welfare, and knowledge of animal welfare, each having an impact on the WTP for animal products derived from sustainable cattle farming. These latent factors have been identified based on the results gleaned from the Ethically Minded Consumer Behavior (EMCB) scale (Sudbury-Riley and Kohlbacher, 2016), Animal Welfare scale (Kendall et al., 2006) and AW knowledge scale, respectively. We also examine the influence of certain socio-economic variables, specifically respondents' age, level of education, and gender, on WTP.

The initial segment of our survey solicited information regarding the respondents' personal demographics and food consumption habits; the subsequent section was designed to evaluate the respondents' WTP choices. The concluding portion comprised attitudinal scales that investigated respondents' ethical and environmental beliefs, attitudes towards animal welfare, and knowledge of animal welfare. The data collection was carried out through an on-line form, distributed among a sample of 200 consumers from May to July 2023; 180 complete questionnaires were collected, thus representing preliminary results.

Values, beliefs, and moral norms play a significant role in shaping individuals' behavior towards environmental issues. Attitudinal scales have commonly been used to measure individuals' attitudes towards the environment. These scales typically consist of a series of statements or questions that individuals respond to, indicating their level of agreement or disagreement with each item. The responses are then used to determine the individual's overall attitude towards the environment, capturing their beliefs, feelings, and evaluations regarding environmental issues. Environmental attitudes, in particular, have been extensively studied in the literature. They involve individuals' perceptions and beliefs about the natural environment, including factors that may compromise its quality. We decided to employ the ethically minded consumer behaviour (EMCB) scale, created and validated by Sudbury-Riley and Kohlbacher (2017), to investigate the influence of various consumption motivations concerning environmental matters and corporate social responsibility.

The concept of animal welfare encompasses societal values, personal beliefs, and ethical considerations, which can influence consumer purchasing decisions. Additionally, intensive livestock systems have had an impact on consumer awareness, leading to changes in consumption patterns. In accordance with the study conducted by Marescotti et al. (2019), the third scale utilized in our research is the "Animal Welfare" scale. This scale, consisting of eight items, was originally developed by Kendall et al. in 2006. It specifically addresses ethical concerns related to animal production.

RESULTS AND CONCLUSIONS

Our preliminary data collection yielded insightful results concerning consumers' awareness of animal welfare issues and their WTP for animal products stemming from innovative livestock practices. Using PLS-SEM, we found a significant positive relationship between our three latent factors and WTP, with each factor contributing to the overall model. Furthermore, our results substantiated the influence of socio-economic variables, such as the level of education and gender, on consumers' WTP.

Firstly, consumers' environmental and ethical attitudes, as measured by the Ethically Minded Consumer Behavior (EMCB) scale, had a significant positive effect on their WTP for animal products from sustainable cattle farming. This finding suggests that individuals who are more conscientious about the environment and uphold stronger ethical principles are more likely to pay a premium for products that promote animal welfare as they may perceive their purchase decisions as a form of support for ethical farming practices and a means of combating issues related to intensive farming systems.Similarly, perceptions of animal welfare significantly affected consumers' WTP, reaffirming the importance of consumer awareness and sensitivity about livestock farming conditions. Consumers with higher scores on the Animal Welfare scale, indicative of more favourable attitudes towards animal welfare, demonstrated a stronger WTP for products derived from ethical farming practices.

Furthermore, consumers' knowledge of FAW, as measured by the AW knowledge scale, positively influenced their WTP. This suggests that an informed consumer base is crucial for the acceptance and adoption of livestock innovations, and more knowledge about the realities of animal farming, such as the common practice of separating the calf from its mother immediately after birth or the lifespan of a dairy cow under intensive farming, encourages consumers to pay more for products that are derived from sustainable cattle farming practices.

Among the socio-economic variables, the level of education was positively correlated with WTP, indicating that more educated consumers were willing to pay more for animal products associated with improved welfare standards.

Our study also revealed a significant knowledge gap among consumers regarding specific livestock practices, particularly within cattle farming. We found that while consumers were generally aware of and appreciated practices like animal grazing, their understanding of the complexities and intricacies of livestock farming was limited. This lack of knowledge extended to practices like the immediate separation of calves from their mothers, artificial insemination, and the shortened lifespan of dairy cows under intensive farming conditions. We found that the perception of innovative practices such as prolonged cow-calf contact and the use of nurse cows was generally positive among consumers, but this perception was not necessarily backed by a deeper understanding of these practices. Despite this, these innovative practices were perceived as more aligned with consumers' ethical and animal welfare considerations, thereby encouraging a higher WTP.

These findings have significant implications for brands' communication and marketing strategies associating themselves with animal welfare and sustainable practices. Providing accurate and accessible information about livestock farming practices, both traditional and innovative, can boost consumers' knowledge, positively impact their perception, and enhance their WTP for products linked with ethical and sustainable practices.

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Supporting the Apulian regional development through sustainable post xylella regeneration strategies: an AHP-ADAM approach

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KEYWORDS
Regional development; food supply chain; regeneration; xylella fastidiosa; Multi Criteria Decision Making method

INTRODUCTION
The Apulia region is characterized by the predominant presence of olive groves. In fact, the Apulian economy, landscape and society are based on the olive supply chain. Olive farming in the southern province of Puglia accounts for about 40% of Italy's olive oil production (ISTAT, 2015). In 2013 in southern Apulia, Salento area, the pathogen *Xylella fastidiosa* subspecies *pauca* was detected for the first time in Europe on olive trees (Bragard et al., 2019; Zarco-Tejada et al., 2018). The devastating spread of the pathogen caused the death of almost all olive trees in the area, and to date its diffusion is still ongoing (Bollettino Ufficiale Regione Puglia n.139). This epidemic represents a complex reality that has impacted the food (olive and olive oil) production, ornamental resources, soil erosion regulation, biodiversity, eco-turism and cultural heritage. The loss of millenarian and centenarian trees, which are the identity of the region and the people, is identified as a massive loss to the history and cultural heritage of the region (Ali et al., 2021).

The scientific literature on the regeneration actions implemented in the Salento area following the epidemic are in line with the results achieved by studies that investigated the best strategies implemented in other shock-affected territories. In particular, it is clear that post-shock regeneration actions can be clustered into three macro-categories: economic, landscape/social/cultural, and environmental.
Sustainable regeneration actions are necessary to be able to restore the balance of the territorial agroecosystem. In recent years, the main strategies at the national and regional levels involve replanting *Xylella fastidiosa* resistant olive cultivars such as *leccino* and *FS-17 "favolosa"* (Vergine et al., 2019). Regeneration processes of olive groves are important from an environmental point of view and for the perception of traditional cultural values of the landscape (Semeraro et al., 2021). However, according to Carpenter's discussion regarding the resilience (Carpenter et al., 2018) the present study intends to investigate which innovative and alternative agri-food chains to olive growing may represent a good opportunity to introduce new economic, social and environmental scenarios.

METHODOLOGICAL FRAMEWORK

In order to identify the best innovative alternative to olive cultivation, from an economic, environmental and social point of view, a three-steps methodological framework was adopted, as shown in figure 1. In a first step, through literature review and direct observation in plant nurseries and agronomical consultancy studies, the criteria and sub-criteria for choosing the best crop and the possible crop alternatives are established.

In particular, three criteria were selected from the literature review: economic, landscape/environmental, social.

The Economic criterion and respective sub-criteria include all aspects related to the impact of regeneration on costs, revenues, and indirect factors: 1) planting costs, 2) maintenance costs, 3) workforce costs, 4) Productivity, 5) market evaluation, 6) national and foreign demand, 7) added value, 8) transformation potential, 9) economic incentives and 10) territorial branding.

The Landscape/Environmental criterion and respective sub-criteria include key aspects of landscape regeneration and impacts on the environment: 1) impact on rural landscape, 2) contribution to biodiversity, 3) water consumption, 4) required use of pesticides/phytopharmaceuticals, 5) delivery of ecosystem services, 6) resilience to shocks, 7) adaptation to climate change , 8) conservation of wildlife, 9) impact on soil fertility, 10) pedoclimatic adaptability.

The social criterion and selected sub-criteria are quite human centered: 1) food security, 2) food safety, 3) cultural heritage preservation, 4) attractiveness of innovative crops, 5) gastronomic innovation, 6) employment/jobs, 7) equitable distribution of value along the supply chain, 8) visual attractiveness for ecotourism purposes, 9) mastery of agronomic techniques, 10) involvement of rural community members (cooperative formation, consortia, local markets...).

The three selected criteria, with their sub-criteria, are often at odds with each other, such as some economically beneficial aspects may conflict with environmental and landscape aspects, the same may happen the other way around. For this reason, a holistic evaluation of all three criteria is deemed useful.

The alternatives are represented by a selection of ten non-traditional crops, which means that these species do not belong to the agricultural tradition of Salento but are adaptable to the soil and climate of the area. Climate adaptability is the basic requirement, otherwise the selection of these ten crops is derived from the most frequent requests in plant nurseries by agricultural enterprises and after research of the various projects proposed by agri-food companies for new crops and new processing plants in different public funding calls. The species selected are: Avocado, Papaya, Mango, Apple, Pistachio, Walnut, Chestnut, Kiwi, Citrus (lemon, tangerine, orange), Carob.

In a second step, a weight is assigned to each sub-criterion using Analytical Network Process (ANP). Based on the judgements expressed by a panel of experts, composed by 20 university professors with interdisciplinary subject matter expertise (botanists, agronomists, economists, etc), each crop was weighted and ranked through the Analytic Network Process (ANP).

The latter is one of the most popular methods of Multi-Criteria Decision Making (MCDM), which generalizes the Analytic Hierarchical Process (AHP) by replacing hierarchies with networks (Chung et al., 2005). The Analytical Network Process ANP is based on the consideration that many decision problems cannot be structured hierarchically because they involve interaction and dependencies among decision elements, is a transdisciplinary explanatory theory of reality; in fact, it considers different levels of information that are related to each other according to a predetermined order, permeating the assessment of structure and continuity (Bottero et al., 2008). ANP provides to quantifying the weights of each criterion and alternative by evaluating qualitative and quantitative aspects and interdependencies. In order to carry out the ANP, the software *SuperDecision* was used, allowing for the definition of the structure model.

Lastly, priority determination of the alternatives is performed through the ADAM method, a new class of MCDM techniques, known as geometric MCDM (Krstić et al., 2023; Agnusdei et al., 2023), which rates alternatives by computing the volumes of complex polyhedra made up of points (vertices) in a three-dimensional coordinate system as an aggregate measurement. The value of each single alternative is based on the opinions expressed by a diversified panel of agricultural entrepreneurs (using a scale from 1 to 7) and on the weight attributed to each criterion in the previous step.

The volume of complex polyhedra defined by the reference and weighted reference points were obtained using the ADAM software package developed by Krstić and Kovač (n.d.).

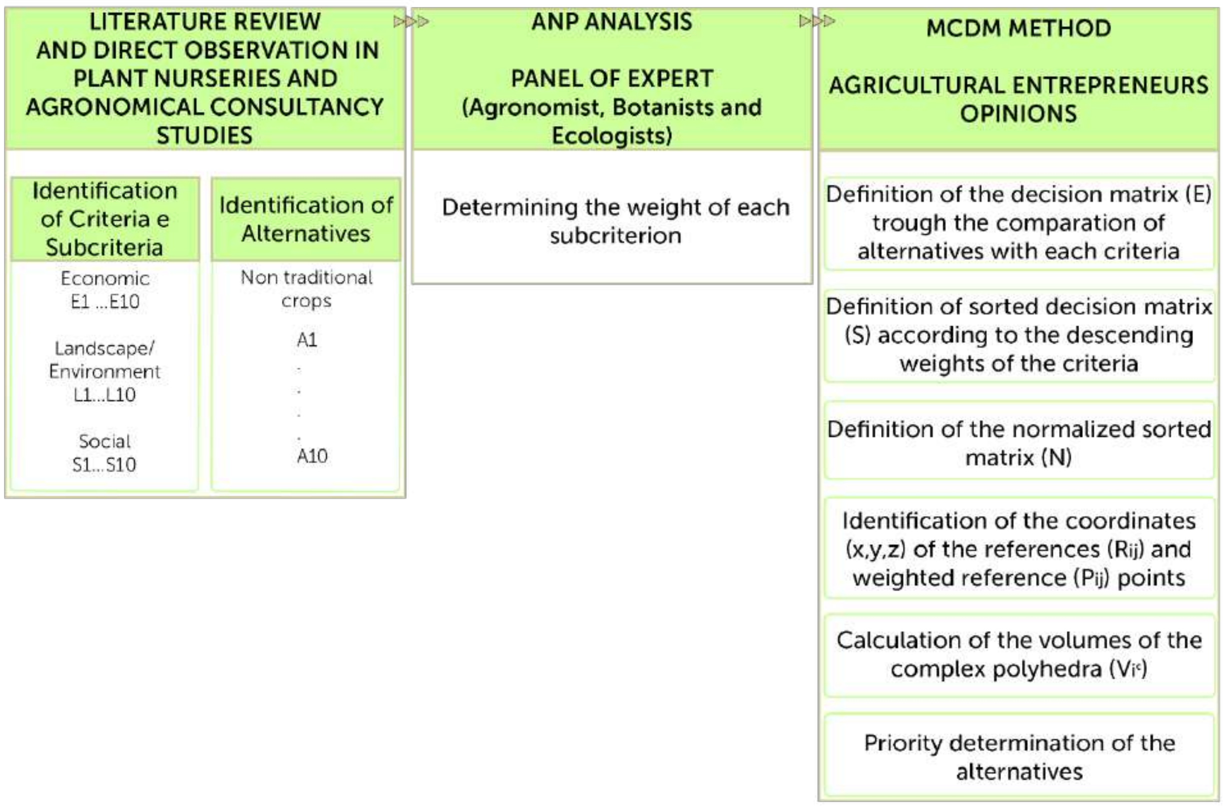

Figure 1 – Methodological framework

PRELIMINARY RESULTS AND CONCLUSION

Through ANP analysis, the inner and outer dependencies between the critical factors evaluated by the panel of experts are considered. Moreover, in order to reveal the best alternative, the best cultivation to be implemented in order to achieve objectives of landscape, economic and environmental regeneration, based on the above identified subcriteria, the ADAM method was applied. The alternatives are assigned a final ranking by arranging them in descending order based on the values of the corresponding polyhedron volumes. The results highlight that the first position in the ranking was assigned to A9, Pistachio. The latter is considered the best crop to ensure regeneration of the area affected by the shock. The latter is considered the best crop to ensure the regeneration of the area affected by the shock. The pistachio adapts favorably to being cultivated in calcareous and rocky soils. This means that, not only could it be grown in land that previously housed olive groves, but it would be suitable for many rocky lands that currently cannot host any crops. Additionally, pistachio has low water requirements and can be grown with relief irrigation only. It is not a particularly sensitive plant to phytopathogens, therefore the use of pesticides can be minimized. The planting costs are acceptable as are the labor costs. The harvest, in fact, can be both mechanized and manual and takes place in a period favorable to finding manpower as it is out of season compared to many other crops typical of the reference area. The yield in terms of quintals/hectare is higher than almost all the alternatives. Furthermore, above all the Italian pistachio is in great demand both on the national and international markets with average market prices that allow excellent returns, especially in the case of products with territorial brands that trace the entire supply chain. The MCDM method represents a support tool for decision-making processes applicable in various fields, in this case it proves useful because it considers and balances the various crucial aspects of the agri-food chain. Sometimes one criterion tends to prevail over another, in this specific case study, for example, the serious economic problems that the epidemic has caused to agri-food companies could be a reason to give extreme priority to new entries rather than the regeneration of the landscape or environmental aspects. Conversely, the launch of new supply chains designed exclusively with a logic of renaturalization are often not supported by assessments of market opportunities and therefore economically disadvantageous. The expected result from the completion of this study is to obtain scientific evidence that orient agricultural policies at the local level and direct public funding for replanting towards alternative crops that represent a concrete opportunity for the economic, environmental and social regeneration of Salento.

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CROP SELECTION TOOL FOR THE RESILIENCE OF THE SALENTO AREA AFTER THE XYLELLA FASTIDIOSA OUTBREAK: A DECISION SUPPORT SYSTEM FOR FARMERS

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KEYWORDS
Crop selection; resilience; decision support; Anayltical Network Process - ANP; Axial Distance-based Aggregated Measurement - ADAM

INTRODUCTION

Rural areas are periodically subject to significant shocks with heavy environmental, economic and social repercussions. Hence, developing useful solutions aimed at ensuring the continuity of the agricultural and agro-industrial systems, the resilience and/or the regeneration of these areas, represent a fundamental need for local communities.

Recently, the pathogen *Xylella fastidiosa* has profoundly changed the Salento area by drying up hundreds of thousands of olive trees, in particular of the Ogliarola cultivar, desertifying the territory. This circumstance has stimulated farmers to replace dried olive trees with resistant olive cultivars (Leccino and Favolosa/FS17) which, however, require irrigation for optimal productivity and emergency irrigation in the summer. By replacing the entire hectares covered by dead olive trees with the resistant Leccino and Favolosa cultivars, the territory would suffer consistent water resource depletion and a consequent competition between different water uses, with a potential increase in the price of water, effectively preventing a sustainable and resilient regeneration of the Salento agriculture.

Diversifying and selecting the appropriate alternative crop to cultivate is a crucial decision for farmers, as it directly impacts their agricultural productivity and economic outcomes (Rivera-Padilla, 2020). Crop selection is a critical aspect of agricultural planning, involving the identification of crops that best match the environmental conditions, market demands, and overall sustainability objectives (Lee *et al*., 2016). By making informed decisions about crop selection, farmers can enhance their competitiveness, profitability, and resilience to various challenges in the agricultural sector (Samantaray *et al*., 2023).

The present study aims at developing a decision support system (DSS) which can help farmers to select, among some crops anciently established in the affected area, the best ones suitable for cultivation based on criteria referring both to contextual factors and the specific intentions of the farmers.

The crop selection tool (CST) is based on expert knowledge and has a user-friendly interactive interface. It combines a multi-criteria decision-making (MCDM) based expert system and participatory approach. It uses expert-defined criteria, interrelations, and the Analytical Network Process (ANP) method for criteria weights, and the Alternative Decision Analysis with Personalized criteria Tuning (ADAPT) – Axial Distance-based Aggregated Measurement (ADAM) approach to rank crops.

The tool should allow farmers to make decisions based on their own capabilities, evaluations and estimations, but supported by the pool of knowledge integrated within it. It can stimulate the implementation of regeneration-based solutions, able to ensure the continuity of the agricultural sector, to create a profitable chain for farmers, oriented, at the same time, towards conservation and protection of rural areas, disincentivizing passive income from agricultural land.

The remainder of the paper provides the theoretical background of the crop selection problem with an emphasis on the application of MCDM to solve it. After that, the proposed methodology is described in detail, after which its application is demonstrated. At the end, there is a discussion with concluding considerations and directions for future research.

THEORETICAL BACKGROUND

The process of diversifying and strategically choosing the most suitable alternative crops to cultivate holds immense significance for farmers, exerting a direct and profound influence on both their agricultural productivity and ensuing economic outcomes (Aziz *et al*., 2022). Within the realm of agricultural planning, the meticulous selection of crops assumes a position of paramount importance, encompassing the nuanced task of pinpointing crops that harmonize seamlessly with prevailing environmental conditions, align with prevailing market demands, and align with overarching sustainability goals (Lee *et al*., 2016). This intricate process of discerning the optimal crop varieties entails multifaceted considerations, extending beyond mere yield potentials to encompass factors such as resource efficiency, ecological compatibility, and socio-economic resonance.

Empowered by well-informed decisions regarding crop selection, farmers unlock the potential to elevate their competitive edge, amplify their profitability margins, and fortify their capacity to navigate the diverse spectrum of challenges inherent in the agricultural domain (Samantaray *et al*., 2023). By embracing a judicious approach to crop diversification, agricultural practitioners position themselves to not only mitigate risks associated with climatic fluctuations and market volatilities but also to leverage emerging opportunities that arise within the evolving agricultural landscape (Chen *et al*., 2023). In essence, the strategic curation of alternative crops stands as a cornerstone of prudent agricultural strategy, bolstering the resilience of farming systems and steering them towards sustainable trajectories of growth and prosperity (Calicioglu *et al*., 2019).

In the literature different approaches for solving the problem of crop selection can be found. Some of the most popular are MCDM methods (Mardani *et al*., 2023), linear programming and optimization models (Dayananda *et al*., 2021), heuristics (Adekanmbi and Green, 2014), expert systems (Managave and Kumbhar, 2019), machine learning and data driven approaches (Meshram *et al*., 2021), crop simulation models (Divya *et al*., 2021) and participatory approaches (van Etten *et al*., 2019), etc. The CST proposed in this study combines several of these approaches. It uses an MCDM-based expert system in combination with a participatory approach.

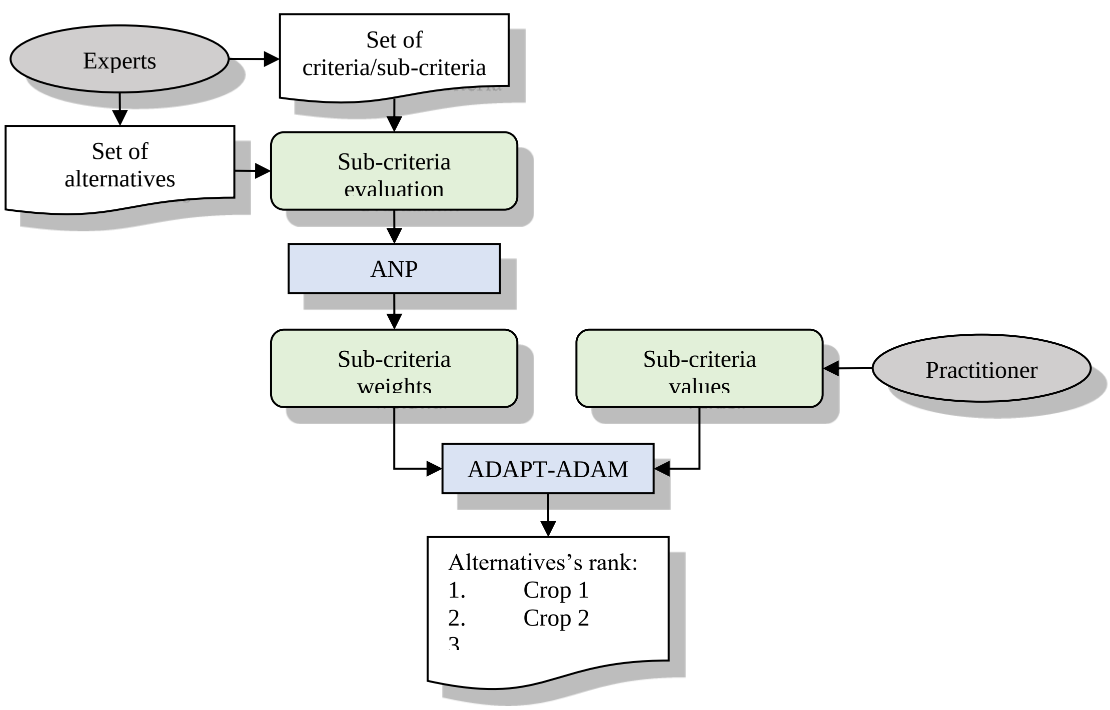
Traditionally, using MCDM for crop selection implies establishment of a set of predefined criteria, assuming equal importance for all of them (e.g. Cobuloglu and Büyüktahtakın, 2015). However, this oversimplified approach fails to consider the crop-specific variations in criteria importance, potentially leading to suboptimal decisions. To account for the varying importance of criteria in crop evaluation, a systematic approach is required. One potential approach involves assigning weights to each criterion based on its relative importance for each crop. These weights can be obtained through combination of expert knowledge and MCDM methods. Expert opinions can offer valuable insights into crop-specific requirements and the significance of various criteria (e.g. Hudait and Patel, 2022). MCDM methods can provide quantitative measures for criteria importance based on expert opinions.

This paper proposes a combination of ANP and an innovative extension of the ADAM method (ADAPT-ADAM). The ANP (Saaty, 1996) accommodates complex interdependencies and feedback loops among criteria, providing a more realistic representation of real-world scenarios (Velasquez and Hester, 2013). ANP's ability to handle both quantitative and qualitative factors enhances its versatility, ensuring a comprehensive evaluation. ANP's capability to handle a diverse range of criteria and its focus on mutual influences sets it apart from less adaptable techniques. Its applicability has been widely proven by solving problems from various fields (Taherdoost and Madanchian, 2023). The ADAM method (Krstić *et al*. (2023) evaluates alternatives based on complex polyhedra formed by criteria weights and values. It offers simplicity, low rank reversal risk, and intuitive graphical representation via polyhedra volume calculations. ADAM's stability and reliability have been proven by solving various problems (Agnusdei *et al*., 2023; Kovač *et al*., 2023).

METHODOLOGY – CROP SELECTION TOOL

The CST proposed in this study combines MCDM-based expert system with a participatory approach. The pool of experts establishes the sets of evaluation criteria for each crop, identifies the interrelations among the criteria, but also between the criteria and specific crops, and evaluates the criteria. The ANP method is used to obtain the criteria weights according to the experts' evaluations. The users (farmers) provide the values of the criteria, after which ADAPT-ADAM approach ranks the crops taking into account both the criteria weights derived by the expert pool and the values provided by the users. Upon receiving the farmers' input, the CST utilizes the assigned weights for each criterion to calculate a suitability score for each crop. The suitability score represents the overall compatibility of a particular crop with the provided criteria values. The tool then generates a ranked list of crops, with the highest-scoring crop(s) recommended as the most suitable option(s) for cultivation. The general overview of the CST is presented in Figure 1.

Figura 1 – Outline of the CST



Step 1: Identify alternatives (crops), as well as criteria and sub-criteria for their evaluation.

Step 2: Establish dependencies between the elements of the problem structure (criteria, sub-criteria and alternatives).

Step 3: Establish alternative-specific criteria weights by applying the ANP (Saaty, 1996) method.

Step 3.1: Form the criteria weighting matrices based on the established dependencies for each crop. The experts' panel utilizes pairwise comparisons on a 1 to 9 scale to determine the relative importance of criteria. The general representation of the matrix is:

$$\boldsymbol{A}=\begin{bmatrix} \mathbf{1} & \boldsymbol{a_{12}} & \cdots & \boldsymbol{a_{1n}} \\ \mathbf{1}/\boldsymbol{a_{12}} & \mathbf{1} & \cdots & \boldsymbol{a_{2n}} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{1}/\boldsymbol{a_{1n}} & \mathbf{1}/\boldsymbol{a_{2n}} & \cdots & \mathbf{1} \end{bmatrix} \tag{1}$$

where a_{ij} indicates the relative importance of the element (criteria, sub-criteria) i over element j $(i, j = 1, \dots, n)$.

Step 3.2: Check the comparison consistency of all matrices using the following equation:

$$\boldsymbol{CR = CI/RI} \tag{2}$$

$$\boldsymbol{CI} = \frac{\boldsymbol{\lambda_{max} - n}}{\boldsymbol{n-1}} \tag{3}$$

where CR indicates the consistency ration which is acceptable if its value is less than 0.1, CI indicates the consistency index, RI indicates random index and λ_{max} is the maximum eigenvalue.

Step 3.3: Construct the initial supermatrices. The general depiction of the three-level hierarchy of the supermatrix is as follows:

$$\boldsymbol{W} = \begin{array}{c c} & \begin{array}{ccc} \boldsymbol{G} & \boldsymbol{C} & \boldsymbol{A} \end{array} \\ \begin{array}{c} \boldsymbol{G} \\ \boldsymbol{C} \\ \boldsymbol{A} \end{array} & \begin{bmatrix} \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{W_{CG}} & \boldsymbol{W_{CC}} & \mathbf{0} \\ \mathbf{0} & \boldsymbol{W_{AC}} & \boldsymbol{I} \end{bmatrix} \end{array} \tag{4}$$

where W_{CG} indicates the eigenvector of the evaluation matrix of the influence of the goal on the criteria, the W_{CC} indicates the eigenvector of the evaluation matrix of mutual influence among criteria and sub-criteria, the W_{AC} indicates the eigenvector of the evaluation matrix of influence of the criteria and sub-criteria on each of the alternatives, and I is the identity matrix.

Step 3.4: Obtain the limit supermatrices. By raising each of the supermatrices to the power of $2p + 1$, with p being a significantly large number, the matrix undergoes convergence. Obtained converged values are adopted as alternative-specific criteria weights (w_j).

Step 4: Obtain the alternatives (crops) ranking using the novel ADAPT-ADAM method. ADAM method (Krstić *et al*., 2023) takes into account the decision makers' (DM) (practitioners') values and alternative-sensitive criteria weights (different set of weights for each alternative) according to the ADAPT approach and forms decision matrices. The aim of the ADAPT approach is to handle the variability of criteria weights across alternatives by allowing decision-makers to specify different weights for each alternative. This approach recognizes that different alternatives may have distinct characteristics or attributes that warrant different levels of importance for specific criteria. Having that in mind, the alternatives' values based on which they can be ranked are not obtained simultaneously, but rather individually and then compared to obtain the ranking. The ADAM calculates volumes of complex polyhedra defined by the criteria weights (expert-based) and criteria values (practitioner-based) for each alternative, ranks them based on the obtained results (volumes) and proposes the best solution (crop).

The detailed steps of the ADAPT-ADAM method are obtained by modifying the original ADAM steps. Their description is provided below.

Step 4.1: Define the decision matrix composed of DM's (practitioner's) evaluations of the criteria j ($j = 1, \dots, n$):

$$\boldsymbol{E} = [\boldsymbol{e_j}]_{\mathbf{1}\times\boldsymbol{n}} \tag{5}$$

where n is the total number of criteria.

Step 4.2: For each alternative define the sorted decision matrix:

$$\boldsymbol{S_k = [s_j]_{1\times n}, \forall k = 1, \dots, m} \tag{6}$$

where m is the total number of alternatives k and s_j are obtained by arranging the evaluations e_j in the descending order according to the alternative-sensitive criteria weights obtained in Step 3.

Step 4.3: For each alternative define the normalized sorted matrix:

$$\boldsymbol{N_k = [n_j]_{1\times n}, \forall k = 1, \dots, m} \tag{7}$$

where n_{kj} are obtained as:

$$\boldsymbol{n_k} = \begin{cases} \dfrac{s_j}{\max\limits_k s_j}, & \boldsymbol{for\ j \in B} \\ \dfrac{\min\limits_k s_j}{s_j}, & \boldsymbol{for\ j \in C} \end{cases} \tag{8}$$

where B and C are the sets of benefit and cost criteria, respectively.

Step 4.4: For each alternative obtain the values:

$$\boldsymbol{V_k^C = \sum_{j=1}^{n-1} V_k, \forall j = 1, \dots, n} \tag{9}$$

where:

$$\boldsymbol{V_k = \frac{1}{3} B_k \times h_k, \forall k = 1, \dots, n-1} \tag{10}$$

in which:

$$\boldsymbol{B_k = c_k \times a_k + \frac{a_k \times (b_k - c_k)}{2}} \tag{11}$$

$$\boldsymbol{a_k = \sqrt{(x_{j+1} - x_j)^2 + (y_{j+1} - y_j)^2}} \tag{12}$$

$$\boldsymbol{b_k = z_j} \tag{13}$$

$$\boldsymbol{c_k = z_{j+1}} \tag{14}$$

and

$$\boldsymbol{h_k = \frac{2\sqrt{s_k(s_k - a_k)(s_k - d_k)(s_k - e_k)}}{a_k}} \tag{15}$$

$$\boldsymbol{s_k = \frac{a_k + d_k + e_k}{2}} \tag{16}$$

$$\boldsymbol{d_k = \sqrt{x_j^2 + y_j^2}} \tag{17}$$

$$\boldsymbol{e_k = \sqrt{x_{j+1}^2 + y_{j+1}^2}} \tag{18}$$

where x, y and z are indicating the coordinates of the reference (R) and weighted reference points (P) obtained in the following way

$$\boldsymbol{x_{kj} = n_{kj} \times \sin \alpha_j, \forall j = 1, \dots, n;\ \forall k = 1, \dots, m} \tag{19}$$

$$\boldsymbol{y_{kj} = n_{kj} \times \cos \alpha_j, \forall j = 1, \dots, n;\ \forall k = 1, \dots, m} \tag{20}$$

$$\boldsymbol{z_{kj} = \begin{cases} 0, for\ R_{kj} \\ w_j, for\ P_{kj} \end{cases}, \forall j = 1, \dots, n;\ \forall k = 1, \dots, m} \tag{21}$$

$$\boldsymbol{\alpha_j = (j-1)\frac{90°}{n-1}, \forall j = 1, \dots, n} \tag{22}$$

Step 4.5: Rank the alternatives (crops) according to the decreasing values of V_k^C $(k = 1, \dots, m)$.

Step 5: Validate the results. Provide the degree of reliability of the proposed solution as an average value of the Spearman Correlation Indices obtained by comparing the results obtained in the previous steps with the results obtained by other relevant MCDM methods (such as TOPSIS, VIKOR, SAW, and COPRAS), as well as with the results obtained by varying the criteria weights (performing sensitivity analysis).

CST TOOL APPLICABILITY DEMONSTRATION

The preliminary outline of the CST interface is presented in Figure 2 and 3.

Figura 2 – Data input interface for farmers

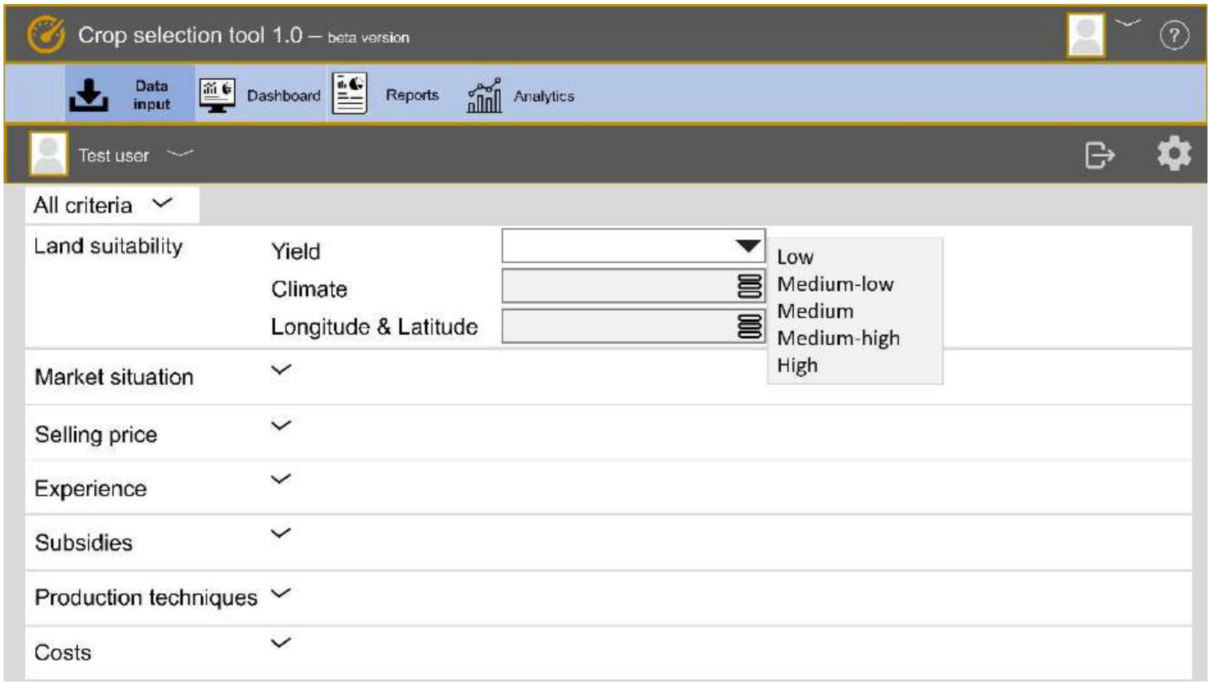
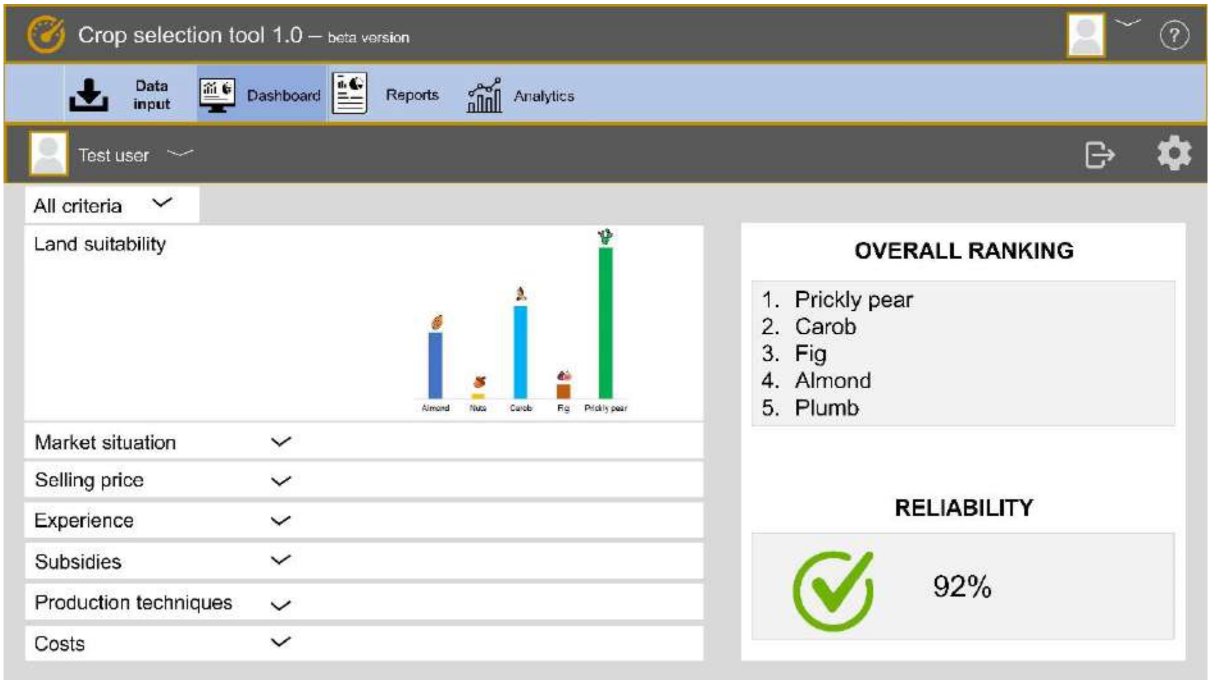


Figura 3 – Dashboard interface for farmers



The functionality of the CST was tested on a case that took into account 15 sub-criteria belonging to one of the 7 criteria groups (Table 1), and 10 crops, namely almond (P_1), nuts (P_2), carob (P_3), fig (P_4), prickly pear (P_5), pomegranate (P_6), citrus fruit (P_7), chestnut (P_8), plumb (P_9), and vines (P_{10}).

Table 1 – Criteria/sub-criteria for the crop suitability evaluation

Criteria		Sub-criteria	
Land suitability	C_1	Yield	C_{11}
		Climate	C_{12}
		Longititude & latitude	C_{13}
Market situation	C_2	Marketing	C_{21}
		Export	C_{22}
		Competition	C_{23}
Selling price	C_3	Selling price	C_{31}
Experience	C_4	Experience	C_{41}
Subsidies	C_5	Sapling support	C_{51}
		Irrigation support	C_{52}
		Credit support	C_{53}
		Subsidies	C_{54}
Production techniques	C_6	Irrigation systems	C_{61}
		Engineer recommendation	C_{62}
		Machinery	C_{63}
Costs	C_7	Labor costs	C_{71}
		Input costs	C_{72}

After applying the steps 1-3 from the CST procedure, the alternative-sensitive criteria weights are obtained. Three farmers (F_1, F_2 and F_3) then provided values for the criteria and the steps 4 and 5 of the tool procedure were applied. Table 2 presents the best ranked crops according to each farmer with the corresponding degrees of reliability. According to the results F_1 would select to grow carob, F_2 plumb, and F_3 fig.

Table 2 – Results of the CST test case

		P_1	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**	**P_8**	**P_9**	**P_{10}**	**Reliability (%)**
F_1	Value	0.693	0.517	1.000	0.966	0.903	0.524	0.400	0.395	0.376	0.329	92.1
	Rank	4	6	1	2	3	5	7	8	9	10	
F_2	Value	0.695	0.645	0.623	0.685	0.719	0.625	0.872	0.872	1.000	0.756	80.8
	Rank	6	8	10	7	5	9	2	3	1	4	
F_3	Value	0.904	0.930	0.986	1.000	0.987	0.898	0.530	0.588	0.576	0.663	88.8
	Rank	5	4	3	1	2	6	10	8	9	7	

CONCLUSION

Incorporating variable criteria importance into crop evaluation offers several advantages over traditional approaches. Firstly, it allows for a more realistic and precise assessment of crop suitability, aligning with the unique characteristics of each crop. Secondly, it enhances the decision-making process by providing a comprehensive understanding of how different criteria contribute to the overall evaluation. This knowledge empowers agricultural practitioners (farmers) to prioritize resources and make well-informed choices tailored to specific crop requirements. Additionally, considering variable criteria importance promotes sustainability by ensuring the efficient allocation of resources, reducing wastage, and maximizing productivity.

While the CST provides valuable assistance, certain limitations should be acknowledged. The tool heavily relies on the accuracy and relevance of the assigned criterion weights, which themselves are subject to evolving agricultural practices and changing market dynamics. Continuous collaboration among experts, researchers, and farmers is essential to regularly update the weights and ensure the tool's relevance. Future enhancements could involve integrating machine learning algorithms to analyze historical data and extract patterns, thereby improving the accuracy of the CST. Moreover, incorporating real-time market data and climate forecasts could enable the tool to adapt to dynamic agricultural conditions and enhance decision-making capabilities further.

The CST offers a valuable resource for farmers seeking guidance in choosing the most suitable crop(s) for cultivation. By utilizing multiple criteria with expert-derived weights and allowing farmers to input their own values, the tool provides personalized recommendations that align with individual requirements. By employing this tool, farmers can optimize their crop selection process, improve agricultural productivity and achieve their farming goals more effectively.

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Does information on improved working conditions in the Amadori farms affect consumers' preferences? An application of discrete choice experiment on consumers from the Emilia-Romagna region.

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Keywords
consumers' preferences; choice experiment; brand equity; technological innovations; worker conditions; animal welfare

Introduction

Sustainable food has gained increasing importance in the framework of political discourse on sustainable food system as the rise in food production and consumption and the vulnerability of natural resources add weight to the call for a shared understanding in sustaining the natural capacity of natural ecosystems to provide food (UNEP, 2016; Olson, Clay, & da Silva, 2014).

The sustainable food issues are also introduced in the market, either as consumer concerns or by the pressure of NGO's on stakeholders in the supply chain (Kalshoven & Meijboom, 2013). Consumers are becoming increasingly aware of the environmental and social implications of their purchasing decisions. To make more responsible purchasing choice, consumers need to receive more information about products (Chiara, 2015; Nguyen-Viet, 2022). As a result, businesses became more proactive for improving the environmental and social performance of their products and building brand equity (Chen, 2010), which creates a sustainable competitive advantage for the company (Akturan, 2018). Brand equity represents the value that a brand adds to a product and it plays a vital role in creating distinctive differentiation that gives rise to competitive advantages through non-price competition (Aaker, 1991). Based on the consumer-based conceptualizations of several authors brand equity constitutes a perceived added value that a brand gives to a product (Aaker 1991; Farquhar 1989; Keller 1993; Davcik, et al., 2015).

Despite considerable interest in brand equity, there has been a lack of empirical research addressing the specific marketing activities that contribute to its formation (Barwise, 1993).

Achieving competitiveness means embracing a new mindset that prioritizes process optimization, while respecting the environment. In this context, investing in emerging technologies not only increases productivity, but also creates better working conditions, which are essential for attracting and retaining a skilled workforce (Fragapane et al., 2022).

According to previous literature on consumer acceptance of food technologies, it is argued that technological innovations play an important role on consumer choices, but the effect of technological development on consumer acceptance of all food-related technologies is not still clear (Boccia et al., 2016; Frewer, 2017).

Previous studies contributed to the problem by investigating the impact of brand equity on purchase intent (Akturan, 2018; Saeed & Shafique, 2021). However, there has not been any study that has examined brand equity dimensions and quantified brand equity enhancement based on communicating better working conditions to consumers.

For this reason, this paper sets out to further investigate whether there is a possible increase in brand value as a function of communicating changed working conditions and well-being to consumers. In particular, it explores the role played by information relating to the adoption of technological innovations that improve worker well-being conditions and animal welfare and if it play a positive and significant impact on consumers' purchase intentions.

In summary, we intend to answer, for the first time in the literature to our knowledge, the following research question:

1. What is the effect of brand names on their brand equity dimensions?
2. Is there an increase in brand value as a function of communicating the changed working conditions in the farms to consumers?

To answer our research questions, we conducted an online survey in Italy with 663 participants using a questionnaire that included a choice experiment (CE). Through a choice experiment, we investigate the effect of brand names on their brand equity dimensions and the quantification of any increase in brand value based on the communication to consumers of improved working conditions and welfare.

To assess the effect of the innovation on brand equity, the sample was randomly divided into two groups: the first provided with information on the consequences on employee well-being of the implementation of the adopted technology solution (treatment), and the second not provided with information (control).

Therefore, our study is, to our knowledge, the first to examine whether the implementation of innovation affects consumer choice behavior towards product alternatives that differ in price, brand, and production method.

The findings of the study could provide insights for firms and marketers interested in understanding the factors that shaping consumer behavior towards more responsible products.

Data and Method

Data collection

To answer the research questions, we carried out an online questionnaire among a sample of Italian consumers. The online survey method allows for easier collection and processing of data. Furthermore, online questionnaires offer a dynamic pool of options for designing questions.

Data was collected during October 2022 online using Qualtrics' platform. Participants from the Emilia-Romagna region (Italy) were recruited through a market research agency and 663 valid questionnaires were obtained out of 1,935 accesses to the questionnaire link.

The survey was tested on 20 randomly recruited respondents to determine the clarity of our questions and the quality of the responses in the CE.

Consumers responding to the questionnaire were informed about the respect of the privacy and anonymity of their answerer.

Before starting the questionnaire, consumers were selected using screening questions. The *"condition sine qua non"* were: (1) the legal age in Italy (at least 18 years old), (2) being aware of the Amadori brand (3) living in the Emilia-Romagna region, (4) being responsible for household grocery purchases, (5) and consuming chicken meat at least once per month.

Respondents who did not meet the five conditions were excluded from participating in the survey. Furthermore, those who always answered "no buy" in the choice experiment were eliminated.

The questionnaire included questions aimed at investigating:

- Respondents' purchasing habits regarding meat in general and chicken meat specifically regarding the brand.
- Perception of the quality of the Amadori brand measured with a Likert scale of 5 levels (1: not at all agree - 5: very agree)
- Perception of Amadori brand equity with a Likert scale of 5 levels (1: not at all agree - 5: very agree)
- Hypothetical choice experiment based on the same type of product identified before (1 kg chicken breast pack) but associated with variable levels of attributes (price, brand, production method). The choice options considered were:
    - the price range: 8.9-13.9-18.9-23.9 starting from the average price of chicken breast indicated by preliminary market research.
    - 4 types of brands: Amadori, Fileni, Aia, and distributor brands.
    - production methods: organic, free-range, cage-free, and standard production methods.

The final part of the questionnaire presented questions about sociodemographic characteristics of the sample, such as gender, age, household members, number of children in the household, education, and income levels.

Choice experiment design

Discrete Choice experiments (DCEs) are widely used in food policy studies because they allow for estimating the welfare effects of policy implementation and individuals' marginal utility and willingness to pay (WTP) for different labeling strategies (Costanigro et al., 2019; Lusk, Tonsor, Schroeder, & Hayes, 2018; Maples, Lusk, & Peel, 2018; Van Loo, Caputo, Nayga, & Verbeke, 2014). Furthermore, the advantage of using DCE compared to different methods to elicit preferences, such as contingent valuation and laboratory auctions, is that it allows preferences for different attributes to be estimated at the same time and is similar to the decision-making mechanism that individuals may experience in real-life purchase contexts (Cerroni, Watson, Kalentakis, & Macdiarmid, 2019; Grebitus, Lusk, & Nayga, 2013; Shi, Gao, House, & Heng, 2015).

DCEs are based on the Lancaster theory of consumer choice (Lancaster, 1966) and the random utility theory (RUT) and considers the assumption that alternatives are exhaustive, mutually exclusive, and finite (Train, 2009).

Table 1. Attributes and attribute levels were used in the choice experiment.

Attributes	Attribute levels
Brand	- Amadori -Aia - Fileni - Distributor brand
Production method	- Organic - Free range - Cage-free - Standard
Price	- €8.90 - €13.90 - €18.90 - €23.90

As a first step towards designing our DCE, we selected the product under consideration, chicken breast fillets. The choice of this product can be explained by the fact that it is a product with a high variety of qualitative cues and therefore suitable for answering one of our research questions.

In the second step, we selected the attributes and levels of our DCE (Table 1). Three attributes were selected (brand, production method, and price).

The first attribute, brand, was selected because the main objective of this study is to understand how the top-of-mind brand can affect consumers' preferences and WTP for chicken breast. Thus, four brands were considered "Amadori" with headquarters in Emilia-Romagna and a well-known brand in Italy for chicken production; "Aia" an Italian brand specialized in meat and egg production; "Fileni" another Italian brand specialized in meat production; "Distributor" brand.

The second attribute is the production method as studies have shown that this is an important characteristic for consumers when purchasing meat, especially chicken meat. The demand for more sustainable production methods for chicken has increased significantly in the last decade, providing new opportunities for producers to differentiate their products. These labels are also often perceived as indicating healthier alternatives. Specifically, four levels of production method included organic, free-range, cage-free, and standard. These levels differ from each other in terms of type of feed, antibiotic usage and the environment in which chicken is raised, in order to capture different aspects of sustainability.

The third attribute is price, which has four levels that cover the range of market price for 1 kg of chicken breast fillets in Italy.

In order to obtain the choice sets, Ngene 1.1.1 was used to design an optimal orthogonal design (OOD). The OOD maximizes the differences in the attribute levels across alternatives, consequently, the information obtained from respondents answering SC surveys by forcing trading of all attributes in the experiment is maximized. OOD are orthogonal within an alternative but have (often perfect negative) correlations across alternatives (Street et al., 2005).

In order to avoid confounding between the constants of the baseline and the constants of the model, effects coding was used in the design of the model (Bech and Gyrd-Hansen, 2005). The utility function for the design was:

$$U = f\,\{Price,\ Brand,\ Production\ method,\ \varepsilon\}$$

Ngene generated 8 choice tasks with 4 alternatives each, where 4 alternatives comprised the chicken breast fillets with one level for each attribute and the fourth alternative was the "opt-out" option. Choice sets alternatives within each choice set, except the opt-out option, were randomized to avoid any ordering effect. Before starting the choice task, participants were randomly assigned to one of the above-mentioned treatments.

Fig.1 Example of a hypothetical choice scenario

In order to identify whether information on the new production methods introduced by Amadori affects consumer preferences towards the Amadori brand, participants were randomly introduced to the following information before being subjected to the discrete choice experiment task: "Amadori has incorporated 'smart farming' into its meat production activities. This term refers to the use of technology to monitor and facilitate the execution of production activities on farms. Environmental sensors have been installed that record, within pilot farms, the temperature of the boxes, the weight, and the temperature of the chickens. This technology makes it possible to increase the well-being of both animals and workers. The analysis of the data recorded by the sensors for precision monitoring makes it possible to assess the health and growth of the animals and to prevent any stress or diseases. The ability to monitor herds remotely increases the quality and safety of work for farmers, who can limit visits to the stalls and better manage working time."

Results

As Table 2 shows, the respondents appreciate the value of the product and prefer to buy one of the alternatives offered rather than none of them. The coefficient of price is significant and negative (-0.13), which confirms that the participants prefer a low-price product. With regard to the brand, Amadori is the preferred brand (coefficient 0.12) compared to other national brands such as Aia and Fileni, and even more so compared to the distributor brand. Regarding the production method, the organic method is widely preferred (coefficient 0.67) over all other methods.

Tab 2. Consumer preferences towards different attributes

Attributes	Levels	Coefficients
Alternative	Alternative 1	3.05***
	Alternative 2	3.23***
	Alternative 3	3.02***
	Alternative 4	3.03***
Price	Price	-0.13***
Brand	Amadori	0.12***
	Aia	-0.07*
	Fileni	-0.02
	Distributors brand	-0.03***
Production method	Organic	0.67***
	Free range	0.14***
	Cage-free	-0.27***
	Standard	-0.54***

Table 3 shows the results obtained considering the information variable and how this information affects consumer preferences. As can be seen, the presence of information increases the preference for the distributor brand, with significant and positive coefficient (0.12).

Tab 3 Consumer preferences obtained considering the information variable

Attributes	Levels	Coefficients
Alternative	Alternative 1	3.05***
	Alternative 2	3.24***
	Alternative 3	3.02***
	Alternative 4	3.03***
Price	Price	-0.13***
Brand	Amadori	0.48***
	Aia	-0.06
	Fileni	0.01
	Distributors brand	-0.43***
Effect of trademark information	Amadori	-0.03*
	Aia	-0.03
	Fileni	-0.06
	Distributors brand	0.12*
Production method	Organic	0.67***
	Free range	0.14***
	Cage-free	-0.27***
	Standard	-0.54***

Discussion and Conclusion

Consumers have a generally positive perception of innovation, but the effect on brand equity is not significant.

The results of the study indicate that consumers generally appreciate the value of the product and prefer to buy one of the alternatives offered rather than none of them. According to our results, consumers prefer a lower-priced product; this is in line with expectations and indicates that participants' choices were made rationally. As for the Amadori brand, according to our results it emerged as the preferred one compared to other national brands such as Aia and Fileni, and even more compared to the retailer's brand. This result is expected, given that the sample interviewed is located in Emilia Romagna, the region where the Amadori company is based and therefore a brand well known to consumers.

Regarding the production method, the organic option is widely preferred over all other methods. Finally, the results of the study demonstrate that information relating to the adoption of technological innovations that improve worker well-being conditions does not have a significant impact on consumers' purchase intentions. This is explainable as the consumer does not perceive a personal benefit from the implemented technology.

Specific field studies are needed (Chamorro & Banegil, 2006), as demand and attitudes towards more responsible products are likely to be inconsistent across market segments and cultures (Ottman, 1993) and vary according to national regulations (Nguyen-Viet, 2022). Furthermore, consumer attitudes toward brand equity vary across countries due to cultural differences (Cui et al, 2008). More research on brand equity functions (Kumar, 2016) should highlight better possibilities based on industry and firm characteristics (Dangelico & Vocalelli, 2017).

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Adoption of technological innovation and farmers' perception in the bakery Italian supply chain

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STATE OF THE ART

Agri-food industries are faced with new challenges concerning the transition of the supply value chain to new technological approaches, by implementing new business models (Vellema & van Wijk, 2015). The risks associated with climate change and the commodity uncertainty require a more resilient food systems based on agricultural processes driven by new techniques and supported by suitable digital tools and advisory network (Boyabatli *et al.*, 2019).

In this regard, the recent regulation 2115/2021 on rural development emphasises the role of AKIS (Agricultural Knowledge and Innovation System), which plays a strategic role in knowledge transfer and innovation adoption (EU SCAR 2019; Masi *et al.*, 2022).

Practices such as crop rotation and crop diversification have become essential for achieving sustainable production models. Crop rotation has recently been introduced as a new requirement within the Good Agricultural and Environmental Conditions (GAEC) under the new Common Agricultural Policy (CAP) 2023-2027. Indeed, trough the GAEC 7, starting from 2024, is introduced the obligation of crop rotation, which means changing the cultivated crop at least once a year at the plot level (National Strategic Plan, 2021). In the first Cap reform Commission proposal was also include as a GAEC the use of Farm Sustainability Tool for Nutrients (European Commission, 2018). This commitment was proposed by Commission to improve the cultivation process efficiency mitigating environmental risks due to nutrient and chemicals pollution (Blasi *et al.*, 2023).

As a result, there is a growing interest in decision support tools that can help farmers in maximize their profits while adhering to sustainability principles. Studies conducted by Britz *et al*., (2012) and De Frahan *et al*., (2016) demonstrate the importance of these tools to support agricultural decisions suitable to promote sustainable practices adoption across agri-food supply chain.

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The Decision Support Systems (DSS) are software systems designed for farmers and farm advisors, that address the use of nutrients, water and pesticides based on local and regional data (Wolfert *et al.*, 2017).

Despite the diffusion of these systems in the last decade, many barriers still exist to their full implementation on a large scale (Renning, 2000) which are more or less relevant depending on the production context, the organization of supply chains and markets, the institutional and norms framework as well on the type of product (Zhai *et al*., 2020). The data required for the use of these models include weather and soil conditions, plant characteristics, and crop management parameters (Zhai *et al*., 2020). However, the complexity involved in managing plot and farms data and the heterogeneity of pedo-climate context affect the identification of clear predictive models parameters. Also, data input operations can sometimes discourage farmers to use properly the tool prevent operators from realizing and easily understand the potential benefits (Blasi *et al*., 2014).

OBJECTIVES

The purpose of this research is to assess the effectiveness and response of farmers to the introduction of an innovation such as decision support systems (DSS) within private initiatives in the bakery products supply chain. The aim is to understand, through the farmers' opinions, which strategies could be more effective in utilizing DSS as part of a stakeholder engagement process and facilitating interactions. The new CAP constraints and private sustainability initiatives both are pushing farmer to make decisions that consider two main aspects: crop rotation and existing regulation aimed to mitigate excessive exploitation of natural resources. According to Matthews *et al*., (2008) one of the key factors for the success of DSS is their simplicity and transparency. For this reason, in the initial phase of the study, it was decided to gather the perceptions of users regarding the adoption of this digital innovation. Secondly, the research focused on estimating the potentially achievable effects by farmers who have followed the tool's advises compared to those who have manage cultivation crops operations follow business as usual practice. The analysis was conducted using technical data provided by a panel of engaged farmers in private sustainable value chain initiative.

DATA/APPROACH

In order to address the questions raised above, an exploratory investigation is presented regarding the application of a Decision Support System based on data from Italian agricultural farms nd current sustainability regulations promoted by public initiatives such as the Common Agricultural Policy (CAP) and private initiatives (promoted by the Barilla Group with the "Carta del Mulino" initiative – CdM). In 2023 the CdM initiative introduces a new rule in supply chain contract, which requires the use of the digital platform "Barilla Farming". All CdM supplier have to use this platform and enter the required data and information to ensure the qualification of environmental impacts related to CO_2 emissions, use of fertilizers, insecticides, and fungicides, and to improve farm management through monitoring agricultural machinery uses and input-output balance across agrarian year. The requested data includes:

- Sustainable wheat plot maps "CdM"
- Flower strips areas maps
- Identification of fields subject to crop rotation
- Identification of selected wheat varieties
- Crop operations
- Herbicide/ fungicide/ insecticide treatments
- Fertilization interventions
- Harvest/yields

The data is organized and subsequently interpreted to provide information, alerts, and operational suggestions for wheat growers.

To understand how the new rule of the regulations has been received, interviews were conducted with stakeholders in the sustainable Mulino Bianco supply chain. The aim was to gather perceptions and opinions regarding the introduction of technology in well-structured farms with high production levels, but which have already been practicing crop rotation for several years. Nine semi-structured interviews were conducted with managers of the stackers involved in the sustainable supply chain of Mulino Bianco brand (Figure 1). Stackers play a pivotal role within the chain, acting as a link between Barilla company, mills and farms. The stacker managers and technician are responsible to enrolled farms in the CdM supply contracts as well as to advise them about the rules and practices that farmers have to adopt to be in compliance with the contract. Each company usually define a network of several farms with different dimensions and structural characteristics, based on the geographical context and related agricultural sector features. The study focuses on the Po-Valley where CdM farms are mostly located. The area included specifically farms, value chain actors and citizens from Piemonte, Veneto, Emilia-Romagna, Lombardia.

Figure 1 – Stackers involved in the interviews.

Tipology	Province		n.Companies	Average area (ha)	Year beginningCdM
Farm with single stacker	PR	Stacker 1	1	45	2019
Consortium	TO, AL, CN	Stacker 2	74	10	2020
Consortium	PC, CR, BS, MN	Stacker 3	15	/	2019
Private	CN	Stacker 4	43	10	2019
Private	TO, AT, CN	Stacker 5	35	20	2019
Private + Mill	BO, FE	Stacker 6	17	60	2019
Private	CN	Stacker 7	25	22	2019
Private	RO, FE, VE, PD	Stacker 8	25	23	2019
Cooperative	RO, FE	Stacker 9	65	20	2019

The interviews allowed gathering the opinions and feedback of farmers regarding the adoption and use of the Barilla Farming platform during the first year of the trial. Furthermore, they helped highlight the main issues and factors influencing the diffusion of innovation from the farmers' perspective.

From the semi-structured interviews (Table 1), emerges that the use of the Barilla Farming Platform has not received a fully positive reception from farmers and also emerges that the age of the farmer, in several cases is a barrier to the use of digital tools. Among the technical and managerial limitations, instead, emerges the greater amount of time required for inputting process data and/or creating partitions/fields by the farmers. The use of the platform is perceived as an additional obligation by farmers who currently cannot perceive its real future benefits. On the contrary, emerges that those with a lower age are more interested in using the platform due to its potential future suggestions.

Table 1 – Summary of the results obtained from the semi-structured interviews.

	n.Farms	n. Farms that use the platform independently	Acceptance of the Rule 5	Problems/limitations
Stacker 1	1	1	Positive	\
Stacker 2	74	10	Negative	Additional commitment
Stacker 3	15	5	Negative	High average age of the farmer
Stacker4	43	4	Positive	High average age of the farmer
Stacker 5	35	0	Negative	Additional commitment and increase workload
Stacker 6	17	2	Negative	High average age of the farmers, distrust in advice
Stacker 7	25	3	Negative	Additional commitment, high average age of the farmers, distrust in advice
Stacker8	25	2	Negative	Increase workload and lack of trust in DSS
Stacker 9	65	0	Negative	High average age of the farmers

As it was the first year of nutrition tool DSS testing, a sample of CdM-affiliated farms and stackers that used the platform for the first time have been selected. The objective was to reconstruct the technical-crop itinerary carried out without using the DSS suggestions but starting from the data inputted by farmers into the platform. A sample of farms has been used to test the decision support model and to compare the actual crop itinerary with the one suggested by the model. This would like to understand the gap between the different scenarios and determine whether the entered information could be sufficient to make the model work. A first sample consisted of 15 farms and 43 observations, of which 21 were excluded due to being incomplete or with outlier values. This selected sample was used to understand how farmers' fertilization techniques deviate from what is suggested by the DSS.

The quantities of nitrogen input into the platform by the farmers were analysed, and these were subsequently compared with nitrogen units recommended by the DSS. The effects of fertilizations were also analysed comparing the yield reported by farmers in the platform with the yield that could have been achieved with DSS suggestions, and using a cost estimate based on the prices and quantities of fertilizers used by farmers in both scenarios. Below is a summary of the data, where a distinction was made between those who use fewer units of nitrogen tan suggested by the DSS (Table 2) and those who use higher quantities (Table 3).

For those two categories, further differentiation was made using the deviation percentage from the suggested quantities as a discriminant. However, the sample used is relatively small, with several limitations (such as real nitrogen too low, high or missing and yields in some cases not available) due to the lack of some data not entered into the platform, since it was the first year of testing.

Table 2 - Observations/groups that administered fewer units of nitrogen than suggested by the DSS

Technical Inputs Impact (medium values)

	Nitrogen			Yield		
	Real (N units/ha) [1]	DSS (N units/ha) [2]	Δ % [3]=(1-2)/2	Real (t/ha) [4]	DSS (t/ha) [5]	Δ % [6]=(4-5)/5
Low N deviation	150,00	160,00	-6%	4,60	6,33	-27%
Medium N devation	150,00	178,60	-16%	4,97	7,54	-34%
High N deviation	92,42	158,40	-42%	4,94	7,22	-32%
Outlier	28,89	162,00	-82%	9,92	6,94	43%

Economic Results Impact and NUE

	N Costs			NUE		
	Real (€) [1]	DSS (€) [2]	Δ % [3]=(1-2)/2	Real (Kg prod./Kg N distr.) [4]	DSS (Kg prod./Kg N distr.) [5]	Δ % [6]=(4-5)/5
Low N deviation	157,30	167,80	-6%	28,91	39,23	-26%
Medium N devation	195,50	230,50	-15%	33,43	42,06	-21%
High N deviation	79,60	139,50	-43%	67,26	44,11	52%
Outlier	38,50	215,50	-82%	343,50	42,84	702%

Table 3 - Observations/groups that administered more units of nitrogen than suggested by the DSS

Technical Inpusts Impact (medium values)

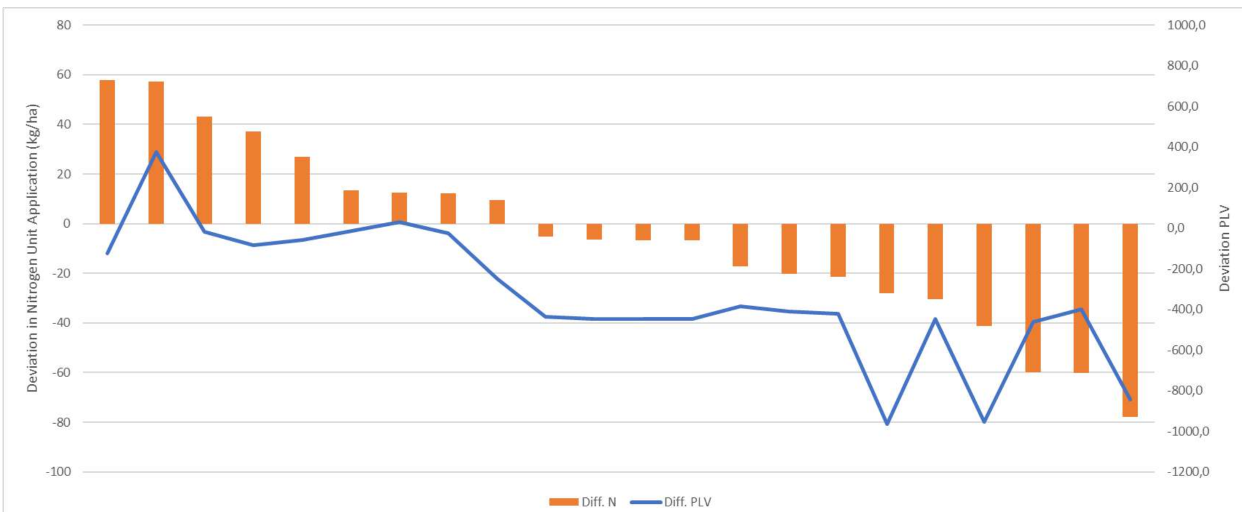
	Nitrogen			Yield		
	Real (N units/ha) [1]	DSS (N units/ha) [2]	Δ % [3]=(1-2)/2	Real (t/ha) [4]	DSS (t/ha) [5]	Δ % [6]=(4-5)/5
Low N deviation	174,45	158,40	10%	6,41	6,68	-4%
Medium N devation	195,35	159,67	22%	6,53	6,74	-3%
High N deviation	219,47	162,00	35%	5,58	6,08	-8%
Outlier	368,76	160,00	130%	6,86	6,81	1%

Economic Results Impact and NUE

	N Costs			NUE		
	Real (€) [1]	DSS (€) [2]	Δ % [3]=(1-2)/2	Real (Kg prod./Kg N distr.) [4]	DSS (Kg prod./Kg N distr.) [5]	Δ % [6]=(4-5)/5
Low N deviation	186,26	173,71	7%	35,80	41,05	-13%
Medium N devation	223,50	182,22	23%	31,11	44,31	-30%
High N deviation	154,66	123,89	25%	34,02	39,72	-14%
Outlier	335,77	145,6	131%	25,38	37,53	-32%

Subsequntly, the Gross Marketable Yield (PLV) was calculated for each observation, using actual yield, DSS Yield and DSS Yield with real nitrogen units. The following graph (Figure 2) displays the deviation of the PLV and the deviation in the application of nitrogen units.

Figure 2 – Deviation in N units application compared with PLV deviation



The graph illustrates how the success or failure of the suggestion is not always clear due to both the small sample size and certain data input inaccuracies, given tat it's the farmers' first year of platform use.

CONCLUSION

The conducted interviews have revealed how often farmers struggle to perceive the actual future benefits of a technological innovation like DSS. These innovations are seen as an additional commitment in terms of work, and there is also a lack of trust, especially among those with a higher average age.

Looking at the sample data presented and considering the data input issues, even when observing companies with the strongest rapport with the technology, it's not entirely straightforward to attribute the success or failure of single-year results solely to following or not the DSS suggestions. To make the effect and results of the DSS more evident, it doesn't seem sufficient to focus solely on fertilization recommendations and the improvement of the NUE parameter within a single year. Instead, it could be necessary to involve farmers in a longer (3-5 years) and assisted transition period, where training in interpreting yield results and economic performance is addressed together. According to this approach, gains (yield) can be juxtaposed with costs (inputs and operations) and subsequently analyzed in terms of marginality.

Farmers are pushed by policies and pulled by the consumers and the society to adopt new practices and to change their production activities along the principles of sustainable agriculture, which is broadly recognized to improve farm's environmental quality, economic profitability and social equity (Behnassi, 2011). Tools like DSS can prove to be innovative and crucial in the current historical period where farmers are required to manage their agricultural businesses differently. Without collaboration among the stakeholders in the supply chain, such tools cannot provide adequate answers. One key issue is the lack of digital skills by farmers, resulting in low participation in online activities and a reluctant approach to data sharing (Castle *et al.*, 2016). The diffusion of a technical innovation intended to improve the efficiency of Italian primary sector is characterized by a structural slow adoption (Avolio *et al.*, 2014). This is probably due to a general risk aversion by cereals growers (Lenzi, 2013). Wheat producers are not yet convinced or conscious about the potential benefits of adopting the DSS, both in terms of cost saving and potential gains in revenues (Blasi & Cicatiello, 2019). For the new technologies to be embraced by farmers, it is necessary for these tools to be made simple and targeted. Additionally, there is a need to build a true partnership between developers and decision-makers, and in the current scenario, the role of AKIS could be significant in guiding and supporting farmers in the adoption of new technologies like the DSS.

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HOW DOES DIGITAL READINESS AFFECT THE ECONOMIC PROFITABILITY OF LIVESTOCK FARMS

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INTRODUCTION

Digitization is the primary driver of increased productivity, economic growth and improved competitiveness. It is crucial in transforming the agricultural sector and supports farmers' livelihoods, well-being and resilience. This transformation can be seen with the changes in livestock management and the interactions in the value chain with the potential to optimize the economic contribution per animal (Neethirajan and Kemp 2021). Its impact remains a mirage due to uneven adoption, leading to unequal distribution of benefits. Some social, economic and environmental factors, including trust, digital literacy ack of digital infrastructure, and regulations, characterize low adoption among farmers.

Digital readiness has been defined and applied in several contexts and domains, including management, education, social sciences, and even more during the Covid 19 pandemic. It has been defined as the attitude, preparedness, competencies, capabilities, willingness, and motivation of individuals, organizations, and institutions to adopt and utilize digital technology to maximize benefits (Dickenson et al., 2022; Susanty and Anindyanari, 2022; Händel et al., 2020; Soomro, 2020; Nasution, 2018). Digital readiness is related to farming engagement and the outcomes of being involved in agricultural activities, i.e., livelihood and increased productivity. Its assessment can identify digital divide in terms of gaps among users, the usage of technologies, and the outcomes. Besides many definitions of digital readiness, this research considers digital readiness as the extent to which digital solutions or technologies are adopted and implemented in livestock farms to ensure maximum benefit. Machado et.al., (2020) viewed digital readiness as a snapshot of the current(digital) ability and determined by the circumstances in which these technologies are implemented. Digital readiness depends on data that leads to improved efficiency and reduced human error, leading to better outcomes and lower costs (Dickenson et al., 2022). Innovativeness is a personality dimension that influences individuals to use technologies; we can, therefore, say that there is a probability of using digital solutions if the farms are willing to accept innovations. The general assumption is that implementing digital technology among farmers has the potential to change the production and management of livestock.

The objective of this paper is to understand how the digital readiness of livestock farmers can affect the percentage revenues from primary activities, i.e. their economic profitability, and if the adoption of innovations by farmers can influence their decision to adopt digital technologies as well as the extent to which the structural factors as it relates to the farm characteristics and their characteristics influence their use of digital technologies for production and management activities.

The possible research questions are:

1. How do individual and farm characteristics influence the implementation of digital technologies (Digital Readiness-DigRead)?
2. Does the Digital readiness of farms affect the economic profitability of livestock farmers?
3. Does the implementation of innovations in the farm influence the adoption of digital technology in the farm and the economic profitability?

DATA AND METHODOLOGY

This research used secondary data from 3 different surveys conducted at different times, ISTAT's 7th Census of Agriculture (2019-2020) and two CATI - CAWI questionnaires (Animal Husbandry and Digitisation - Cattle, Buffalo, Pig and Sheep and Goat Livestock) December 2020 and 2021. After cleaning and merging the three datasets, the final sample size was 4,133. The data was analysed using the STATA 18 statistical package.

The proposed model in Fig. 1 and the theoretical framework reported in Fig. 2 describe the relationship between innovativeness, digital readiness, and economic profitability. The endogenous observed outcome (dependent variable) is represented as "perc_rica_1", the percentage profitability from primary activities of the farm. Innovativeness is the exogenous observed predictor (independent variable), and it is measured as a dummy variable, i.e. (1 if the farmers adopt one or more innovations in the farm and 0 if otherwise). Digital readiness is an endogenous mediator called the latent variable (i.e., it is both a dependent and independent variable based on the path model) with seven exogenous observed indicator variables and seven exogenous variables that include the structural (association, UBA-livestock unit, UAA-utilized agricultural area, legal form) and personal (education, age, training) characteristics that affect the latent variable directly.

Figure 1 – A proposed model of causal relationship among the study variables

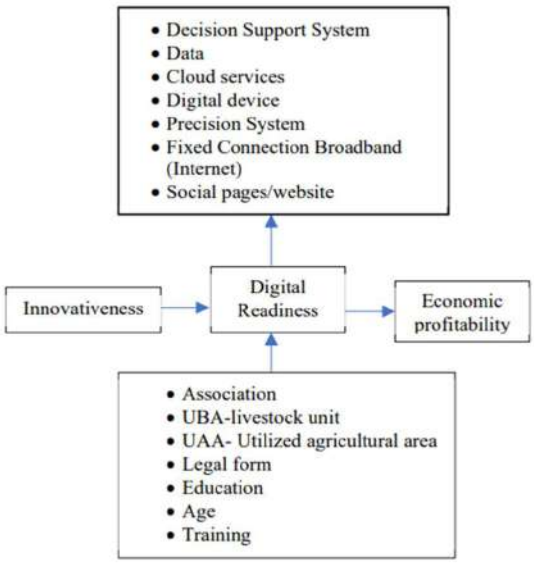
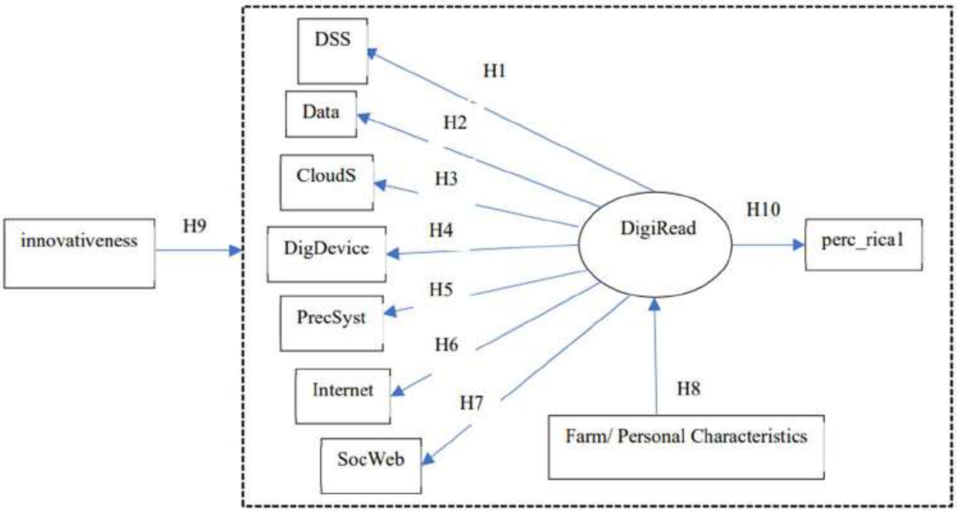


Figure 2 – Theoretical framework



We used the structural equation model (SEM) to test the model because SEM it is an extension of factor analysis to test substantive theory from empirical data. SEM comprises two parts. The measurement model specifies the relationship between the latent and observed indicator variables. Latent (unobserved) variables can be formative or reflective variables. Our latent construct is a reflective variable because digital readiness is independent of the observed indicator variables, and it is reflected in their adoption and use of a range of digital innovations. The structural model specifies the relationship between the latent variable (DigiRead) and its observed indicators.

$$\boldsymbol{Y} = \lambda_y \boldsymbol{X} + \boldsymbol{\varepsilon} \tag{1}$$
$$\boldsymbol{X} = \lambda_X \boldsymbol{\eta} + \boldsymbol{\omega} \tag{2}$$
$$\boldsymbol{Z} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1 U} + \boldsymbol{\beta_2 X} + \boldsymbol{\mu} \tag{3}$$

Equation (1) represents the measurement model. It is a multiple regression involving more than one dependent variable, an independent variable, and an error term. Y= p x 1 vector of endogenous observed variables (DSS, Data, CloudS, DigiDevice, PreciSyst, Internet, SocWeb); λ_y is the p x 1 matrix of regression coefficients; X = 1 x 1 vector of latent endogenous variable (Digital Readiness) and ε = p x 1 vector of measurement errors of Y.

Equation (2) and (3) is the structural model. η is a q x 1 vector of exogenous observed variables (innovativeness, association, UBA-livestock unit, UAA- utilized agricultural area, legalform, education, age, training) that affect the latent variable; λ_X is the q x 1 matrix of regression coefficients; ω is a 1 x 1 vector of the measurement error of X.

Z is a 1 x 1 vector of the outcome variable (perc_rica_1= % profitability from primary activities); β_1 & β_2 are the 1 x1 matrices representing the effect of farm innovativeness and digital readiness on the % profitability from primary activities; μ is a 1 x 1 vector of disturbances of the structural model, and β_0 is the intercept.

The CFA model was fit using the STATA 18 SEM builder. We assessed goodness of fit using the "Confirmatory Factor Analysis (CFA)". CFA was done to estimate reliability. Reliability refers to the proportion of the total variation in a scale formed by our indicators attributed to the true score. Our reliability estimate is 0.625, meaning that our true score can account for 63% of the variation in the scale used.

FIRST RESULTS AND CONCLUSION

In our analysis, we considered the specific characteristics of farms because when studying innovation in the agricultural sector, it is reported in the literature that in addition to considering structural characteristics (as we consider UBA, UUA and legal form), we should also consider the farmers' characteristics (as age and level of education) that may explain the farmer's behaviour (Diederen et al., 2015; Firsova and Derunov 2018). Before performing the structural model, we did a descriptive analysis that allowed us to understand all the variables included in the surveys, and we reported all the results and the description of the variables used in the model in Table 1.

Table 1 – Descriptive result of the variables

Variable		Scale	Freq	Perc (%)
DigiRead				
DSS	What type of decision support software does the company use? 1. Irrigation 2. Herd management 3. Fertilisation and crop protection 4. Systems for traceability and quality management 5. Others... (please specify)	0=No	3,125	75.61
		1=Yes	1,008	24.39
Data	Which of the following data does the farm use to carry out its current agricultural activity? 1.Meteorological data 2. Satellite data 3. Data collected by drones 4. Others....(please specify)	0=No	3,342	80.86
		1=Yes	791	19.14
CloudS	Which of these cloud services does the company use to carry out its current farming activities? 1. File storage and sharing 2. Office software 3. Data analysis 4. Other.... (Please specify)	0=No	3,098	74.96
		1=Yes	1,035	25.04
DigiDevice	What types of digital devices for individual animal monitoring has the farm introduced to carry out its activities? 1. Sensors on limbs, neck, or ear tags 2. Quanti-qualitative detectors of individual production 3. Image analysers of behaviour 4.Other ...(please specify)	0=No	3,023	73.14
		1=Yes	1,110	26.86
PrecSyst	What precision animal husbandry systems or machinery has the farm introduced into production? (robot_mungitura sistemi_informatici macchinari_qual_alimenti misuraz_online_q_latte sist_rem_ident_animali altri_sist_precisione)	0=No	4,070	98.48
		1=Yes	63	1.52
Internet	Did the farm use at least one fixed broadband internet connection in 2020? 0=Yes; 1=No	0=Yes	2,064	49.94
		1=No	2,069	50.06
SocWeb	Does the farm have its own website or pages on social networks? 0= Yes, a website (or one or more Internet pages) or pages on social networks; 1=No	0=Yes	3,530	85.41
		1=No	603	14.59

Personal and Farm Characteristics				
education	From 1 to 9: 1=no one; 2=elementary school; 3=secondary school;4= Professional Diploma; 5=Professional Diploma; 6=High school Diploma; 7=High school Diploma (agrarian); 8= Degree (agrarian); 9= Degree	1	27	0.65
		2	461	11.15
		3	1,714	41.47
		4	183	4.43
		5	202	4.89
		6	501	12.12
		7	737	17.83
		8	117	2.83
		9	191	4.62
age	From 18 to 100			
innovativeness	In the last three years (2018-2020), has the company made investments aimed at innovating technique or production management? Yes __| No |__|	0=Yes 1=No	2,516 1,617	60.88 39.12
training	Did you attend at least one agricultural training course in 2020? Yes __| No |__|	0=Yes 1=No	1,519 2,614	36.75 63.25
UBA- livestock units	From 1 to 5: where 1 = 0/24.994; 2 = 25/49.99; 3 = 50/74.99; 4 = 75/100.99; 5 = 101/10000	1	1,255	30.37
		2	701	16.96
		3	440	10.65
		4	320	7.74
		5	1,417	34.29
UAA- utilised agricultural area	From 1 to 5: where 1 = 0/11.99; 2 = 12/31.99; 3 = 32/51.99; 4 = 52/100.99; 5 = 101/3000	1	946	22.89
		2	1,133	27.41
		3	660	15.97
		4	781	18.90
		5	613	14.83
legal Form	From 1 to 5	1	2,637	64.82
		2	1,199	29.47
		3	109	2.68
		4	91	2.24
		5	32	0.79
Revenues				
perc_rica1	% revenues from primary production from 1 to 100: 1 = 0/10; 2 = 12/31; 3 = 32/51; 4 = 52/100	1	421	10.19
		2	172	4.16
		3	532	12.87
		4	3,008	72.78

The descriptive analysis shows that our sample respects the main characteristics of modern Italian agriculture, such as the prevalence of individual farms (usually family-run). In this study, 65% are individual farms, with most of the sample having a UUA between 0 and 30 hectares and individuals who are not highly educated (most of the sample, 42% have a high school degree or 18% an agricultural diploma). these could be factors that explain the difficulty of entrepreneurs to be ready for the new digital technologies.

These factors probably mean they need access to scientific and technical developments or other information that could be crucial for their development (Ibragimov 2014; Mencarelli and Mereu 2021). Most of the sample state that they do not have decision support software (75.61%), do not use data (81%), cloud (75%), digital devices (74%) and precision systems (98%), half of the sample do not have access to the internet (50%). In comparison, while the majority use social networks or own websites (85%).

From the questionnaire responses, using factor analysis, we were able to create the latent variable expressing digital readiness (DigiRead) and then see how this influenced the percentage of revenues from primary production (Table 2). We check through Cronbach's alpha[1] the reliability of the construct that is equal to 0.63 which means it has an acceptable level of reliability.

Table 2 – Structural results

Structural	perc_rica1_groups			DigitRead		
	Coef.	S.E.	P>|z|	Coef.	S.E.	P>|z|
Intercept	62.77	**2.79*****	0.000			
DigiRead	12.3	**1.97*****	0.000			
legalForm	3.43	**0.87 *****	0.000			
UAA	-0.03	**0.01*****	0.000			
age	0.00	0.04	0.993			
education	-1.05	**0.24*****	0.000			
training	7.33	**1.00*****	0.000			
UBA	0.00	**0.00*****	0.000			
association	4.25	**0.99*****	0.000			
Innovativeness				0.22	**0.01*****	0.000

Significance is as follows: * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

From the first analysis of the results, we see that from the structural model, the variable of Digital Readiness is positively significant on the revenues of livestock farms while the level of education is negatively so; therefore, this means that the more educated the farmers are, the less they earn from primary activities, probably because they will also invest in other activities. On the other hand, almost all structural factors are positively significant for DigRead; as the UBA, the complexity of the business management system and the innovativeness increase, the willingness to adopt new digital technologies also increases.

In answering the question "How well does our model fit?", the table 3 provides extended statistical information involving the goodness of fit (gof). The root mean squared error of approximation (RMSEA) is used to measure fit and the comparative fit index (CFI). 0.05 < (RMSEA) < 0.08 is considered a reasonably close fit, while 0.05 is a good fit so in our case being RMSEA equal to 0.06 and CFI equal to 0.76 (the benchmark would be 1), we have a good fit (Chen et al., 2008; Bentler, 1990).

Table 3 – Goodness of fit

Fit statistic	Value	Description
Likelihood ratio		
Chi2_ms(76)	1182.202	Model vs. saturated
p> chi2	0.000	

[1] Cronbach's alpha indicates strong reliability if $\alpha \geq 0.8$, good reliability if $0.7 \leq \alpha < 0.8$, and acceptable reliability if $0.6 \leq \alpha < 0.7$.

Chi2_bs(92)	4728.996	Baseline vs. saturated
p> chi2	0.000	
Population error		
RMSEA	0.059	Root mean squared error of approximation
90%, lower bound	0.056	
Upper bound	0.062	
Pclose	0.000	Probability RMSEA <=0.05
Information criteria		
AIC	244353.280	Akaike's information criterion
BIC	244555.736	Bayesian information criterion
Baseline comparison		
CFI	0.761	Comparative fit index
TLI	0.711	Tucker-Lewis index
Size of residuals		
SRMR	0.062	Standardized root mean squared residual
CD	0.155	Coefficient of determination

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The economic burden of the bluetongue disease for the sheep industry in Sardinia: an evaluation of private and public costs of the 2017 BTV-4 epidemics

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Keywords
Ovine bluetongue, evaluation of bluetongue costs, bluetongue economic burden, sheep farming, sheep milk.

Background and objectives

Bluetongue (BT) is a viral disease primarily transmitted by biting midges (*Culicoides* spp.) and affecting wild and domestic ruminants. Severe disease is mostly limited to some breeds of sheep and some species of deer. In Italy, the first outbreak, caused by BT virus serotype 2 (BTV-2), was detected in summer 2000. Since then, there have been at least 13 incursions and more than 50.000 outbreaks involving different BTV strains and serotypes (Belbis et al., 2017; Bonfanti et al., 2008; Cappai et al., 2019; Carpenter et al., 2009; Federici et al., 2019; Giovannini et al., 2004; Lelli et al., 2000; Lorusso et al., 2013; Maclachlan et al., 2019; Mellor et al., 2008; Rolesu et al., 2019; Savini et al., 2021; Spedicato et al., 2022; Sulis et al., 2000; Wilson and Mellor, 2008). Being regarded as a disease with potential economic consequences, BT is qualified as "notifiable disease" by the World Organisation for Animal Health (WOAH, 2023) and listed in categories C+D+E of the new European Animal Health Law (European Union, 2016). BTV infection may cause losses in production (e.g. deaths, weight losses, reduced milk yields, infertility, and abortions), increased expenditures by farmers and/or health authorities (cost of treatments, vaccines, surveillance and control plans), and lost revenues due to restrictions of movement and trade (involving also other species, e.g. cattle) (Duncan Grewar, 2016; Fofana *et al.*, 2009; FOFANA *et al.*, 2016; Gethmann *et al.*, 2020; Häsler *et al.*, 2012; Pinior *et al.*, 2015, 2018; Rushton and Lyons, 2015; Senthil Kumar *et al.*, 2020; Tago *et al.*, 2014). This study aims to quantify the BT economic impact on the sheep industry and the national health service (NHS) institutions. The analysis considers the economic burden of the 2017 outbreak caused by BTV-4 in Sardinia, the region where half of Italian sheep is concentrated, the flock density is very high (AGRIS, 2018; ARA, 2009; Idda et al., 2010; ISMEA, 2018; Paoli, 2018; Rolesu et al., 2018, 2019; Spezzigu, 2014; Sulis et al., 2000). The research was funded by the Ministry of Health and implemented by the University of Bologna and the Istituto Zooprofilattico Sperimentale (IZS) of Latium and Tuscany, the IZS of Sardinia, and coordinated by the IZS of Teramo and included an evaluation of the BTV-4 damages in Latium and Tuscany.

Materials and methods

The study developed a deterministic farm model that incorporates epidemiologic, zootechnical and economic variables. This process relied on data from the national veterinary database – the livestock registry (Anagrafe Zootecnica Nazionale) and the animal disease database (SIMAN) – a questionnaire survey to farmers, as well as interviews to experts. A major hindrance to farm cost evaluation was that the SIMAN database reports only data on the number of farm outbreaks, the number of cases, and the deaths. No data are provided about the different categories and ages of sheep livestock (e.g., sucking lambs, fattening lambs, replacement young ewes and rams, first lambing sheep, adult sheep and rams, ect.) affected, nor on their productive status (e.g., lactation, pregnancy, dry period), which are crucial for cost evaluation. Based on estimation assumptions, a sequence of equations described the costs in the different livestock categories according to the clinical courses of the disease (acute, sub-acute and asymptomatic), by allowing a comprehensive assessment at the farm level (Fig. 1 and 3).

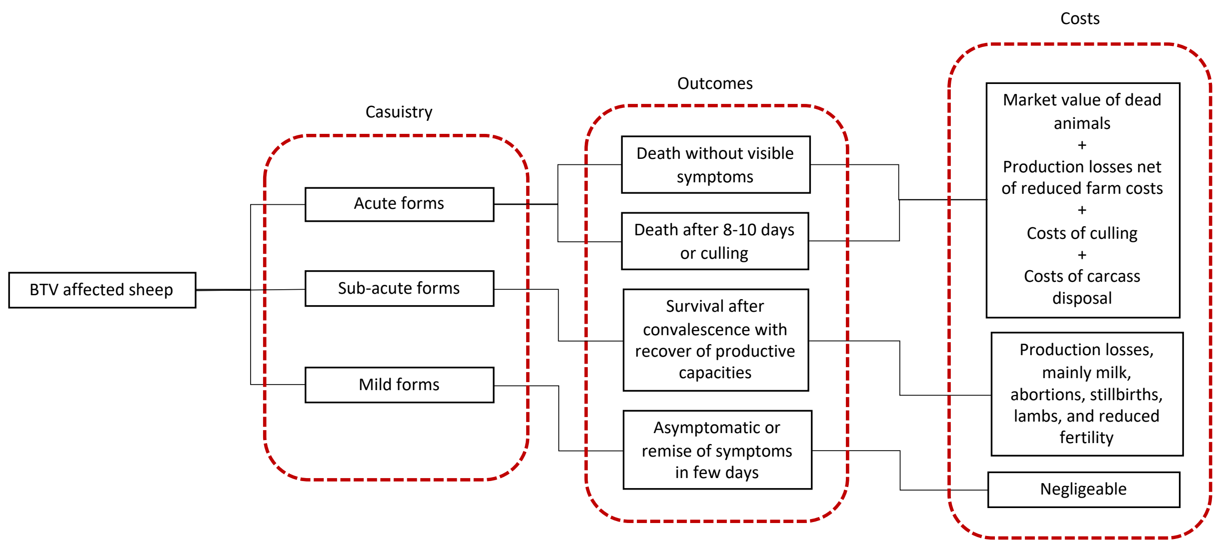

Figure 1 – Hypotheses for the estimation of farm damages

The parameters for the quantification of damages to sheep affected in sub-acute forms were deducted from farm interviews. NHS costs were evaluated by analysing the activities needed to implement BT surveillance and intervention measures (Fig. 2 and 3).

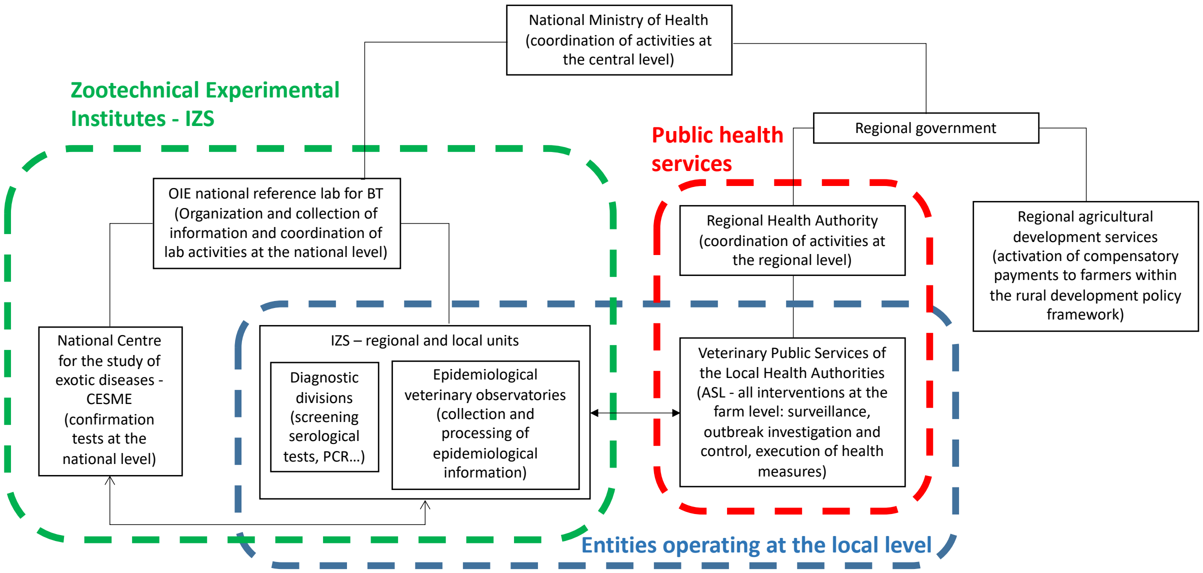

Figure 2 – Cost spreading throughout the public institutions involved

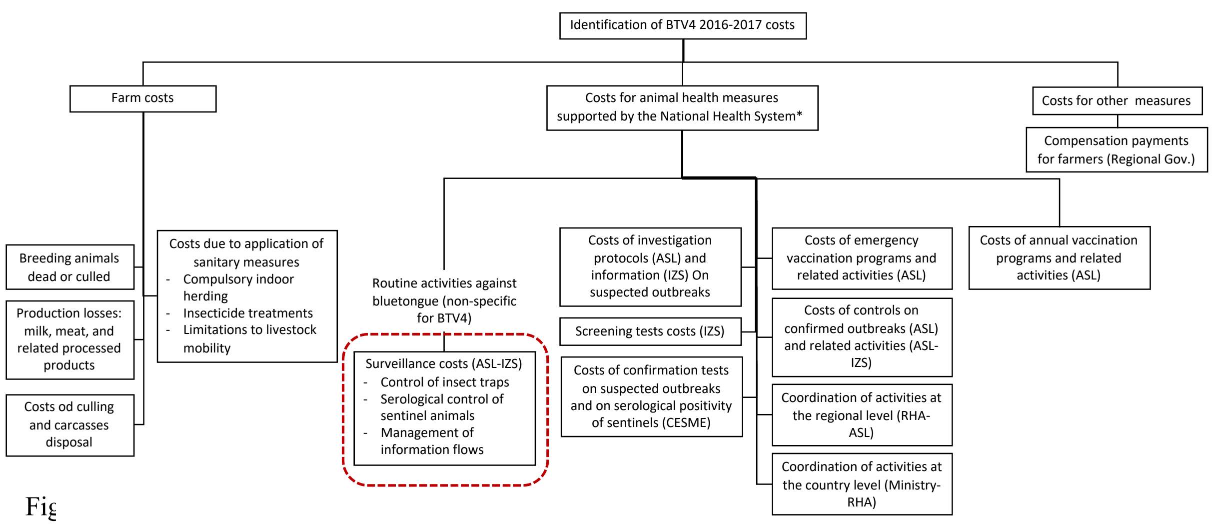

Figure 3 – General overview of the identified costs

Public subventions to affected farms were included in the estimation. Data on resource consumption were collected through a questionnaire submitted to the public institutions involved: the regional and local health authorities (Aziende Sanitarie Locali, or ASL), and veterinary public laboratories (Istituti Zooprofilattici Sperimentali, or IZS). The corresponding monetary values were calculated through the attribution of standard costs to the operational protocols.

Results

In Sardinia, the 2017 BTV-4 epidemics affected 2,393 farms with 830,634 sheep. 121,913 cases were recorded with 34,574 deaths. Table 1 summarizes the damages suffered by farms, and the cost supported by the NHS for animal health interventions and the regional administration for subventions to affected farms. The total cost was estimated in € 29.6 million, out of which € 18.6 million or 63% were farm production losses, € 7.1 million or 24% were the costs for the NHS, and € 3.9 million were subventions to affected farms.

Table 1 – Synthesis of the evaluation results

Items	Costs (€)	%
Farm costs related to the BT-4 2017 epidemics:		
- Production and livestock losses for deaths	5.049.855,46	17,1
- Production losses from clinical cases surviving the epidemics	11.694.756,36	39,5
- Costs for intervention measures in farms	1.874.808,15	6,3
Sub-total farm costs	*18.619.419,98*	*62,9*
Public costs for interventions against BT and aids to farmers		
- Personnel costs	2.750.226,31	9,3
- Sanitary materials and vaccines	1.668.098,57	5,6
- Use of vehicles	458.614,05	1,5
- Laboratory tests	2.216.404,79	7,5
- Subventions to farmers	3.876.529,01	13,1
*Sub-total public costs**	*10.969.872,74*	*37,1*
Total costs*	**29.589.292,72**	**100,0**
Total costs attributable to the 2017 BT4 epidemics of 2017 (€)**	29.373.252,93	
Average per adult sheep in the outbreak-farms (€)	39,46	
Average per productive ewe in the outbreak-farms (€)	42,38	
Average per sheep head in the outbreak-farms (€)	35,36	
Average per outbreak-farm (€)	12.279,79	
Average per productive ewe in the region (€)	10,49	

* Including the costs of routine BTV surveillance.
** This item excludes the costs of routine BTV surveillance.

Discussion and conclusions

The scientific literature provides limited information about the specific economic consequences of BT in Italy (Rushton and Lyons, 2015), although its geographical position and epidemiological situation make this country constantly exposed to the incursions of new BTV strains and the risk of new epidemics. This study proposes a wide analysis of losses and resource consumption caused by BT at different levels (private and public sectors) for a comprehensive assessment of the disease economic outcomes in the Italian situation. The resulting epidemiological-economic model could provide important information to evaluate the cost-effectiveness of new possible intervention strategies against BT, also in the context of other middle-and-high income countries and regions affected.

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FATTORI CHE INFLUENZANO L'INTENZIONE DI CONSUMO VERSO IL TARTUFO FRESCO E TRASFORMATO: UN'APPLICAZIONE DEL MODELLO PLS-SEM

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PAROLE CHIAVE
Tartufi; Intenzioni di consumo; Sostenibilità; Calabria; PLS-SEM;

Introduzione

Rafforzare la resilienza, arrestare la perdita di biodiversità e costruire un sistema alimentare sano e sostenibile, già evidenziati da tempo, sono diventate priorità imprescindibili a seguito della crisi innescata dal COVID-19 che ha mostrato tutta la fragilità del sistema alimentare.La pandemia ha evidenziato il valore delle aree rurali per il benessere dell'intera società e il loro contributo specifico nell'affrontare la crisi climatica, la transizione verde e digitale.Nell'ambito del PNR 2021-27, particolare importanza è attribuita alla valorizzazione multifunzionale delle produzioni forestali per un approccio sostenibile ai prodotti non legnosi del bosco e in relazione ai servizi immateriali delle foreste e alle soluzioni basate sulla natura (NBS) e sulle opportunità verdi.

Recentemente molti autori hanno posto la domanda secondo l'approccio del "ripensare il consumo" (Moreau *et al.*, 2017; Privitera and Nicolosi, 2017), dal punto di vista emotivo, dal punto di vista delle scelte razionali che muovono il consumatore verso pratiche di consumo sostenibile(Tukker, 2015)ed in relazione al suo know-how interpretando quindi il consumo come pratica complessa e come combinazione di elementi di scelta e abitudini di consumo(Mylan, 2014; Warde, 2014).

Obiettivo del presente lavoro è esplorare motivazioni e preferenze di consumo di tartufo e di prodotti a base di tartufo.Lo studio è stato condotto attraverso un'indagine sui consumatori intercettati in Calabria e in Italia da remoto con interviste online.

Il Tartufo in Calabria rappresenta una interessante risorsa economica sia con riferimento ai tartufi spontanei, sia con riferimento alle tartufaie artificiali ed offre possibilità di reddito a differenti figure che a vario titolo entrano nella filiera.Le tartufaie consentono di recuperare e valorizzare territori marginali, di introdurre nuova occupazione, nuove possibilità di reddito,di promuovere le potenzialità legate al turismo gastronomico che ruota intorno alla produzione di tartufi e alla gastronomia a base di tartufi(freschi e/o trasformati).Grazie al loro elevato prestigio culturale e gastronomico, varie specie di tartufi sono apprezzate in tutto il mondo per il loro alto valore nutritivo, i composti bioattivi e il prestigioso aroma.Anche in Calabria cresce l'interesse verso questi pregiati prodotti.

In Italia il mercato del tartufo è molto frammentato ed è costituito da una moltitudine di piccoli operatori (raccoglitori, coltivatori di tartufaie artificiali, distributori, ristoratori ecc).Non ci sono dati ufficiali circa la quantità reale di tartufi raccolti ogni anno soprattutto in rapporto alla tipologia di vendita e negoziazione.Molte transazioni sono ancora effettuate in fiere locali nelle principali regioni di produzione e in molti casi considerate cessioni occasionali direttamente al consumatore finale di piccoli quantitativi(Piano della filiera del tartufo 2017-2020).

La domanda di tartufo è prevalentemente legata all'industria della ristorazione, della trasformazione e del turismo ed è fortemente stagionale, raggiungendo un picco nei mesi di ottobre-novembre, periodo di maggiore raccolta del tartufo.

I prezzi medi al dettaglio oscillano molto a seconda delle specie variando da 300,00 €/Kg del *Tuber Uncinatum Vitt* a circa 1000,00 €/Kg del *Tuber Melanosporum.*I prezzi indicati sono orientativi,in quanto è la natura stessa del tartufo a rendere le quotazioni così altalenanti, ma sono proprio questi prezzi "aleatori" che rendono la ricerca e l'acquisto del prezioso fungo ipogeo un'esperienza tanto attraente(Oliach *et al.*, 2021).

Inquadramento teorico-metodologico

Il presente lavoro ha lo scopo di analizzare le abitudini e le preferenze di consumo del tartufo e dei prodotti a base di tartufo al fine di evidenziare come la filiera tartuficola possa contribuire alla promozione di strategie di crescita anche per la Calabria così come è avvenuto in molte regioni d'Italia e all'estero.

La ricerca è stata svolta nel periodo di gennaio-febbraio 2021 durante la pandemia da Covid-19; si è optato per una consultazione online di consumatori predisponendo un questionario semi-strutturato, mediante la piattaforma Microsoft Forms.

Il questionario è stato pubblicato sulle bacheche telematiche di diversi gruppi "social" che sono stati impiegati per la condivisione del questionario, come WhatsApp, Instagram e Facebook.Il questionario è stato compilato da 121 utenti, residenti in Calabria e in altre regioni italiane.

Lo strumento di rilevazione si articola in una griglia di domande a scelta usata per rilevare:

- caratteristiche socio-demografiche, occupazionali e reddito familiare;
- conoscenza, abitudini, luoghi di consumo (ristorante, casa, casa di amici), frequenza e prezzi;
- eventuali ragioni del non acquisto (non piace, prezzi elevati, scarsa reperibilità, ecc.);
- motivazioni per gustare i tartufi: aroma; gusto; fiducia e consiglio del venditore;
- attenzione alla sicurezza alimentare;
- curiosità e atteggiamenti;
- opinione su tartufaie e sostenibilità nei territori;

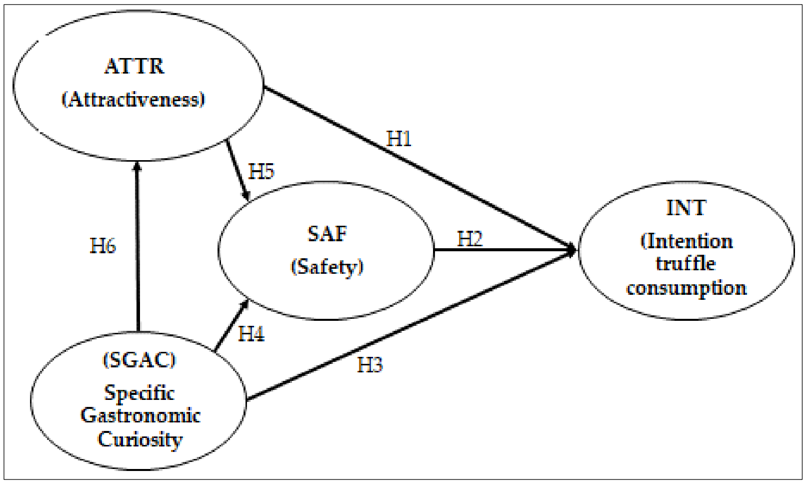
Le domande sono state organizzate in modo da raccogliere sia risposte binarie (sì/no) che a scelta multipla (3-4 tipologie di scelta) ed altre si basano su una scala Likert a cinque punti, 1=in forte disaccordo; 2=in disaccordo; 3=né disaccordo, né accordo; 4=d'accordo e 5=fortemente d'accordo.

L'attuale tendenza a studiare relazioni sempre più complesse rende utile l'applicazione di metodi e tecniche di analisi multivariata pertanto sulla base delle risposte raccolte sono stati realizzati dei database con l'ausilio dei software SPSS.20 e SmartPLS4 finalizzati a rilevare il comportamento dei consumatori. In totale sono state codificate 26 variabili, seguendo l'ordine delle domande poste nel questionario.

I dati sono stati elaborati, analizzati, sintetizzati ed interpretati per descrivere le caratteristiche del campione, per individuare le principali variabili esplicative e per evidenziare gli attributi distintivi che maggiormente condizionano i processi decisionali dei consumatori.

Le ipotesi di ricerca sono illustrate nel grafico 1: l'attrattività ha un impatto positivo e significativo sulla intenzione di consumo (H1); la sicurezza ha un impatto positivo e significativo sulla intenzione di consumo (H2); la curiosità ha un impatto positivo e significativo sulla intenzione di consumo (H3); la curiosità gastronomica ha un impatto positivo e significativo sulla sicurezza (H4); l'attrattività ha un impatto positivo e significativo sulla sicurezza (H5) e la curiosità gastronomica ha un impatto positivo e significativo sull'attrattività (H6).

Figura 1. Ipotesi di ricerca. Fonte: gli autori



Nel procedimento di analisi, in primo luogo è stata applicata l’Analisi Fattoriale Esplorativa (EFA) basata sull'analisi dei componenti principali (PCA) per individuare i fattori latenti e per una prima interpretazione della soluzione ottenuta.Le componenti principali sono estratte in modo tale da massimizzare la proporzione di varianza spiegata. L'affidabilità del modello è stata valutata utilizzando il test Kaiser-Meyer-Olkin (KMO) e il test sferico di Bartlett (Kim and Kwak, 2015; Lukinac and Jukić, 2022).

La teoria del comportamento pianificato (TPB) (Ajzen, 1991) è stata utilizzata in molti studi per indagare le intenzioni e i comportamenti dei consumatori. Il potere predittivo del TPB è stato applicato con successo in molti campi di ricerca sul consumo alimentare. Attualmente la modellazione delle equazioni strutturali (SEM) è diventata la metodologia di scelta per molti ricercatori che studiano relazioni complesse tra costrutti latenti, come nel marketing, nelle scelte dei consumatori e in altri campi, essa consente di valutare modelli complessi e percorsi strutturali che coinvolgono molte variabili.Come evidenziato da Lei e Wu (Lei and Wu, 2007), SEM rappresenta una versione avanzata delle procedure generali di modellazione e viene utilizzato per valutare se il modello ipotizzato in teoria è coerente con i dati raccolti (Hayes, Montoya and Rockwood, 2017; Hair *et al.*, 2019).

Risultati

La tabella 1 mostra le informazioni socio-demografiche, che indicano la percentuale di intervistati maschi e femmine, pari rispettivamente al 47,1% e al 52,9%.Inoltre, il 22,3% degli intervistati ha tra 26-35 anni e la maggior parte è laureato (31,4%) o è dottore di ricerca (24,8%), sono impiegati (43,8%),hanno un reddito annuo medio alto (43,0%).Risiedono in Calabria (47,1%), al centro Nord (25,6%) e in altre regioni del sud(27,3%).

La maggior parte degli intervistati ha dichiarato di apprezzare i tartufi(70%), il 13% non li ha mai assaggiati ma sono curiosi ed interessati al consumo, mentre il 17% degli intervistati dichiara che i tartufi non piacciono e non li consumano(Tabella 2).

Quanto alla frequenza, solo il 14% li consuma più o meno regolarmente sia a casa che al ristorante; il 56% li consuma saltuariamente ed infine il restante 30% non li ha consumati perché non piacciono (17%) oppure perché non li ha mai assaggiati (13%). Per i prezzi di acquisto la maggior parte (85%), non risponde, non ricorda oppure dichiara di non acquistare.Il 9% degli intervistati ha acquistato ad un prezzo compreso tra 50,00 e 100,00 €/etto; solo il 5% dei rispondenti ha dichiarato di aver pagato un prezzo inferiore a 50,00 €/etto; ed, infine, il restante 1% ha dichiarato di aver pagato un prezzo maggiore di 100,00 €/etto.

Tabella 1. Caratteristiche socio-demografiche del campione

		n.	%			n.	%
Genere	Maschio	57	47,1	Responsabile acquisti alimentari	Intervistato	87	71,9
	Femmina	64	52,9		Altri	34	28,1
Età	18–25 anni	20	16,5	Livello di istruzione	Scuola primaria	1	0,8
	26–35 anni	27	22,3		Liceo	22	18,2
	36–45 anni	18	14,9		Studente universitario	30	24,8
	46–55 anni	25	20,7		Laureato	38	31,4
	Oltre 55 anni	31	25,6		Dottore/dottorando di ricerca	30	24,8
Reddito (€ annuo)	Nessun reddito	6	5,0	Occupazione	Impiegato	53	43,8
	≤15.000	16	13,2		Imprenditore	18	14,9
	15.001–30.000	45	37,2		Disoccupato	4	3,3
	30.001–48.000	52	43,0		Studente	29	24,0
	≥48.001	2	1,7		Altro	17	14,0

Tabella 2. Consumo, frequenza e prezzi di acquisto dichiarati dai consumatori intervistati

Consumo di tartufi e di prodotti a base di tartufi	Li apprezza	70,0 %
	Non piace	17,0 %
	Non li ha mai assaggiati, ma è curioso, interessato	13,0 %
Frequenza di consumo	Regolarmente, a casa o al ristorante	14,0 %
	Saltuariamente, a casa o al ristorante	56,0 %
	Non consuma perché non piace	17,0 %
	Non li ha mai assaggiati	13,0 %
Prezzi di acquisto	inferiore a 50,0 €/etto	5,0 %
	50,0 e100,0 €/etto	9,0 %
	maggiore di 100,0 €/etto	1,0 %
	Non sa, non ricorda, non risponde	85,0 %

Dal punto di vista metodologico l'elaborazione dell'EFA ha permesso di ridurre la complessità del nostro database in un numero inferiore di variabili. L'analisi, eseguita su 12 variabili, ha individuato quattro "fattori latenti" che spiegano il 72,3% della varianza totale. Una rotazione ortogonale è stata applicata con il metodo Varimax,permettendo una lettura più semplice della matrice delle componenti estratte. L'adeguatezza del campione è stata verificata con il test KMO (il valore ottenuto, pari a 0,781, è considerato accettabile). Le quattro componenti estratte sono:"Attrattività e preferenze ed esperienza personale";"intenzioni e motivazioni di consumo";"norme soggettive sull'attenzione alla sicurezza alimentare";"curiosità e atteggiamento nell'approccio al consumo di tartufo".

L'applicazione della procedura PLS-SEM ha consentito di costruire il modello strutturale, di esaminare i risultati finali e i criteri di qualità del modello (Ringle *et al.*, 2022).Le metriche più importanti del modello valutano l'affidabilità, la validità convergente e la validità discriminante.

La validità convergente è valutata dai fattori di caricamento degli item e dalla Varianza Media Estratta (AVE).I"Fattori di caricamento standardizzato" dei 12 item considerati dovrebbero essere mantenuti nel modello di misurazione solo se i loro carichi standardizzati sono uguali o superiori a 0,6(Chin, 2010; Dash and Paul, 2021). Infatti, come evidenziato nella figura 4 le saturazioni degli item che compongono il modello di misura sono tutte valide e comprese tra 0,620 e 0,913.

La misura comunemente utilizzata per stabilire la validità convergente è la Varianza Media Estratta (AVE). Essa è considerata accettabile con valori che superano 0,50 ed indica che la varianza condivisa tra un costrutto e i suoi elementi supera la varianza dell'errore di misura(Hair *et al.*, 2019).I risultati rivelano che per tutti i costrutti i valori AVE sono maggiori di 0,6 (Tabella 3), l'indice dei quattro fattori latenti è pari rispettivamente a: INT= 0,656; ATTR=0,658; SAF=0,609; SGAC=0,655.

Tabella 3. Caricamento standardizzato dei singoli Item, CR,AVE e Alfa di Cronbach.

Fattori e Item		Caricamento standardizzato dei singoli Item	Affidabilità composita (CR)	Varianza media estratta (AVE)	Alfa di Cronbach
	Intention truffle_consumption - INT		**0,851**	**0,656**	**0,741**
Int_1	Mi affido al consiglio del venditore di cui ho fiducia	0,799			
int_2	Lo considero un Prodotto sostenibile	0,821			
Int_3	Preferisco i tartufi della mia area	0,810			
	Attractiveness - ATTR		**0,884**	**0,658**	**0,827**
Attr_1	Preferisco consumarli in casa (propria o da amici)	0,710			
Attr_2	Piace a tutti in famiglia	0,806			
Attr_3	Mi piace/sono disponibile al consumo	0,846			
Attr_4	Mi piace l'aroma	0,872			
	Safety - SAF - Norme Soggettive		**0,751**	**0,609**	**0,396**
Saf_1	Mi considero molto attento alla salute	0,913			
Saf_2	Seguo resoconti dei mass media e i social per avere informazioni sulla sicurezza alimentare	0,620			
	Specific_Gastronomic Curiosity SGAC_		**0,850**	**0,655**	**0,736**
Sgac_1	Mi incuriosisce conoscere la cultura gastronomica	0,881			
Sgac_2	Mi piace provare cibi nuovi e nuove esperienze gastronomiche	0,789			
Sgac_3	Per me è importante fuggire dalla routine	0,752			

Fonte: elaborazione degli autori dall'analisi dei dati da Smart-PLS4).

L'affidabilità della coerenza interna del modello è rappresentata dall'affidabilità Composita (CR, Composite Reliability), essa varia da 0 a 1, con valori più alti che indicano livelli più elevati di affidabilità. Tale affidabilità composita nei quattro fattori latenti supera il valore raccomandato di 0,7: INT=0,851;ATT=0,884;SAF=0,751;SGAC=0,850. Quanto all'Alfa di Cronbach essa è una misura conservativa dell'affidabilità e restituisce valori relativamente più bassi della CR e ne rappresenta il limite inferiore.Pertanto, appare opportuno riportare e confrontare entrambi i parametri.

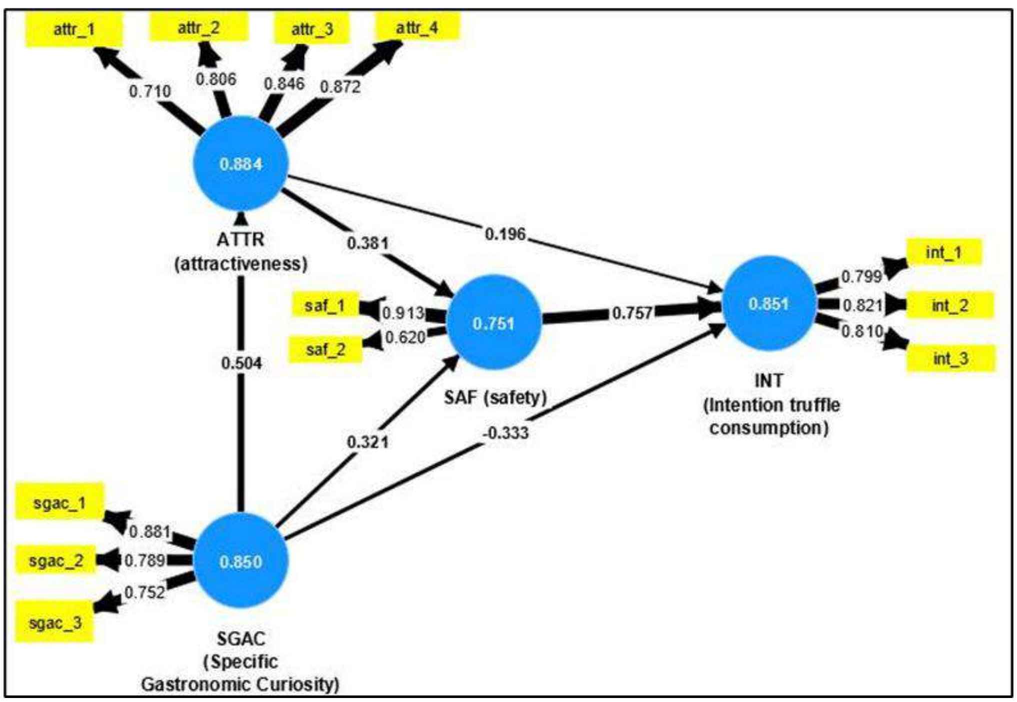
Per quanto riguarda la validità discriminante si utilizza il criterio di Fornell-Larcker (Mustapa, Amin and Frewer, 2020),esso è valido quando la radice quadrata dell'AVE di ogni costrutto è maggiore della sua massima correlazione con qualsiasi altro costrutto nel modello.I risultati presentati nella Tabella 4 indicano che ogni costrutto condivide una maggiore varianza con gli elementi ad esso assegnati(valori in grassetto sulla diagonale della tabella)rispetto ai restanti costrutti nel modello, confermando così che i requisiti del criterio di Fornell-Larcker sono soddisfatti.

Tabella 4. Criterio di Fornell Larcker

	ATTR	INT_	SAF	SGAC
ATTR	**0.811**			
INT_	0.439	**0.810**		
SAF	0.542	0.693	**0.781**	
SGAC	0.504	0.154	0.513	**0.809**

Il risultato grafico in figura 2 mostra l'Affidabilità Composita(CR)dei costrutti,le Saturazioni del Modello esterno e i Coefficienti di percorso del Modello Interno.Le dimensioni delle frecce evidenziano il valore relativo dei Percorsi.

Figura 2. Il risultato della PLS-SEM. Elaborazione e adattamento a cura degli autori.



Sono inoltre validi i criteri di qualità R^2, f^2 e le statistiche di collinearità (Tabelle 5-6). Il primo R^2 riguarda il cosiddetto "coefficiente di determinazione" che è una misura della quota di varianza di un costrutto endogeno che viene spiegata dai suoi costrutti predittori (tutti i costrutti ad esso collegati).

Il secondo f^2 viene indicato come "dimensione dell'effetto". Le linee guida per valutare f2 sono le seguenti: valori di 0,02 rappresentano effetti deboli; valori di 0,15 rappresentano effetti medi e valori di 0,35 rappresentano effetti sostanziali(Cohen, 1988).

Inoltre, con riferimento alla collinearità, tutti i percorsi ipotizzati sono validi poiché i "valori di soglia del VIF" (Fattore di inflazione della varianza) rientrano nei limiti del range 0,20-5,0 registrando valori compresi tra 1,0 e 1,589 (Tabella 6).

Anche il valore di Q^2 è valido (tabella 5), essa rappresenta una misura della potenza predittiva del modello e, come indicato da Benitez (Benitez *et al.*, 2020) è considerata valida quando ha valori superiori a 0,000.

Tabella 5. R^2e Q^2

	R^2	R^2	Q^2predict
ATTR_(attractiveness)	0,254	0,248	0.237
INT_ (Intention truffle_consumption)	0,559	0,548	0.006
SAF (safety)	0,371	0,360	0.244

Tabella 6. f^2 e Statistiche di collinearità VIF

	f^2	VIF
ATTR_(attractiveness) -> INT_ (Intention truffle_consumption)	0,056	1,571
ATTR_(attractiveness) -> SAF (safety)	0,172	1,341
SAF (safety) -> INT_ (Intention truffle_consumption)	0,817	1,589
SGAC_(Specific_Gastronomic Curiosity) -> ATTR_(attractiveness)	0,341	1,000
SGAC_(Specific_Gastronomic Curiosity) -> INT_ (Intention truffle_consumption)	0,168	1,504
SGAC_(Specific_Gastronomic Curiosity) -> SAF (safety)	0,122	1,341

La Tabella 7 mostra i risultati del percorso SEM. I valori t dei 6 percorsi sono tutti supportati dall'analisi, l'ipotesi H2 (SAF -> INT) ha il valore t più alto (11,729) e conferma l'importanza attribuita dai consumatori alla sicurezza alimentare, seguito dall'ipotesi H6 SGAC -> ATTR (7,413) che conferma come la curiosità per un prodotto di pregio, oltreché considerato di lusso, sia fresco al naturale che proposto come prodotto gourmet attrae molto i consumatori.

L'ipotesi H5, ATTR -> SAF (4,176) conferma l'importanza attribuita alla sicurezza anche a fronte di una forte attrattività del prodotto per l'aroma, per il piacere di gustarlo e per condividerlo con altri (familiari e/o amici). Anche l'ipotesi H3, SGAC -> INT (3,914) conferma come la curiosità e la cultura gastronomica conducano verso l'intenzione di consumo di tartufi. Infine i valori più bassi della t-value sono registrati per i percorsi SGAC -> SAF (ipotesi H4) e ATTR -> INT (ipotesi H1) che sono pari rispettivamente a 2,978 e a 2,743.

Tabella 7. Risultati della verifica delle ipotesi

Coefficienti di percorso	Campione originario (O)	Intervallo di confidenza 97.5% (*)	t-value (|O/DEVST|)	p-value	Ipotesi	Risultati
ATTR -> INT	0,196	0.345	2,743	0,006	H1	supportato
ATTR -> SAF	0,381	0.555	4,176	0,000	H5	supportato
SAF -> INT	0,757	0.868	11,729	0,000	H2	supportato
SGAC -> ATTR	0,504	0.622	7,413	0,000	H6	supportato
SGAC -> INT	-0,333	-0.172	3,914	0,000	H3	supportato
SGAC -> SAF	0,321	0.500	2,978	0,003	H4	supportato

(*) Intervallo di confidenza al 97,5% con distorsione corretta

Come si vede dalla tabella 8 gli effetti specifici indiretti che rappresentano gli effetti di mediazione (Zhao, Lynch and Chen, 2010), migliorano il Valore-t rispetto al percorso diretto nei seguenti due percorsi:

-nel primo percorso di mediazione ATTR->SAF->INT (cioè dall'attrattività all'intenzione di consumo, mediato da una specifica attenzione alla sicurezza alimentare) il Valore-t è pari a 4,088 (il valore diretto ATTR->INT è 2,743);

-nel secondo percorso di mediazione che abbiamo verificato SGAC->ATTR->SAF (cioè la curiosità verso la sicurezza alimentare mediato dall'attrattività)il Valore-t è pari a 3,370 (il valore diretto SGAC->SAF è 2,978).

Anche in questi due casi si sottolinea l'importanza attribuita alla sicurezza alimentare che ha l'effetto di mediare e migliorare la relazione osservata tra le due variabili latenti "Attrattività" e "Intenzione di consumo" e tra le due variabili latenti "Curiosità" e "Sicurezza-alimentare", aspetti che migliorano le potenzialità di consumo di tartufi.

Tabella 8. Effetti specifici indiretti e processo di mediazione

Effetti specifici indiretti	Campione originario (O)	Intervallo di confidenza 97.5%(*)	Valori-t	Valori-p	Percorso Ipotesi	Significa-tività p<0,05 ?
ATTR_-> SAF -> INT	0,288	0,426	4,088	0,000	H5 -> H2	SI
SGAC -> SAF -> INT	0,243	0,411	2,675	0,007	H4 -> H2	SI
SGAC -> ATTR -> SAF	0,192	0,318	3,370	0,001	H6 -> H5	SI
SGAC -> ATTR -> SAF -> INT	0,145	0,241	3,291	0,001	H6 -> H5 -> H2	SI
SGAC-> ATTR -> INT	0,099	0,198	2,390	0,017	H6 -> H1	SI

(*) Intervallo di confidenza al 97,5% con distorsione corretta

Conclusioni

I risultati di questo studio suggeriscono che le intenzioni dei consumatori di consumare tartufo fresco e trasformato derivano da un complesso processo decisionale che coinvolge vari fattori quali le esperienze personali dei consumatori, la comunicazione di marketing, la sicurezza alimentare, gli aspetti organolettici, l'aspetto green dei prodotti e più in generale la tutela dell'ambiente.

Lo studio ha esaminato l'attrattività del tartufo e dei prodotti a base di tartufo, le esigenze di sicurezza alimentare, le motivazioni di consumo reale o potenziale e le intenzioni di consumo e guarda ai cambiamenti nei modelli alimentari e all'importanza che i consumatori attribuiscono alla sostenibilità dei sistemi di produzione (Mancini *et al.*, 2019; Dong *et al.*, 2022).È stato messo in luce il ruolo che i tartufi possono avere nel mantenimento dei boschi e delle imprese agricole di montagna, nella produzione di cibo, bellezza e benessere fisico ed economico delle aree interne e boschive.Le attività che ruotano attorno al tartufo rappresentano un volano commerciale promettente ed in continua crescita.

Si tratta di un segmento di nicchia con un mercato sempre più orientato all'ampliamento della platea di consumatori, anche grazie agli innumerevoli prodotti a base di tartufo che ne rendono più appetibile e più accessibile l'acquisto.Negli ultimi decenni il mercato europeo ha subito cambiamenti dovuti alla coltivazione del tartufo e alla comparsa di nuovi produttori in un settore tradizionale legato alla produzione naturale e sono emerse nuove opportunità di marketing determinate dalla promozione e dalla vendita online che hanno dato maggiore visibilità al tartufo.

Le limitazioni dello studio attengono al numero delle interviste,alla scarsa chiarezza sulla disponibilità e possibilità di acquisto del prodotto.

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Developing a taxonomy of costs and benefits for the digitalization of Agriculture and Rural Areas

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PAROLE CHIAVE
Digitalization, Digital transformation, Agriculture, Rural Areas, Costs, Benefits;

Abstract:

Digitalization in agriculture has the potential to bring numerous benefits, but if not properly regulated, it can also lead to adverse economic, social, and environmental outcomes. This paper aims to provide insights into the digital, socioeconomic, and ecological costs and benefits associated with the digitalization of agriculture, forestry, and rural areas. Through a systematic review of the literature, the study identifies the main typologies of costs and benefits in these domains and explores the drivers within a socio-economic and ecological system perspective. The goal is to enhance the distribution of these costs and benefits to ensure inclusivity and sustainability. The study employs the standalone methodology for literature review and utilizes the Socio-ecological System (SES) Framework as an analytical guide. The framework helps identify the activities of the digitalization process that give rise to costs and benefits and considers dimensions such as actors, resource units, resource systems, and governance. The identified costs and benefits are subjected to a qualitative inductive thematic analysis to ensure coherence. Overall, this study provides a comprehensive analysis of the costs and benefits of digitalization in agriculture and rural areas, offering practical guidance for policymakers and stakeholders in assessing the potential of digital technologies.

INTRODUCTION

Digitalization in agriculture offers various benefits, such as increased productivity, improved work efficiency, resource conservation, and market integration (Porter and Heppleman, 2014). However, if implemented without proper regulations, it can pose risks and lead to detrimental economic, social, ethical and environmental consequences (Floridi et al., 2021; Vial, 2021). To ensure sustainable outcomes that encompass economic, environmental, and social sustainability, public policies need to enhance monitoring, steer technology development, and consider costs and benefits beyond the farm gate. While extensive literature explores the costs and benefits of digitalization in agriculture and rural areas, focusing on specific technologies (e.g., mobile technologies, blockchain, artificial intelligence, platforms, and the Internet of Things) across different scales (individuals, groups, and value chains) and sectors (e.g., agriculture, energy, industry, transportation, information & communication, commerce), these studies often overlook the social, organizational, and environmental implications of digitalization adoption (Irani et al., 2006).

Furthermore, conventional investment appraisal methods predominantly focus on financial metrics, often falling short of encompassing the comprehensive range of costs and benefits linked to digitalization. The inherent complexity of the digitalization process, intricately entwined with shifts in human behavior, institutional and socioeconomic frameworks, and elements like market dynamics and corporate structures (Rolandi et al., 2021), poses challenges to employing conventional tools.

For instance, socio-organizational costs, including changes in work processes, employee training, or resistance to change, are challenging to quantify and may not fit neatly into traditional cost evaluation frameworks. These approaches often emphasize solely market-related facets or present the advantages of mechanized agriculture, yet they disregard the significance of private investments, digital skills, disparities in the labor market, and the escalation of social inequalities.

Therefore, there is a widespread need for a more comprehensive analysis that considers the social-economic and ecological perspectives, providing a comprehensive taxonomy of the costs and benefits linked to the introduction and utilization of digital technologies. To conduct such an analysis, a systemic perspective is needed to effectively grasp the interplay between social, technological and ecological systems, along with their intricate dynamics.

This analysis aims to bridge the gap in understanding and enable informed decision-making by considering the broader implications of digitalization on society, organizations, and the environment.

This paper aims to provide insights into the digital, socioeconomic, and ecological costs and benefits associated with the digitalization of agriculture, forestry, and rural areas. The analysis addresses three main research questions: 1) What are the primary types of costs and benefits identified by scholars in agriculture, forestry, and rural areas? 2) What are the key drivers from a socio-economic and ecological systems perspective? 3) How can the distribution of these costs and benefits be enhanced to ensure inclusivity and avoid leaving anyone behind?

By conducting a systematic review of existing literature, this paper identifies the major areas of influence and presents a comprehensive overview of the costs and benefits of digitalization. The main objective of this study is to develop a unified analytical framework that provides practical guidance for identifying, categorizing, and illustrating the potential costs and benefits of digital technologies in rural areas and agriculture, as documented in scientific literature. The findings of this study can be valuable for policymakers and other stakeholders in assessing the potential of digital technologies and making informed decisions.

AN INTEGRATED VIEW ON COSTS AND BENEFITS

The landscape of technological innovation has evolved from linear models to systemic perspectives, emphasizing factors like knowledge flows and cultural influences. The terms "digitalization" and "digital transformation" are significant in this context. Digitalization converts analog processes into digital formats, while digital transformation encompasses broader socio-economic impacts of interconnected digital tools. Digitalization involves digitizing existing processes, while digital transformation restructures strategies to leverage digital technologies for value creation. Both concepts revolve around change. Decision-making is crucial in steering change, necessitating evaluating activities, gauging risks, considering resources, and estimating outcomes.

Change carries costs and potential benefits. Decision-makers must scrutinize costs like investments, training, and disruptions. They assess benefits like efficiency, customer satisfaction, and long-term profitability. However, adopting an evaluative approach beyond financial boundaries is vital due to complex and changing landscapes. Effective decision-making requires understanding the interplay between change, decision-making, and costs and benefits. Costs and benefits encompass different dimensions and perspectives, influencing their identification and assessment.

The literature offers diverse approaches to understanding digitalization's costs and benefits, from IT investment to ethics. Traditional appraisal techniques encompass various economic, strategic, and analytical methods. However, they fall short in providing a holistic understanding of digitalization's full spectrum of costs and benefits.

Addressing this requires an integrated approach, considering financial, social, economic, environmental, and cultural aspects. The Socio-ecological System (SES) Framework by Elinor Ostrom offers insight (Ostrom, 2007, 2009). It acknowledges digitalization's embedding in complex social and ecological systems, analyzing interactions between technological advancements, social dynamics, and environmental factors. The SES framework allows for a comprehensive analysis of digitalization's costs and benefits, aiding in identifying direct and indirect aspects across various dimensions (actors, governance, resource systems, resource units). It acknowledges positive and negative outcomes, facilitating trade-off assessment.

The framework equips decision-makers with an integrated view, enabling navigation of digitalization's complex landscape. It's valuable in analyzing interactions between digitalization, subsystem changes, and their impact on costs and benefits. The framework assists in identifying stakeholders, evaluating governance structures, analyzing costs, and exploring benefits.

In conclusion, technological innovation's landscape emphasizes digitalization and its impacts. An evaluative framework considering multi-dimensional effects of digitalization is crucial. The SES Framework provides an integrated lens, enabling a holistic understanding of digitalization's costs and benefits in a socio-ecological context, empowering informed decision-making.

METHODOLOGY

This study employs the standalone methodology for literature review (Xiao and Watson, 2019), focusing on the costs and benefits of digitalization in agriculture and rural areas. The objective is to enhance understanding in this area by conducting a comprehensive review of relevant literature. The identification of relevant literature involved a thorough search of both grey and white literature published between 2015 and 2021 in English. Following the recommendations of Atkinson and Cipriani (2018), specific keywords and their combinations were used to execute the search on Scopus, Google Scholar, and the University of Pisa library system. The keywords used included "digitalization" (or "digitization") AND "costs" OR "benefits" AND "agriculture" OR "forestry" OR "rural area". The selection of papers was based on their relevance to the research questions, considering titles, abstracts, and keywords. Initially, 246 works were identified, which were then narrowed down to 40. These selected works provide descriptions of the costs or benefits associated with digitalization processes, as well as application scenarios and contexts.

To identify the activities of the digitalization process that give rise to costs and benefits, we utilized the Socio-ecological System (SES) Framework, developed by Elinor Ostrom, as an analytical guide (Ostrom, 2007, 2009). This framework allowed us to ask specific questions, such as which dimension (actors, resource units, resource systems, governance) the costs and benefits are related to, who is responsible for these activities, and whether there are costs incurred due to salary increases for employees acquiring new skills and experience. We also examined the digitalization characteristics that drive the factors influencing costs and benefits, as well as the rules that govern the change process and who sets these rules. Furthermore, we explored whether the organization and community are aware of the costs and benefits associated with the resource system. The identified costs and benefits were then subjected to a qualitative inductive thematic analysis, following the approach outlined by Clarke et al. (2019). This process involved clustering the costs and benefits to ensure consistency and coherence in the language used.

RESULTS

Preliminary results show that the SES Framework, provides a valuable lens for understanding the relation between digitalization and the broader socio-ecological context. It recognizes that digitalization is not a standalone process but occurs within complex social and ecological systems (Rolandi et al., 2021; Irani et al. 2006). The framework considers the interplay between technological advancements, social dynamics, and environmental factors, emphasizing the interdependence and feedback loops between them. It helps identify and evaluate the direct and indirect costs and benefits associated with digitalization, such as economic, social, environmental, and cultural aspects. The framework acknowledges that digitalization can have both positive and negative consequences, and it helps assess trade-offs and synergies among various dimensions. It offers an integrated view on multiple perspectives, timeframes, measurements and priorities. Results provide an aggregation of costs and benefits that was performed through a conceptual analysis for each sub-systems of the SES framework and of the category described in the literature (intial, ongoing, financial, non-financial, direct, indirect, hidden, etc.). For each domain that has an influence on digitalization we identify the transition, transaction and switch costs, as well as tangible and intangible benefits and co-benefits.

From the developed taxonomy, we propose a tool to stimulate reflections on potential outcomes in specific situations and contexts of digitalization. The intention is to provide guidance to academics and practitioners when analyzing themes related to the digitalization of agriculture and rural areas.

DISCUSSION AND CONCLUSION

Effective decision-making in organizations requires a comprehensive understanding of the relationship between change, decision-making processes, and the associated costs and benefits (Irani et al. 2006). Costs and benefits are two crucial concepts that encompass different aspects of actions, investments, or decisions related to change. In the context of digitalization, it is crucial to consider the distinct nature of costs and benefits to conduct a thorough evaluation of trade-offs, risks, and returns associated with adopting digital technologies. Costs are typically examined from the perspective of the entity incurring expenses, while benefits can be perceived from various stakeholder perspectives, such as customers, employees, society, and the environment. These diverse perspectives can lead to variations in the identification and assessment of costs and benefits. Moreover, costs are often immediate and tangible, whereas benefits may be long-term and intangible, creating a discrepancy in the perceived timeframe of costs and benefits. Additionally, costs are relatively easier to measure and quantify compared to the more challenging task of quantifying and valuing benefits, which can include factors like increased innovation or ethical values. This disparity in measurement can result in discrepancies during the assessment process. Furthermore, different stakeholders may prioritize costs and benefits differently based on their interests and objectives. For instance, a business owner might prioritize short-term financial costs, while customers might prioritize the quality of products or services they receive. These varying priorities can lead to differences in the perceived importance and evaluation of costs and benefits. Considering these factors is essential for organizations as well as for policy makers to make informed decisions and drive sustainable digitalization efforts.

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Maximising the CO-benefits of agricultural Digitalisation through conducive digital ECoSystems

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Atti del LIX Convegno SIDEA
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The foresight technique applied to the value chain of pasta filata cheeses in the central-southern Apennines: first evidences for an effective planning of rural development policies in remote and mountainous areas.

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KEYWORDS
Foresight exercise; food value chains; spoon paste cheeses; mountain areas; resilience.

INTRODUCTION

Building more effective mountain policies requires the development of new value chains capable of contributing to the resilience and sustainability of these areas. The resilience of local and territorial mountain production systems can be ensured by the introduction of new participatory and cooperative models, capable of involving at the same time actors and stakeholders of the main agri-food value chains. This is the main objective of the MOVING project "MOuntain Valorization through Interconnecteness and Green Growth" (H2020), in the framework of which the authors are investigating the case of *pasta filata* cheeses in the central-southern Apennines, which have historically shaped the territorial capital of that area - think of the influence of the millenary practice of transhumance. However, some practices of the actors involved are endangering this capital, worsening the already significant phenomenon of depopulation. Rural development policies do not seem to have acted incisively on this problem so far, probably also due to excessively superficial or simplistic interpretations of the needs of mountain territories, which are instead more multifaceted and complex than those considered, characterised moreover by deep conflicts between actors (e.g. between breeders and processors), whose composition could benefit precisely from the introduction of participatory practices, aimed at sharing more effective regulatory formulas (public and private). This is the framework for the foresight exercise, outlined in this contribution, whose objective is to answer the following two research questions: a) which scenarios are likely to be foreseeable in the analysed territorial context?; b) which policy actions can ensure an approximation to the preferred scenario, among those that the forecasting exercise has identified for the area?

With the intention of field-testing a model approach capable of providing useful indications for policy makers, not only for the purposes of the most correct implementation of community programming, but above all to attempt an exercise in assessing the expected impact in the central-southern Apennines, as well as forecasting needs and scenarios for subsequent programming periods, reaching up 2050-time horizon.

MATERIALS AND METHODS

As is well known, Foresight is a systematic and participatory process of collecting information about the future and building medium- to long-term visions, aimed at facilitating decisions in the present and mobilizing joint actions by territories (http://foresight-platform.eu). There is an extensive literature dealing with this topic and important journals dedicated to it to which we refer (Godet, 2000; Johansen, 2018; Glover et al., 2015, Andreescu et al., 2013).

The proposed foresight exercise, which borrowed a pattern common to all other cases analyzed by the MOVING project, involved, first, the definition of a panel of actors, called the foresight group (FG). In the same, 4 categories of actors were involved: 1) MAP[1] members; 2) experts in the various stages of the value chain (1 CREA researcher expert in animal production, 1 researcher expert in animal breeds and production, 1 expert in pasta filata cheese); 3) policy network referents (local - LAG director; regional - RDP technical assistance coordinator of the Molise Region; national-European - CREA-PB researcher participating in the PNS project); 4) other stakeholders (1 environmental guide, 1 official of SviluppoItalia-Molise tourism referent, mayor of one of the MRL[2] municipalities).

The activities were carried out between February and May 2023, and were divided into three successive participatory workshops:

Workshop 1 (WS1):
Preliminary activities: baseline scenario (BS) definition based on the results of WP4[3].
WS activities:
- sharing, integration and validation of the BS;
- participatory identification of key variables of the BS through serious games (Bontoux et al., 2016; Hebinck et al., 2018; Störmer et al., 2020);
- identification of long-term forces underlying the key variables.
Output: long-term forces.

Workshop 2 (WS2):
Input: long-term forces shared by the FG.
Preliminary activities: definition of the 4 potential scenarios by constructing a 2x2 matrix (Rhydderch, 2017), based on the long-term forces that emerged from WS1 activities. The four scenarios were constructed using a 4x4 matrix, whose axes consist of the first two long-term forces resulting from the ranking obtained in WS1. The combination of the high and low levels of the identified long-term forces led to the scenarios, the description of which is based on the prediction of the impact of these forces on the key elements of the value chain.
WS activities:
- sharing, integration and validation of the 4 scenarios;
- discussion on the preferred scenario for the observed area;
- scenario selection by serious game;
- continuation of the serious game until consensus is reached on Miro platform.
Output: elements for defining the preferred scenario

[1] Multi-actor platform is a category and structure of the MOVING project, the objectives of which are to co- operate and compare the main outcomes of the project and to foster the exchange of knowledge and experience to improve expertise on mountain value chains (Salvia et al., 2019; Dania et al., 2018).

[2] MRL (Mountain Reference Landscape), according to the project nomenclature, consists of one or more administrative units in which the activities of the value chain under consideration take place. In this specific case, it consists of 5 municipalities in Alto Molise (Agnone, Capracotta, Carovilli, Pescolanciano, Vastogirardi).

[3]WP4 activities include an in-depth value chain analysis through participatory workshops, desk analysis, and in-depth interviews. This is followed by the assessment of its vulnerability, sustainability and resilience through a participatory workshop.

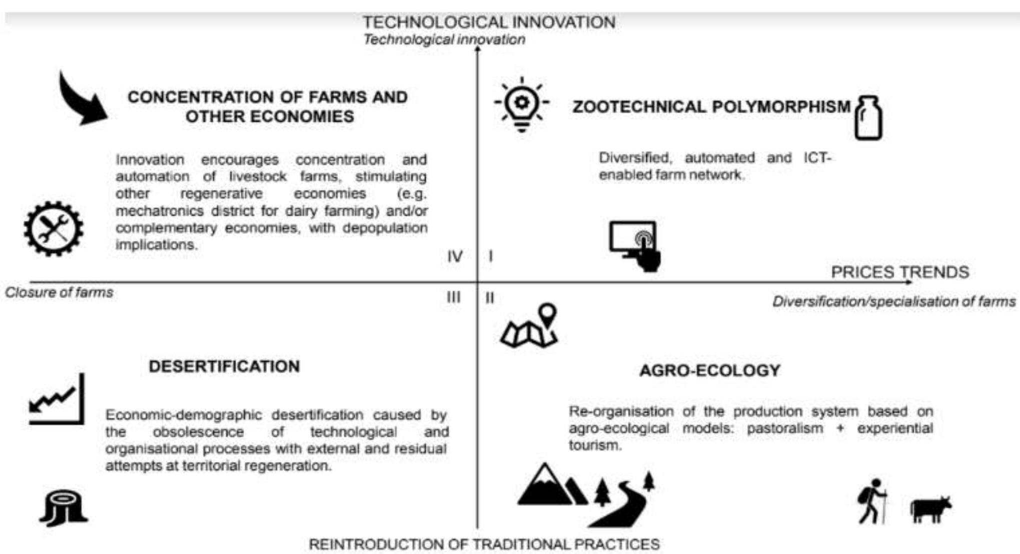
Workshop 3 (WS3):
Input: materials collected in WS2
Preliminary activities: construction of a fifth "hybrid" scenario
WS activities:
- sharing, integration and validation of the fifth hybrid scenario;
- discussion on practices, actions and policy interventions needed to achieve the fifth hybrid scenario, through serious game. The starting point for the identification of the future needs for the area was the baseline scenario, after which elements for the implementation of the CAP in the Central-Southern Apennine area were identified. The intermediate stage was identified with the year 2030, in relation to which a series of expected outcomes were designated, from which policy hypotheses to 2050 come to life, and then to the end point of the journey, i.e. the preferred scenario to 2050.

Output: policy orientations for the near and distant future of the subject area.

RESULTS

From the first workshop, it emerged that the most important and uncertain long-term trends that seem to drive the key variables underlying the baseline scenario are recognisable in price trends and technological innovation. Therefore, using them as the axes of a 2x2 matrix, it was possible to outline 4 possible future scenarios for the south-central Apennine area, as shown in Figure 1.

Figure 1 – Possible scenarios



Source: own elaboration.

In the first scenario (zootechnical polymorphism), ICT offers the opportunity for remote control of stables and better management of livestock activities, enabling an increase in the availability of local raw material, which could be a source of positive externalities benefiting even smaller and technologically less advanced farms, whose local demand could be supported by tourism.

In the second scenario (agroecology), the conscious and strategic rejection of technological innovation is accompanied by the ecological and social dimensions of agricultural systems, steeped in tacit knowledge related to milk production and processing. Growing consumer interest in products obtained through agro-ecological processes has generated significant price increases, a necessary condition for the phenomena of neo-pastoralism to also be economically viable.

In the third scenario (desertification), refractoriness to technological innovation could prove fatal. The simultaneous absence of significant support from consumers, unwilling to pay rising prices to compensate for the inefficiency of business models that have become obsolete, could generate a stalemate, disincentivizing generational turnover and further desertification, both economically and demographically, in the south-central Apennines.

Finally, in the fourth scenario (concentration of farms), technological innovation generates a strong polarization of farms, favouring especially large ones. The gradual and inexorable decrease of small farms would increase the perception of “industrialization”; of the environment by consumers, who would reduce their willingness to pay for food whose uniqueness would, in their view, be questioned.

During the second workshop, in choosing the preferred scenario, the panel failed to converge on a common scenario, showing preferences for scenario 1 (zootechnical polymorphism) and 2 (agro-ecology). From the considerations gathered through Miro platform, it emerges that the panel agrees on the need to innovate, with the intention of not totally giving up the technology, but using it without disrupting the process, giving companies time to get used to it (scenario I and II).

Taking into account the comparison developed in WS2, a hybrid scenario (scenario 5) was developed by the research team that incorporates the need for the advanced technological innovations to ensure that farms (particularly livestock farms) would have the necessary generational change, through mitigation of operating costs and mitigation of the hardship caused by the lack of and/or remoteness from essential services, but at the same time would continue to ensure a significant availability of local raw material, which processors could further enhance in national and international markets, emphasizing the strong link of their products with the territory of origin. Smaller and less structured farms could also benefit from this notoriety, if accompanied by a conscious and strategic adoption of organic.

The future needs (near and far) of the area, as well as the policy demand that emerged from the foresight exercise can be summarised as follows:

o horizon 1 implementation of CAP 2023-2027 programme, impacts to 2030:

-Technology- policies intervene to provide a basic level of digitization to farms in the south-central Apennines and to potential infrastructure.

- Social- Policy needs are directed at halting depopulation by encouraging growth in the share of neo-rural residents and promoting social control practices aimed at protecting the reputation of value chain production practices.
- Markets - Policies aim to strengthen alternative food markets (short supply chains, GAS, Community Supported Agriculture, Food Policy Council) and a connection with certified circular economy markets.
- Training - policy needs aim at increasing the availability of formal and informal training courses related to value chain production practices, including in the circular economy.
- Environment - policies enable widespread dissemination of monitoring plans for the management of areas with high wildlife value, improved coexistence with wildlife, and sustainable management of water resources.
- Organisation - policies aim to rehabilitate significant portions of abandoned and degraded land and introduce rational grazing plans.

o horizon 2 needs to 2030 and policy actions to pursue the hybrid scenario to 2050:

- Technology - Policies are aimed at increasing the availability of digital and information services, improving the quality/cost ratio of production, and grazing and animal welfare assurance techniques.
- Social- Policies aimed at restoring and enhancing essential services, particularly health and transportation and strengthening social inclusion initiatives for the purpose of attractiveness to neo-rural people.
- Markets - Policies for markets, on the other hand, concern the improvement of access to credit through innovation in financing instruments and procedures, as well as the rationalization of supply through cooperative practices and tourism diversification of farms and dairies.
- Training - Policies aim to increase and ensure long life learning initiatives to value chain operators and to design and implement e-learning platforms.
- Environment - Policies aim to define and update indicator sets for environmental monitoring, as well as pasture monitoring and the adoption of regenerative farming techniques.
- Organisation -policies act to reorganise and simplify the territorial governance.

The methodology provided for the foresight exercise has been adapted to allow the panel to express themself. Indeed, achieving the shared scenario required further additions after the II workshop, using the Miro digital tool to allow for further interactions and comments.

The panel actors have shown a certain vivacity in participation, related not so much to the exercise itself, but to the current state of affairs. The risk is that the attitude was distorted by the existing conditions and conflict situations, i.e. those concerning regional policy sharing and the distance between policy makers and farmers. Hence, the scenarios were also drawn on the basis of this distortion and the comparison, also interfacing with the 'environmentalism'-'productivism' clash, which found a meeting point in the hybrid scenario adopted and validated.

With regard to policies, there are actors who are fully aware of their criticalities and limitations, on the other hand, who are waiting for the results with regard to their own situation. This points to differences in perception, awareness and experience on the part of the actors involved.

What emerges from the foresight exercise is that the habit of conducting shared foresight exercises is lacking. This highlights, on the one hand, the limitations of the exercise, but also its pedagogical value, which can be seen in the introduction of the method and the direct involvement of the actors.

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The role of research in the sustainability transition(s) in rural areas: a survey on Living Labs operated in EU-funded projects

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Rural areas; sustainability transition; Living Labs; survey; transdisciplinary research.

The challenges that current societies face have evolved to become increasingly complex. To address the 'wicked problems' of the Anthropocene and support sustainability transition(s), a new role of research in knowledge production has been called for (Caniglia *et al.*, 2021; Ravetz, 1999). Until recently, researchers analysed the Earth's system functioning and dynamics, and supported policymakers to come up with solutions (Schneider *et al.,* 2019). However, current challenges go beyond individual fields of study, involve multiple sectors and actors and link local and global aspects (OECD, 2020), raising the need for a broader collaboration between science, policy, and practice (Schneider *et al.,* 2019).

Engaging into meaningful dialogues and learning processes with a broader set of societal actors has entered rightfully within the research agenda. The European Commission's Standing Committee on Agricultural Research (SCAR) has outlined "a transformative research agenda to be implemented in synergy with long-term policy strategies" (European Commission – SCAR, 2021, p.16), urging that research becomes more responsible and collaborative. To inform better action in a complex field such as food and agriculture, the views from different stakeholders must be gathered through better science-policy-society interfaces (European Commission – SCAR, 2021). Accordingly, the H2020 and Horizon Europe frameworks emphasise the notion of multi-actor approaches as "collaboration between various actors to make best use of complementary types of knowledge in view of co-creation and diffusion of solutions/opportunities ready to implement in practice" (EIP-AGRI SP, 2017). The opportunity for science to "collect research needs from practice" is also emphasised (EIP-Agri, no date).

Transdisciplinary (TD) research offers new ways of generating and integrating different kinds of knowledge through collaborative approaches (Lawrence *et al.,* 2022). Amongst these, the Living Lab approach holds great promise for accelerating the co-development and adoption of innovations, catalysing system-wide transitions for greater sustainability, encouraging knowledge exchange and mutual learning (Knickel *et al.,* 2023), and driving policy development (McPhee *et al.,* 2021). The application of Living Lab (LL) approaches is growing in many fields, including agriculture and environmental sustainability (Beaudoin *et al.,* 2022) and rural development. Despite this, there are varying opinions and perceptions regarding the reliability, validity, and impact of TD research in academia, with some scholars expressing skepticism about its effectiveness and practical implementation in the absence of an official definition, a concrete framework and empirical research strategies (Thompson *et al.,* 2017; Jahn *et al.,* 2012). Empirical evidence is therefore needed to assess the capacity of TD research and, in particular, Living Lab approaches to address sustainability challenges.

The aim of this study is to reflect on the role of researchers in TD research collaborations in the rural and agri-food field. In particular, our ambition is to enhance our understanding of the evaluation and effectiveness of Living Lab approaches in achieving the stated objectives of the collaboration, and the perceived added value for researchers. We draw on almost a decade of experience of doing research in Living Labs within EU-funded projects on digitalisation, rural development, agriculture, and sustainable food systems, as well as on available scientific literature in the field of TD research in these fields.

Our methodology entails a three-step approach. Firstly, we carried out a focus group session designed as a dialogue among researchers from the field, aiming to elicit their experiences and identify knowledge gaps. Subsequently, we facilitated a World Café workshop, with extensive participation from European researchers and practitioners from various EU-funded projects. Drawing upon the insights gathered from these activities, we synthesised the findings to establish a framework for designing our survey.

The survey (Arcuri *et al*., 2023) is designed as an open access tool to address multiple purposes. First, it offers a checklist for setting up Living Labs, and is categorised into five main themes/blocks: (i) the Structure and aims of the Living Lab, (ii) Process and activities, (iii) Actor dynamics, (iv) Impacts, (v) The role of research. In addition, this tool can be used – either as it is or adjusted to meet specific project's requirements – for monitoring and evaluating Living Labs. Its primary audience consists of researchers working in projects focused on rural areas and agri-food systems that involve Living Labs.

Between February and April 2023, following a pilot phase, we ran the survey within an EU-funded project working with Living Labs to address challenges and identify solutions related to digitalisation in agriculture, forestry, and rural areas. We received 24 responses, representing a diverse range of perspectives from researchers working in 9 different Living Labs. The findings of our study provide valuable insights into how researchers perceive and engage with the Living Labs in the context of rural areas, making a distinction between the themes and objectives in relation to the content (sustainability, policy-oriented action, rural areas, …) and to the methods for, and modes of, implementing the collaboration (communication, engagement, facilitated interactions).

We use these findings to explore future opportunities and challenges on how these collaboration processes are managed, how actor dynamics are navigated, and assess actual and potential effectiveness and overall value of these approaches.

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CO-PROGETTAZIONE DI UNA FILIERA ALIMENTARE COMUNITARIA COME STRATEGIA PER LA RIGENERAZIONE E LA RESILIENZA ALIMENTARE DELLE AREE INTERNE

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PAROLE CHIAVE
Agricoltura civica, community engagement, world café, Alternative food network.

INTRODUZIONE

Il cambiamento degli stili di vita dei cittadini insieme alle nuove prospettive di sviluppo rurale in chiave multifunzionale, aprono spazi innovativi di integrazione tra contesti urbani e rurali (Duvenroy *et al*., 2005; Torquati e Giacchè, 2010). È evidente che entrambi gli spazi, rurale e urbano, sono alla ricerca da una parte di nuovi equilibri che necessariamente fondano le loro radici su nuove politiche urbane e, dall'altra, sulla loro capacità di riorganizzare produzioni e servizi rurali in risposta all'evolversi della domanda di cibo e di connessione con la natura. In tale contesto si prospettano nuove opportunità connesse alla cosiddetta Agricoltura Civica, che lega la presenza di processi produttivi vitali ad interazioni estese tra mondo agricolo e bisogni alimentari, educativi, sociali ed ambientali espressi dalla cittadinanza (Di Iacovo *et al*., 2010). Tali legami possono risultare duraturi solo grazie a politiche urbane, introdotte dalle amministrazioni comunali, in grado di coinvolgere comunità capaci di dialogare e organizzarsi intorno al campo di azione dell'agricoltura civica. È chiaro che sia la riorganizzazione di filiere produttive in chiave locale, dove gli attori coinvolti sono principalmente appartenenti al settore agroalimentare, sia la riorganizzazione di servizi sociali e ambientali, dove gli attori coinvolti appartengono a contesti molto diversi, richiedono anche il coinvolgimento della comunità del territorio. Tale partecipazione dovrebbe partire dalla consapevolezza che le comunità connesse all'agricoltura multifunzionale sono e devono essere formate da aziende, istituzioni e consumatori/utilizzatori consapevoli, cioè persone ed enti che considerano la produzione del cibo e di servizi ambientali e sociali mediante un approccio olistico. Lo studio della letteratura su ciò che di norma è definito come "community engagement" mostra come tale concetto includa un'ampia gamma di strategie messe in atto da molteplici attori sociali (Torquati *et al*., 2020). Molte azioni sono qualificate in base all'impegno e al coinvolgimento da parte della comunità: dalla co-progettazione al coinvolgimento nello spazio pubblico, dalle pratiche di attivisti a progetti cooperativi radicati in contesti locali. La ricerca sociale, in particolare quella antropologica, ha come suo fondamento un "uso sociale" della pratica etnografica volta ad analizzare i problemi della società (Seppilli, 2008) mostrando come sia di fondamentale importanza lavorare direttamente con le comunità e a stretto contatto con gli attori sociali. Michele Micheletti, studiosa dei fenomeni di partecipazione e coinvolgimento di comunità, definisce i percorsi di consumo come azioni politiche all'interno delle quali gli attori sociali hanno come obiettivo il cambiamento di pratiche istituzionali e di mercato (Micheletti, 2003). Tali scelte, in un'ottica collettiva, rientrano nell'interesse di questo lavoro in quanto rapportabili alle istituzioni, quale soggetto mediatore di tali pratiche, e alle imprese agricole che tentano di costruire strategie di produzione agricola in chiave multifunzionale.

In particolare, il lavoro esplora la possibilità di costruire una rete di produttori e consumatori in un'Area Interna della regione Umbria secondo il modello del Villaggio del cibo (Stella *et al*., 2022), che richiede l'attivazione di un'ampia gamma di strategie messe in atto da molteplici attori sociali, tra cui quelli pubblici.

IL TERRITORIO

I territori delle Aree Interne vivono da sempre una situazione di sofferenza e disagio rispetto alle altre aree del paese, sia per colpa della migrazione del dopoguerra che ha portato al loro progressivo spopolamento, sia per i tagli alla spesa pubblica attuati dai governi che si sono succeduti (Alho *et al*., 2006; Münz, 2007). E invece, questi territori mostrano grandissime potenzialità a volte inesplorate e sconosciute anche a chi ci abita. Le attuali politiche nazionali stanno cercando di invertire la tendenza che si è verificata fino ad ora per rigenerare le Aree Interne, dotarle dei servizi minimi di cittadinanza e promuovere le bellezze storiche ambientali e culturali che li caratterizzano.

Il territorio oggetto di studio è quello dei comuni umbri della valle del Chiani che fanno parte dell'Area Interna sud-ovest Orvietano e della Green Community denominata "Umbria Etrusca" costituita per valorizzare il capitale naturale e il patrimonio storico. Per questi areali è stata effettuata una diagnosi territoriale che ha riguardato la struttura, l'evoluzione demografica, le caratteristiche del mercato del lavoro e l'analisi dei settori economici. L'analisi del territorio ha permesso di evidenziare e confermare un progressivo impoverimento del tessuto socio-economico dell'area in termini di evoluzione ed età media della popolazione residente, tasso di attività e tasso di occupazione.

Alla fase di diagnosi è seguita la ricerca e l'analisi delle politiche attuate sul territorio e, in particolare, la Strategia Nazionale Aree Interne (SNAI) ed il patto territoriale V.A.T.O. Il lavoro ha riguardato la redazione di un resoconto dei progetti realizzati, di quelli in fase di progettazione e di quelli programmati, cosa che ha fatto emergere sia le potenzialità che si è riusciti ad esprimere tramite queste politiche, sia le difficoltà ed i ritardi accumulati nella realizzazione delle opere.

Gli interventi attuati fino ad ora con le politiche di base hanno portato al mantenimento dei servizi essenziali, mentre le politiche definite di sviluppo locale hanno condotto alla valorizzazione delle risorse ambientali, turistiche e storiche presenti portando così ad un aumento dell'attrattività del territorio che ha determinato un aumento dei flussi turistici verso questi luoghi.

IL MODELLO

Partendo dal presupposto che il comparto agroalimentare possa costituire un importante volano di sviluppo per il territorio, tra i diversi modelli delle cosiddette Alternative Food Network (AFN) il modello del Villaggio del Cibo (VdC) è stato individuato quale strumento in grado di costruire valori e pratiche condivise attorno al cibo, alla sua produzione, al suo impatto sull'ambiente, sull'economia e sulla società.

Il VdC è un modello di produzione e distribuzione alimentare che ha un approccio innovativo e il cui obiettivo è creare un modello di filiera alimentare ultracorta, co-progettata e partecipata tra produttori e consumatori (Stella *et al.*, 2022). Al centro del modello c'è il "Patto comunitario per il Cibo" che consiste in un insieme di valori e pratiche condivise attorno al cibo, alla sua produzione, al suo impatto sull'ambiente, sull'economia e sulla società. Il Patto comunitario per il Cibo è basato sui principi della Sovranità alimentare, dell'Economia Civile e del Bene Comune.

Il VdC vuole essere una espressione diretta dei bisogni di tutte le persone che partecipano alla Comunità del Cibo, ed è costituito da uno spazio fisico dove co-esistono:

1. food market, dove sono venduti prodotti alimentari, realizzati preferibilmente con tecniche agricole ecosostenibili, provenienti per il 20% da aziende "ultra-locali" (distanza massima 50 km) coinvolte nella cooperativa, per circa il 60%, da aziende "locali" non associate ed ubicate a un massimo di 160 km di distanza, per la rimanente parte, che riguarda in particolare le produzioni non producibili nell'areale, aziende fino a 500km e oltre;
2. laboratori di micro-trasformazione, quali molino, pastificio, caseificio, frantoio, pulitura sementi, trasformazione carni, lavorazione e trasformazione frutta e ortaggi ecc., dove sono realizzati processi di trasformazione dei prodotti agricoli delle aziende socie da parte dai lavoratori della cooperativa;
3. spazi di democrazia partecipativa e di formazione, finalizzati alle assemblee sociali, alla formazione partecipata dei prezzi, alla coprogettazione delle produzioni e alla certificazione partecipata delle produzioni, nonché alla formazione permanente a produttori e consumatori;
4. spazi di intrattenimento e ristorazione, dove le persone potranno incontrarsi e assistere a eventi culturali.

Quattro sono gli assi fondamentali:

1. Possibilità di lavorare all'interno del supermercato secondo il "Modello Food Coop Park Slope" - i soci consumatori potranno scegliere di lavorare 3h al mese all'interno del food market e in cambio riceveranno uno sconto del 20% sui prodotti acquistati. A differenza del "Modello Park Slope" lavorare all'interno del supermercato non sarà obbligatorio, ma una scelta del consumatore.
2. Co-progettazione delle produzioni - una volta all'anno i "soci consumatori" a seguito di un processo guidato di analisi dei propri consumi medi, decidono insieme ai produttori le colture da coltivare, partecipando all'investimento per l'impianto, le operazioni agricole e quelle di trasformazione, per poi ricevere i prodotti richiesti in maniera regolare durante l'anno. I soci consumatori che sceglieranno di co-progettare le produzioni riceveranno uno sconto del 10% sui prodotti acquistati.
3. Formazione del prezzo annuale - tale asse coinvolge direttamente le produzioni conferite dai produttori locali. Ogni anno una "Commissione di soci" (produttori e consumatori), realizza un report dove sono indicati i costi di produzione, trasformazione e commercializzazione di ogni prodotto alimentare realizzato a partire dalle produzioni agricole conferite dai produttori soci della cooperativa. Sulla base di questo report sono stabiliti i prezzi di vendita dell'anno tenendo in considerazione in particolare l'equo compenso per i soci produttori, l'equo prezzo per i soci consumatori, nonché i costi di replicazione/disseminazione del modello.
4. Sistema di garanzia partecipativa (SPG) - È un sistema di certificazione dei prodotti agricoli operata direttamente dai soci produttori e dai soci consumatori basato sulla fiducia, su una costante interazione e sullo scambio di conoscenze proprie del luogo in cui si sono sviluppate. Il SPG prevede un protocollo di verifica delle produzioni basato su un disciplinare realizzato dalla Comunità del Cibo che attua le verifiche stesse.

L'innovazione contenuta in questo modello è l'idea che, al fine di realizzare una filiera realmente equa ed ecologica, produttori e consumatori debbano essere coinvolti nello stesso soggetto giuridico tramite il quale avvengono aggregazione dell'offerta, trasformazione e commercializzazione. In questo modo si può auspicare che il processo economico sia ecologico e realizzi contemporaneamente efficienza, redistribuzione e relazionalità, divenendo così un organismo funzionale al bene comune della collettività intera.

Nella tabella 1 sono state sintetizzate e messe a confronto alcune caratteristiche che contraddistinguono le principali Alternative Food Network presenti in Italia, quali: il Gruppo di acquisto solidale (GAS), il Gruppo Organizzato Domanda Offerta (GODO), il Community Supported Agriculture (CSA) e la FOOD COOP -Park Slope a cui il VdC si ispira.

Tabella 1: Confronto tra le principali Alternative Food Network presenti in Italia

	GAS	**GODO**	**CSA**	**FOOD COOP - Park Slope**
Localizzazione/ prossimità	Elevata	Media	Non è stretta	Non è stretta
Coinvolgimento dei consumatori	Alto	Medio	Medio	Alto
Motivi di adesione	Motivi personali (qualità dei prodotti, valori etico-morali, fiducia nei produttori)	Motivi personali (qualità dei prodotti, valori etico-morali, fiducia nei produttori)	Motivi personali (qualità dei prodotti, valori etico-morali, fiducia nei produttori, acquisizione di nuove conoscenze)	Motivi personali (qualità dei prodotti, valori etico-morali, fiducia nei produttori, acquisizione di nuove conoscenze, prezzo equo)
	Motivi community -oriented (interazioni sociali, supporto ai produttori)	Motivi community -oriented (interazioni sociali, supporto ai produttori)	Motivi community -oriented (interazioni sociali, supporto ai produttori, ragioni ecologiche)	Motivi community -oriented (interazioni sociali)
Effetti di sostenibilità	Nascono con l'intento di sostenere un certo tipo di agricoltura, locale e a basso input.	Consumo critico di cibi sani, che abbiano un buon livello nutritivo, nonché una qualità organolettica elevata.	Sana alimentazione e uso attento delle risorse naturali	Sana alimentazione
Limiti	Mercato di nicchia	Assortimento limitato	Scarsa corrispondenza tra prodotti ordinati e prodotti consegnati	Adesione e collaborazione da parte dei consumatori
Diffusione in Italia	Alta	Bassa	Media	Bassa

LA METODOLOGIA DEL WORLD CAFĔ

Per saggiare i feedback della popolazione riguardo al modello è stato fatto un focus group utilizzando la metodologia del World Café (Löhr *et al.*, 2020), metodo nato in America agli inizi degli anni ’90. Esso consiste nel ricreare l’ambiente simile a quello di un “café” per instaurare una conversazione tra i partecipanti che espongono e scrivono le loro idee su dei post-it applicati su dei cartelloni nei quali vengono pre-identificati gli argomenti da trattare. L’evento, che ha visto la presenza di sindaci, ricercatori, produttori agricoli, consumatori e commercianti, è stato promosso da due sindaci a sottolineare l’interesse delle istituzioni locali. L’incontro è iniziato con la descrizione del contesto territoriale e del modello del VdC; successivamente i partecipanti sono stati suddivisi in tre gruppi ognuno dei quali a rotazione ha discusso i tre macro-temi che identificano i punti chiave del VdC e i rispettivi sottotemi che costituiscono gli assi portanti per lo sviluppo del progetto:

1. organizzazione dell'offerta, declinata in: portatori di interesse da coinvolgere, strategie di coinvolgimento, contrattualistica tra produttori e villaggio del cibo;
2. sensibilizzazione della domanda, declinata in: portatori di interesse da coinvolgere, strategie di coinvolgimento, interconnessione con i progetti realizzati sul territorio;
3. organizzazione della vendita e governance, declinata in: modello di governance del VdC, organizzazione del punto vendita, co-progettazione dei prezzi, interazioni tra consumatori, VdC e scontistica, interconnessione con i progetti attivi del territorio.

Nella fase di analisi dei risultati sono stati raccolte le considerazioni proposte declinate nei vari focus da cui poi è stata elaborata un'analisi SWOT.

I RISULTATI

Tra i punti di forza emergono le sinergie che possono scaturire tra le attività già presenti sul territorio e la realizzazione del VdC, la presenza nel territorio di impianti di micro-trasformazione, la messa a disposizione da parte di uno dei comune dell'area (Fabro) di un terreno posto all'uscita dell'autostrada, la presenza di professionalità vista la presenza sul territorio di un Istituto professionale agrario.

Le opportunità emerse sono numerose. Tra queste, quella di collegare il progetto al altre iniziative come quella del nascente Distretto del Cibo promosso del Gal Trasimeno-Orvietano e quella consolidata del Biodistretto del Lago di Bolsena. Molta rilevanza è stata data alla possibilità di aumentare l'offerta coinvolgendo i produttori dei territori vicini e di conferire i prodotti alle mense scolastiche del territorio.

I punti di debolezza identificati riguardano un ridotto numero di imprese agricole rimaste nel territorio, la mancanza di strutture di trasformazione per la filiera carne, la difficoltà a collaborare tra le istituzioni locali.

Le minacce maggiori sembrano derivare dalle normative europee sulla trasformazione e vendita dei prodotti alimentari e dalla concorrenza esercitata dalla GDO.

In generale è stata sottolineata la difficoltà del "fare comunità" a causa di una certa diffidenza da parte dei cittadini che vedono le azioni proposte sul territorio come frutto di una parte politica. Mentre i punti cardine del modello del VdC sono stati ritenuti capaci di generare un interesse trasversale tra consumatori, produttori e enti locali e di spingere verso la creazione di una community engagement, tra questi: la possibilità di lavorare all'interno del supermercato secondo il "Modello Food Coop Park Slope", la co-progettazione delle produzioni, la formazione del prezzo annuale, l'implementazione di un sistema di garanzia partecipativa (SPG)

L'evento del World Café ha messo in evidenza una volontà di partecipazione da parte della popolazione e degli stakeholder, l'interesse di condividere esperienze e di conoscere nuovi strumenti che aiutino alla definizione di una strategia unitaria. In particolare, ha permesso di analizzare e far conoscere ai portatori di interesse le potenzialità del VdC, le disponibilità di infrastrutture sul territorio, le sinergie con progetti già realizzati o in corso di realizzazione e, soprattutto, ha permesso di mettere in evidenza le criticità che questi soggetti del settore agroalimentare riscontrano quotidianamente. Infine, ha sollecitato i sindaci dell'Area Interna sud-ovest Orvietano a presentare congiuntamente un progetto di ricerca triennale per realizzare un percorso partecipativo permanente basato sui principi del Community engagement intorno al tema del Villaggio del Cibo.

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PERFORMANCE ASSESSMENT OF PARMIGIANO-REGGIANO DOP DAIRIES: A COMPARATIVE ANALYSIS BY ALTITUDE RANGE AND LEGAL FORM

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KEY WORDS
Parmigiano-Reggiano DOP, EM-Score, Net working capital, DuPont chart, Cooperative dairies

1. Introduction and objectives of the work

Agri-food productions play an important role in the social and economic system. Not only they guarantee food needs, but create employment, protect the territory and play a role in the field of environmental and social sustainability (De Luca *et al.*, 2015; Lanfranchi *et al.*, 2015; Stillitano *et al.*, 2021; Zarbà *et al.*, 2021). Typical food products in Italy, protected by the European Union with the PDO, PGI and TSG marks are widespread even in disadvantaged areas, the total value of production in 2021 is 19.1 billion euros, of which 10.7 billion for export, equal to 21% of total Italian agri-food exports (ISMEA, 2022); there are 845 PDO, PGI and STG productions in Italy (3,069 in Europe), of which 526 are wines, and involve 198,842 operators organized in 291 Consortia for the protection of typical products and Parmigiano-Reggiano PDO is the first Italian production with PDO, PGI and TSG mark.

Parmigiano-Reggiano PDO (PR-RE) is regulated the production specification (Disciplinare di Produzione, in Italian, https://www.parmigianoreggiano.com/it/consorzio-disciplinare-normative, accessed 24th July 2023), which defines the rules to which the production of this cheese must comply, and it states: "*3.2) Il «Parmigiano Reggiano» è un formaggio a pasta dura, cotta e a lenta maturazione, prodotto con latte vaccino, crudo, parzialmente scremato per affioramento naturale. Il latte non può essere sottoposto a trattamenti termici e deve provenire da vacche la cui alimentazione si basa sull'impiego di foraggi ottenuti nella zona d'origine. La stagionatura deve protrarsi per almeno 12 mesi. Il «Parmigiano Reggiano» può essere commercializzato in forme intere, in porzioni ovvero grattugiato. … 3.3) L'alimentazione delle vacche si basa sull'impiego di foraggi della zona geografica delimitata ed è definita in quantità ed in qualità. Almeno il 75 % della sostanza secca dei foraggi deve essere prodotta all'interno della zona geografica. I mangimi possono costituire al massimo il 50 % della sostanza secca della razione. È vietato l'uso di insilati di ogni tipo. Latte vaccino, sale, caglio di vitello. Il latte proviene da vacche allevate nella zona geografica delimitate. … 3.4) Gli allevamenti di bovine da latte la cui produzione è destinata alla trasformazione in «Parmigiano Reggiano» sono ubicati nella zona geografica delimitata. La produzione del latte e la sua trasformazione devono avvenire nella zona geografica delimitata. Il latte, ottenuto dalla mungitura della sera e dalla mungitura del mattino, è consegnato crudo ed integro al caseificio, nel rispetto del disciplinare di produzione. Il latte del mattino viene immesso in caldaie di rame e miscelato con il latte della sera, parzialmente scremato per affioramento naturale. … La stagionatura minima di 12 mesi deve avvenire nella zona geografica delimitata. … 4) La zona geografica delimitata comprende i territori delle* *province di Bologna alla sinistra del fiume Reno, Mantova alla destra del fiume Po, Modena, Parma e Reggio nell'Emilia.*". Production specification shows that: 1) the production area is delimited, at each stage of production; 2) there are regulatory constraints that influence both the breeding phase, the transformation and the subsequent aging; 3) these constraints can have an effect in limiting dimensional economies of scale. Furthermore, the aging constraints increase the need for investment for businesses, both as regards the milk transformation phase and the subsequent aging of the product. The increase in investments has the effect of: i) the need to find the necessary sources of financing on the debt capital market or with contributions from members, in terms of equity capital and, for cooperatives, with payment deferrals to members for the payment of the milk delivered; ii) the reduction of turnover and the need to increase margins on sales (ROS) so that ROA > ROD is verified; iii) evaluate production diversification actions, if permitted by the Disciplinare di Produzione, or marketing of other products, which allow for an increase in turnover ratio.

Several studies have shown that agricultural businesses suffer from structural difficulties in accessing the capital market, especially small businesses and start-up (European Commission, 2020). Other studies have explored the difficulties in accessing credit and the relationship between agricultural businesses and banks in Italy (Dono *et al*., 2022; Bonazzi *et al*., 2021) and in other European Countries (Fenyves *et al*., 2020), particularly in the management of working capital, which affects cheese processing companies in the aging phase and management of the collection of trade receivables (Fernández-López *et al*., 2020). The topic of financial instruments that are available for the financing of agricultural businesses, also with reference to fin-tech and crowdfunding operations to finance rural development, is widely discussed, particularly in recent years, during and after Covid-19 pandemic (Licciardo, 2020).

Given these general premises, it can be observed that firms in the PR-RE PDO sector have to face a series of critical issues: 1) increase in production costs, in particular energy costs; 2) more difficult access to credit and higher interest rates, especially in the last year; 3) market difficulties, linked to changes in consumer choices and competition from similar products.

Given these premises, the work has several objectives: 1) to analyze the economic and financial performance of the companies in the PR-RE DOP sector, in relation to the aspects of economic results and capital structure, 2) to investigate whether there are significant differences in the economic and financial performance between mountain companies and companies operating in plain and hilly areas and between cooperative companies and limited liability companies and joint stock companies. The analysis of these points intends to deepen some themes: 1) the economic and financial sustainability of companies in the sector and the ability to attract capital and access credit, 2) the presence of management risks, highlighted by the analysis of economic and financial data, 3) the possibility of transferring to sector operators and public decision-makers private and public interventions in support of investments in the sector and, if possible, also replicable in sectors other than the one being studied.

2. Theoretical-methodological framework

The performance of companies can be read through balance sheet data, in particular, the analysis of the financial statements makes it possible to analyze the economic, equity and financial balance and to identify the strong / critical elements in company management. This analysis is conducted through balance sheet ratios, which are aimed at investigating the aspects of profitability, capital solidity, short-term financial sustainability and capital turnover. The analysis is based on the financial ratio analysis methodology, through the ratio decomposition approach according to the DuPont scheme (Jin et al., 2017; Davidson, 2020; Anderson et al., 2023). This approach allows, through the calculation of scoring ratios, to analyze the ability of companies to have access to credit. In the paper, it is applied the following additive formula to decompose return on equity (ROE):

$$ROE = \left[ROA + \left(ROA - \frac{SF}{D^T}\right)\frac{NFP}{E}\right](1 - T_m) = \left[ROA + (ROA - ROD)\frac{NFP}{E}\right](1 - T_m) \quad (1)$$

An increase in the difference between return ROA and ROD, so called financial leverage, has the effect to increase net profitability (ROE) thus expressing that capital invested has a return (ROA) higher than cost (ROD) to be paid to finance investments.

In the research, the reclassification of the annual account statements was carried out, considering the balance sheet assets and liabilities and the income statement, and the related methods of exposure in a reclassified form for the purpose of calculating the performance (method that exposes the balance sheet reclassified according to the net invested capital format and income statement reclassified according to the added value format). The methodology deals with the issue of the representation of the investment in the financial statements of companies, considering the legal constraints and the indications contained in the accounting standards, as they are able to generate expectations of future income. The economic (ROE, ROA, ROS, TURNOVER), capital (DER, CREDIT_DAYS, DEBT_DAYS, INV_DAYS, CCC_DAYS) and financial performance ratios (EBITDA/Sales, ROD) are widely applied, as regards access to credit[1]; EM-Score index, derived from Altman was applied (Altman, 1968; Altman, 2015) to quantify firms' credit access capacity and financial sustainability of the operational cycle, using progressively increasing scoring classes (Fig. 1), from D (default) to AAA+ (lower risk of insolvency).

Fig. 1 – EM-Score scoring table

EM-SCORE	RATING
EM ≥ 8,15	AAA
7,60 ≤ EM < 8,15	AA+
7,30 ≤ EM < 7,60	AA
7,00 ≤ EM < 7,30	AA-
6,85 ≤ EM < 7,00	A+
6,65 ≤ EM < 6,85	A
6,40 ≤ EM < 6,65	A-
6,25 ≤ EM < 6,40	BBB+
5,85 ≤ EM < 6,25	BBB
5,65 ≤ EM < 5,85	BBB-
5,25 ≤ EM < 5,65	BB+
4,95 ≤ EM < 5,25	BB
4,75 ≤ EM < 4,95	BB-
4,50 ≤ EM < 4,75	B+
4,15 ≤ EM < 4,50	B
3,75 ≤ EM < 4,15	B-
3,20 ≤ EM < 3,75	CCC+
2,50 ≤ EM < 3,20	CCC
1,75 ≤ EM < 2,50	CCC-
EM < 1,75	D

[1] ROE = Π:E. ROE > 0 is a first-order condition to provide convenience in business management; second order condition is expressed as follows: ROE > Ke > 0, where Ke is the cost E. ROA compares the operating income with the total capital invested in the firm; ROA is the ratio between the earnings before interest and tax (EBIT), and the total asset (TA): ROA = EBIT:TA; ROA expresses the annual percentage yield of each unit of capital invested in a firm, regardless of the cost of debt and the taxes. ROD aims to quantify, in percentage terms, the average cost of the debt; ROD is expressed as the ratio between the economic result of financial management (SF) and net financial position (NFP), as follows: ROD = SF:NFP. debt equity ratio (DER) is calculated as the ratio between E and NFP, as follows: DER = NFP:E. DER expresses the level of debt, taking into account the degree of use of financial debt; DER is frequently applied to quantify the financial strength of a firm's capital structure. To quantify the duration of NWC financial cycle, three main financial ratios for the NWC duration are frequently applied: (1) CREDIT_DAYS, calculated as follows: CREDIT_DAYS = Accounts Payable x 365 : S; this expresses the length of the payment deferral given for accounts payable, in days; (2) DEBT_DAYS, calculated as follows: DEBT_DAYS = Accounts receivable × 365 : S; this expresses the length of the payment given by suppliers in days; (3) INV_DAYS, calculated as follows: INV_DAYS = Inventories × 365:S; this expresses the length of inventory rotation in days; (4) the duration of working capital in days, (CCC_DAYS), thus expressing the so called Cash Conversion Cycle (CCC), the formula is: CCC_DAYS = CREDIT_DAYS + INV_DAYS - DEBT_DAYS (Curtis *et al*., 2015; Faello, 2015; Das, 2019).

The research considers the data of all the PR-RE PDO dairies, it is a sample of 214 companies, out of a 10-year historical series, for a total of 2,062 available observations, it is a data extraction from the AIDA database which covers all the dairies currently active in the transformation of milk into Parmigiano-Reggiano DOP and which deposit the balance sheet. the data of all the dairies that file financial statements and which, therefore, operate in the legal form of joint-stock companies or cooperative societies were considered. Sole proprietorships and partnerships were not considered in the research because balance sheet data is not available. The companies were further subdivided on the basis of the following criteria: 1) location in a mountain area or in a hilly/plain area; 2) legal form of cooperative company, or in the form of limited liability company or joint-stock company.

The data of the companies in the sample are treated as follows: 1) descriptive statistical approach on the balance sheet values of the companies and on the relative ratios, 2) ratio decomposition (multiplicative and additive DuPont chart, applying a decomposition approach), 3) analysis EM-Score ratio, 4) analysis of significant differences between mean / median values. The sample showed a divergent distribution with respect to the normal distribution for which a non-parametric approach was applied.

3. Analysis of the results

The research confirms that the sector is characterized by the presence of dairies that operate in the legal form of cooperatives; the sector includes 363 dairies and, of these, the available data of 214 companies were analyzed, of which 172 cooperatives. The research allowed to highlight the following results:

1. Overall, the dairies of the PR-RE PDO sector are characterized by high capital intensity, long duration of the aging cycle, low profitability, however, the effect of the cooperative legal form on the low profitability must be considered, where the remuneration of the members generally occurs through the remuneration of the milk.
2. Firms operating in the plains and hills (both in the form of joint-stock companies and cooperatives) are larger than the companies that operate in the mountain areas (Sales and Total Asset). Firms operating in plains and hills are characterized by larger average sizes, better economic and financial performance and better access to credit, as evidenced by the respective ratios; mountain dairies are on average smaller in size and have higher production costs and access to credit.
3. The size of joint-stock companies is larger than cooperatives, both in terms of sales volume and invested assets (investments). Joint-stock companies make greater use of risk capital to finance themselves while cooperatives use other sources of capital, including debt to members for milk deliveries; in fact, cooperatives of sub-sample B.1 have a long aging period (INV_DAYS = 406.55) financed with commercial debts (DEBT_DAYS = 392.85) including debts to members of the cooperative for milk deliveries.
4. Joint-stock companies are financed more with equity capital than cooperatives (DER are 0.71 and 3.86 respectively).
5. Cooperative firms suffer from undercapitalization and have worse scoring values than corporations, in particular in cooperatives based in mountain areas; the best balance sheet scores (EM-Score = 6.99) are achieved by joint-stock companies operating in the plains and hills, with only two joint-stock companies operating in mountain areas; the analysis how the cooperative legal form influences profitability; in fact, median ROE is zero for both sub-samples B.1 and B.2; the profitability to the members is, as emerges from the additional notes to the annual account statements, attributed through refunds on the raw milk material supplied for processing.

Tab. 1 – Total Sample data, 2,062 observation data points (214 firms for 10 financial years), descriptive statistics

Financial Value	Mean	Median	St. Dev.	Skewness	Kurtosis
Sales (€)	17,249,449	3,531,659	74,204,918	9.63	108.66
EBITDA (€)	771,072	110,116	4,827,268	0.00	211.31
Net Profit (€)	90,069	0	4,812,446	-32.39	1,268.19
Total Asset (€)	20,758,785	6,230,940	72,771,531	9.78	114.08
Equity Capital (€)	4,188,433	172,197	22,872,553	6.94	72.07
EBITDA/Sales (%)	4.13	3.00	12.31	-30.95	1,252.40
Return on Sales (ROS) (%)	1.92	0.90	3.93	1.18	20.28
Return on Asset (ROA) (%)	1.14	0.56	4.56	-20.43	757.83
Return on Debt (ROD) (%)	0.95	0.75	0.01	1.45	2.91
Return on Equity (ROE) (%)	1.24	0.00	10.40	-1.97	54.97
Debt/Equity ratio (DER)	32.08	2.43	112.62	5.32	30.59
Turnover (T)	0.66	0.62	0.28	2.19	12.06
INV_DAYS (duration of inventories)	399.55	388.29	239.83	10.93	206.00
CREDIT_DAYS (duration of acc. receivable)	91.03	73.44	82.34	5.69	62.25
DEBT_DAYS (duration of acc. payable)	377.61	365.79	275.61	7.53	116.88
CCC_DAYS (cash conversion cycle)	112.97	88.78	226.86	0.97	82.45
EM-Score	7.00	4.25	43.03	19.39	400.70

The data highlights the following significant differences:

- The majority of the median values for joint stock companies are statistically different from the data observed for cooperative firms (Sales, EBITDA (€), Net Profit (€), Total Asset (€), Equity Capital (€), EBITDA/Sales (%), Return on Sales (ROS) (%), Return on Asset (ROA) (%), Return on Equity (ROE) (%), INV_DAYS (duration of inventories), CREDIT_DAYS (duration of acc. receivable), DEBT_DAYS (duration of acc. payable), DEBT_DAYS (duration of acc. payable), CCC_DAYS (cash conversion cycle), EM-Score).
- Firms in all sub-samples have low turnover of invested capital (maximum turnover is 0.62, A.1 and B.1, minimum turnover is 0.25, B.2).
- The cost of financial debt (ROD) is higher (median ROD = 0.75) than the return of invested capital (median ROA = 0.56) and this result is extremely important in the actual market scenario of increasing interest rate to evaluate, even in perspective, the firms' capacity to sustain the cost of financial debt.
- Joint-stock companies operating in the plains and hills (A.1) are larger and have better performance than joint-stock companies operating in the mountains (A.2), the latter are only two companies; Joint-stock companies that operate in the plains and hills (A.1) are larger and have better performance than cooperative companies, both those that operate in the plains and hills (B.1) and those that operate in the mountains (B.2).
- The cooperatives that operate in the plains and hills (B.1) are larger (Sales and Total Assets in particular) than the cooperatives that operate in the mountains (B.2); Both of these firms have high median values of INV_DAYS (duration of inventories) and DEBT_DAYS (duration of acc. payable), even if B.1 firms have higher CCC_DAYS (cash conversion cycle) than B.2 firms. consequently, with almost the same risk capital, B.1 firms are more indebted; despite the higher level of financial leverage, the scoring of B.1 cooperative is higher than B.2 cooperative (EM-Score 4.21 and 3.35, respectively).

Tab. 2 – Sub-Samples: A: corporations (plain/hill/mountain), B: cooperatives (plain/hill/mountain)

Financial Value	Median	
	Sub-Sample A 42 Firms 365 Observ.	**Sub-Sample B 172 Firms 1,697 Observ.**
Sales (€)	6,166,468	3,355,654
EBITDA (€)	695,536	93,926
Net Profit (€)	205,422	0
Total Asset (€)	14,411,127	5,543,739
Equity Capital (€)	5,189,094	113,330
EBITDA/Sales (%)	8.40	2.66
Return on Sales (ROS) (%)	4.44	0.73
Return on Asset (ROA) (%)	2.60	0.46
Return on Debt (ROD) (%)	0.90	0.70
Return on Equity (ROE) (%)	4.52	0.00
Debt/Equity ratio (DER)	0.71	3.86
Turnover (T)	0.60	0.62
INV_DAYS (duration of inventories)	280.15	396.96
CREDIT_DAYS (duration of acc. receivable)	93.72	66.76
DEBT_DAYS (duration of acc. payable)	135.57	397.28
CCC_DAYS (cash conversion cycle)	211.70	71.06
EM-Score	6.92	4.05

Tab. 3 – Sub-Samples: A.1: corporations (plain/ hill), A.2: corporations (mountain), B.1: cooperatives (plain/hill), B.2: cooperatives (mountain)

Financial Value	Median			
	Sub-Sample A.1 40 Firms 353 Observ	**Sub-Sample A.2 2 Firms 12 Observ**	**Sub-Sample B.1 130 Firms 1,277 Observ.**	**Sub-Sample B.2 42 Firms 420 Observ**
Sales (€)	6,833,438	1,387,370	3,708,667	2,950,453
EBITDA (€)	746,902	-6,054	92,668	96,546
Net Profit (€)	228,305	-134,796	0	0
Total Asset (€)	14,685,978	5,394,740	6,103,666	4,828,967
Equity Capital (€)	5,626,657	272,584	113,330	117,820
EBITDA/Sales (%)	8.50	-0.94	2.50	3.17
Return on Sales (ROS) (%)	4.60	-3.24	0.73	0.75
Return on Asset (ROA) (%)	2.72	-0.85	0.47	0.46
Return on Debt (ROD) (%)	0.84	1.71	0.68	0.74
Return on Equity (ROE) (%)	4.62	-46.35	0.00	0.00
Debt/Equity ratio (DER)	0.72	0.00	5.42	3.39
Turnover (T)	0.62	0.25	0.62	0.61
INV_DAYS (duration of inventories)	266.80	368.45	406.55	370.89
CREDIT_DAYS (duration of acc. receivable)	92.21	182.95	67.12	66.88
DEBT_DAYS (duration of acc. payable)	134.87	273.39	392.85	411.33
CCC_DAYS (cash conversion cycle)	211.21	253.93	86.26	18.38
EM-Score	6.99	3.65	4.21	3.35

In evaluating the conclusions, it must be considered that the research has some limitations: a) the analysis of financial statements is affected by accounting principles and the limitation of some information;

moreover, dairies that do not file their annual account statements are excluded from the sample; b) the data in the annual account statements do not consider the company's confidential cost and revenue data for each single product or production line and do not consider the data relating to sales prices and processed quantities, such data is largely confidential and cannot be accessed using open access databases; further investigations could be carried out on this point; c) the data relate to the period 2012/2021 and therefore may be affected by the economic situation of that period.

The analysis assumes interest and the possibility of further developments as: 1) mountain dairies are relevant for the protection of the territory and it is therefore interesting to investigate, also with future research, which strategies they can implement to reduce production costs and operate production enhancement actions; 2) cooperative firms are single-product firms, while joint-stock companies, on the basis of reading the explanatory notes of the annual account statements largely produce other cheeses and food products; 3) in the financing of dairies, the following play a significant role: i) collateral guarantees, also with the tools of the revolving pledge in agriculture; ii) the issue of mini bonds and, in particular, ESG compliant loans (Li *et al*., 2023); iii) the role of guarantee consortia. For these reasons the research may have further developments, even in other sectors, in order to analyze the economic and financial sustainability, in particular, for firms located in disadvantaged mountain areas or operating in legal form cooperative.

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Quality of life in inland areas

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PAROLE CHIAVE
Quality of life, Inland areas, Rural development, Rural areas, Socio-economic development.

INTRODUCTION AND OBJECTIVES

The expression Quality of Life (QoL) was introduced in the 1970s in the United States to denote a new trend of studies with the aim of providing an estimate the distribution of social well-being, in order to help administrations make the best choices of intervention in sectors of society where there was a need to improve standards of well-being (Di Franco, 1989). There are many questions around this issue, which even today have difficulty finding an uncivocal and generally accepted answer. First of all, the question of definition. Indeed, QoL and Well-Being are often used as synonymous (McCrea *et al*., 2014; Pavot and Diener, 2008; Prilleltensky *et al*., 2015), this is primarily due to the fact that QoL is in many ways considered an intrinsically abstract concept, i.e. a vague and ethereal entity (Campbell *et al*., 1976) that needs to be concretised in order to be understood (Barofsky, 2012). Secondly, it is an extremely dynamic concept both in time and space, depending on the historical moment of evaluation and the society to which it refers (Pontin *et al*., 2013). In fact, it is no coincidence that QoL is defined as a multidimensional and integrated concept to assess the state of people's lives and often involves economic, social, cultural, political, ecological and other aspects (Boncinelli *et al*., 2015; Casini *et al*., 2019). As can be seen, it is a combined set of material and thus tangible aspects (income, housing, infrastructure, etc.) and non-material i.e. abstract aspects (spirit, psychology, cultural quality, etc.). Moreover, it does not only refer to an individual level, but also to a social level (Viccaro *et al*., 2021).

The literature has multiple theoretical and methodological proposals that focus on the issue of QoL assessment. However, despite their diversity, they all converge on the same aspect: Quality of Life is not the same as standard of living and cannot be reduced to Well-Being in the meaning of the provision of economic benefits and services (Ibidem). This has induced researchers to shift their focus. Indeed, they are no longer focused only on those factors that determine the evolution of the system of production and distribution of richness in a geographical area (e.g. income and PIL) but on deeper analytical aspects (Musella, 2015). In this view, the contribution of Amartya Sen (the main interpreter of the Human Development Theory) is particularly relevant. He shifted his focus from what man has (maximising the quantity of material wealth) to what man is and can achieve, i.e. his own freedom to be and to do (Sen, 2001). Sen clarifies that one the hand the increase in material assets can promote the expansion of such freedoms, on the other hand the link between increased material assets and improved QoL is not regulated by mechanical automatisms, but rather by a space to be filled with culture and appropriate policies (Musella, 2015).

This is all about the policies implemented or to be implemented to promote the improvement of quality of life of those geographical areas that cannot guarantee essential services and are therefore defined as marginal (National Strategy Inner Areas -NSIA, 2023). The later ones, which in the context of our National Territory correspond to 60% of the territorial area, 52% of the communes and 22% of the Italian population (Ibid.), are characterised by being communes with a great distance from the large urban poles, suffering socio-economic marginality and underdevelopment compared to the larger cities (Iammarino *et al.,* 2018). In fact, the lack of satisfactory levels of fundamental components of Well-Being determines a progressive impoverishment of the quality of human resources and also the possibilities for economic and social development. In such a context, the fear is to generate entire areas at risk of social exsclusion (Nuvolati, 2010).

In addition to this, many rural areas have to fight with a structural challenges due to a combination of population loss and/or ageing population, making it more difficult to maintain their living conditions (Zang *et al*., 2020). In particular, poor access to public services, lack of alternative employment and age structure significantly reduce development possibilities, especially with regard to opportunities for women and youth (Li *et al*., 2019). Despite the relevance of the issue, action strategies aimed at solving possible quality of life problems in rural areas have rarely been implemented (Casini *et al*., 2019).

For these reasons, the goal of my research project is to try to develop tools and practices to be applied in the future in order to improve the Quality of Life in rural areas. This as a prerequisite to reduce, and where possible prevent, episodes of youth emigration, avoid the emergence of new categories of at-risk individuals and ensure that marginal areas and communities are transformed into attractive places to live and work (Cork, 2016).

The achievement of this ambitious objective passes through the evaluation not only of the geographical components that characterise the territory under examination, but also through the analysis and evaluation of the territorial services present. The aim is to identify the most effective policies for improving the QoL, also thanks to the identification of its ex ante determinants, the design of targeted and articulated interventions, and the identification of targets and stakeholders to involve. The aim is to track and fix any criticalities, because a low standard of Quality of Life can compromise any possibility of development.

Moreover, the peculiarity of this research project consists in the fact that it does not refer exclusively to the agricultural sector, but has the prerogative of referring to rural society in general. These are areas defined by SNAI (2023) itself as "areas significantly distant from the centers of offer of essential services (education, health and mobility), rich of important environmental, cultural resources and highly diversified in nature as a result of secular processes of anthropization. These areas have gradually suffered a process of marginalization marked by: decline in population; reduction in employment and land use; decreasing local supply of public and private services; social costs to the nation as a whole, such as hydro-geological disruption and degradation of cultural and landscape heritage".

METHOD AND DATA

There are two types of approaches to measuring the quality of life in a particular community: the qualitative approach (which refers to subjective measures, i.e. based on citizens' perceptions of their living conditions), and the quantitative approach (which refers to objective measures, i.e. based on the manipulation of observable and measurable indicators).

For this type of research project was adopted an integrated qualitative-quantitative approach, and then contextually dividing the investigation into three phases. As for the scale of the choise of analysis, a local-level scale was chosen. More specific, in the first and current phase, the study is based on the multi-case design (Creswell, 2014; Yin, 2014), a qualitative approach involving desk analysis, online survey and interviews. Privileged stakeholders of the territory (Presidents of the Unions of Communes and Trade Representatives) were identified in order to understand, from the point of view of the institutional figures, the starting level of well-being of the administered territory, with a particular focus on the agricultural sector, as well as the main strengths and weaknesses. Specifically, seven stakeholders were contacted via e-mail and submitted to an online semi-structured interview. These interviews started in May 2023 and are still ongoing.

In this regard, it is hoped that at the end of the interviews, content analysis can be carried out using the IRAMUTEQ software, an R interface for the multidimensional analysis of texts, interviews and questionnaires. This analysis will focus on the meaning and semantic relationship of words and concepts, also in relation to the different methodological approaches described above. The result of this analysis will make it possible to move on to the second phase, which will involve the construction of a questionnaire, using a specially identified classification scale, in order to investigate citizens' perception of their living conditions. In addition, the results of the first phase are also important because they will allow the identification of specific municipalities, under inland areas, to which the questionnaire will be administered. Always from a local scale perspective. Finally, following the submission of the questionnaire, it will be possible to move on to the final phase which will involve the processing of the data collected and the interpretation of the results obtained.

CONCLUSIONS

The proposed theoretical-methodological framework can be a useful tool for evaluating inequalities in rural contexts based on the assumption that a reduction in local inequalities, carried out in terms of Quality of Life, can also promote an increase in rural performance and promote balanced development over time. In particular, it provides important information for those working to improve the living conditions of local communities according to an integrated approach.

The expected results of this research project, in a predictive manner, are: firstly, to delineate the framework that define the dimension and value of Well-Being, both in terms of material (income, housing, infrastructures) and immaterial elements (culture, landscape, spirituality). Secondly, to create a Decision Support System (DSS) able to increase the efficacy of analyses and at the same time obtain a composite view of the phenomena at work. This will make it possible to make complex and strategic operational choices, to carry out concrete interventions that can increase the level of the QoL of the area examined and, on the basis of these choices, trigger further processes and interventions to improve the socio-economic context of the area. Finally, establish a sequence of procedures that start from local needs, develop through the participation of local users and stakeholders and flow into the generation of effective policies to help the development of marginal inland areas.

It is all about to identify and implement concrete action that will bring about real change in these areas by promoting the socio-economic development of inland areas. In other words, the aim is to develop a model, a best practice, applicable and replicable in multiple contexts with same characteristics.

RINGRAZIAMENTI E FONTI DI FINANZIAMENTO

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ANALISI DELLE SINERGIE E DELLE POLITICHE PER RAFFORZARE I SISTEMI DI CONOSCENZA E INNOVAZIONE NEL MICRO-AKIS DEL CONTESTO OVINO DEL SUD DELLA TOSCANA

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PAROLE CHIAVE

Agricultural Knowledge and Innovation System; Ecosistema dell'Innovazione; Living Lab; Sinergie; Filiera ovina toscana; Caso studio

TESTO

Per promuovere l'innovazione è necessario un approccio sistemico, che parta dalla definizione dei bisogni attraverso strategie collaborative di co-creazione. Infatti, nella riforma della Politica Agricola Comune (PAC), adottata formalmente a dicembre 2021 ed entrata in vigore il primo gennaio 2023, la Commissione Europea per l'implementazione dei Piani Strategici Nazionali (PSN) ha richiesto ad ogni Stato membro di definire delle priorità d'intervento che, nell'insieme, contribuiscano alla risoluzione delle sfide comuni per l'Europa proposte dal *Green Deal* europeo. Al contempo, nel contesto della transizione verso nuovi sistemi agroecologici e digitali, si riconosce all*'Agricultural Knowledge and Innovation System* (AKIS) un ruolo cruciale nel facilitare la diffusione di conoscenze e nuove pratiche agricole che mettono al centro la sostenibilità e l'innovazione tecnologica (European Commision, 2019). L'innovazione, infatti, è vista non più come singolo evento ma come un processo e può essere co-prodotta attraverso le interazioni tra agricoltori, ricercatori, consulenti, consumatori ed altri attori intermedi, creando soluzioni grazie ad un processo di apprendimento collettivo che prevede la condivisione delle conoscenze (Fieldsend et al., 2021).

Il sistema AKIS, nell'ambito della PAC 2023-2027, detta un'impostazione strategica che privilegia un approccio sistemico territoriale che coinvolga una rete di attori, strutture e risorse necessarie alla creazione, diffusione ed utilizzo delle conoscenze nel settore agricolo (European Commission, 2019). A questo fine, la Commissione Europea incentiva e finanzia misure che promuovono la condivisione e la sperimentazione di nuovi strumenti digitali attraverso iniziative come i cosiddetti "Partenariati Europei per l'Innovazione in Agricoltura" (PEI-AGRI), che facilitano la collaborazione tra diversi attori, con lo scopo di identificare nuove soluzioni ed opportunità che abbiano un risvolto pratico sulla gestione sostenibile delle imprese agricole. Il processo di transizione verso sistemi agricoli maggiormente sostenibili non implica solo dei cambiamenti marginali, ma che necessitano di prendere in considerazione congiuntamente gli aspetti tecnologici e socioeconomici, dell'importanza dei diversi sistemi di organizzazione, dei processi di apprendimento e della diversità delle dinamiche di conoscenza che non possono essere racchiuse in un unico modello integrato (Ollivier et al., 2018).

Come sottolineato da Brunori (2022), le tecnologie offrono un gran numero di opportunità per la transizione ecologica dell'agricoltura. Tuttavia, la tecnologia da sola non è sufficiente a supportare delle strategie nel medio-lungo periodo che affrontino la complessità delle cause alla radice delle problematiche legate all'agricoltura. Questo cambio di paradigma necessita di politiche trasformative adeguate ad affrontare e a supportare i bisogni dal basso, che integrino le dimensioni della direzionalità, l'articolazione del mercato e la riflessività, per lo sviluppo di ecosistemi dell'innovazione favorevoli a tutti gli attori coinvolti nel processo, capaci di tener conto delle vulnerabilità delle infrastrutture e del divario digitale nelle aree rurali, favorendo il coinvolgimento degli utenti per rimodellare il processo sulla base dei risultati ottenuti (Grillitsch et al., 2019; Brunori, 2023).

Alcuni autori hanno studiato il processo di adozione delle innovazioni in agricoltura utilizzando la chiave di lettura del capitale sociale, poiché gli agricoltori, oltre alla necessità di avere accesso alle risorse finanziarie, alla formazione e alla conoscenza, necessitano del supporto emotivo e di stabilire un rapporto fiducia tra i diversi attori pubblici e privati come: altri agricoltori, consulenti e ricercatori, ecc. Esaminando le diverse tipologie di legame *bonding, bridging* e *linking*, che rispettivamente descrivono la capacità di creare capitale sociale aderendo a reti di conoscenze e relazioni già esistenti, connettendosi con nuove reti di collaborazione più ampie, e collegandosi a reti aperte che prevedono l'uso di risorse e informazioni da parte di istituzioni formali al di fuori della propria comunità, gli autori mettono in rilievo come queste possano rappresentare un'ulteriore variabile da analizzare per definire il contesto delle relazioni all'interno di una rete di supporto alla conoscenza (Cofré-Bravo, et al., 2019; King et al., 2019), come, ad esempio, il caso dei Living Lab (LL), in quanto laboratori aperti per la sperimentazione di approcci multi-stakeholder orientati all'innovazione, possono rappresentare un campo di studio per analizzare e sostenere la transizione dei sistemi agroalimentari locali (Gamache et al., 2020).

Pertanto, le sinergie tra gli attori, le risorse e le attività diventano un elemento chiave nell'ottica dei processi innovativi. Comprenderne le caratteristiche, a partire da maggiori evidenze empiriche, diventa fondamentale per un uso ottimale dei fondi europei per l'innovazione in agricoltura (European Commission, 2019). Volendo contribuire a colmare questo *gap*, il presente studio ha l'obiettivo di proporre un framework per l'analisi della complessità delle dinamiche che possono incentivare il trasferimento delle conoscenze nel settore agricolo, approfondendo quelle di policy che spingono la *twin transition.* In questa direzione, si considera l'Università come promotore di conoscenza e facilitatore nei processi di co-creazione dell'innovazione (Rinaldi et al., 2018) e di creazione di capitale sociale, rafforzando i legami nel territorio per favorire il processo di trasferimento delle conoscenze con una strategia a medio lungo termine.

Questo contributo si inserisce nel contesto del progetto PRIN SMARTIES – "*Puzzling out smart ruralities, sound knowledge and rural (agricultural/agrifood) entrepreneurial ecosystem*", che si propone di concettualizzare l'ecosistema digitale e la dimensione sistemica delle pratiche individuali che alimentano i sistemi socio-tecnici e i sistemi-socio-ecologici. Considerando il caso studio (Yin, 2003) del Living Lab di Manciano, che stimola sinergie all'interno filiera del Pecorino toscano, siamo andati a mappare gli attori, le strutture, le risorse, i flussi di conoscenza e le connessioni che alimentano il micro-AKIS del contesto della filiera ovina del sud della Toscana.

Seguendo lo schema proposto da Kah e Gruber (2019), che mette in luce i fattori chiave per la creazione delle sinergie, andremo ad analizzare: (i) fattori abilitanti che possono fornire una guida e un coordinamento nei sistemi di innovazione agricola; (ii) strategie utili a definire obiettivi e priorità; (iii) incentivi per mettere in atto le strategie (iv) armonizzazione dei regolamenti e semplificazione delle procedure che insieme alla fiducia, la trasparenza e la cultura dell'innovazione concorrono a migliorare i flussi di conoscenza e rafforzare lo scambio reciproco tra ricercatori e produttori (Fig.1).

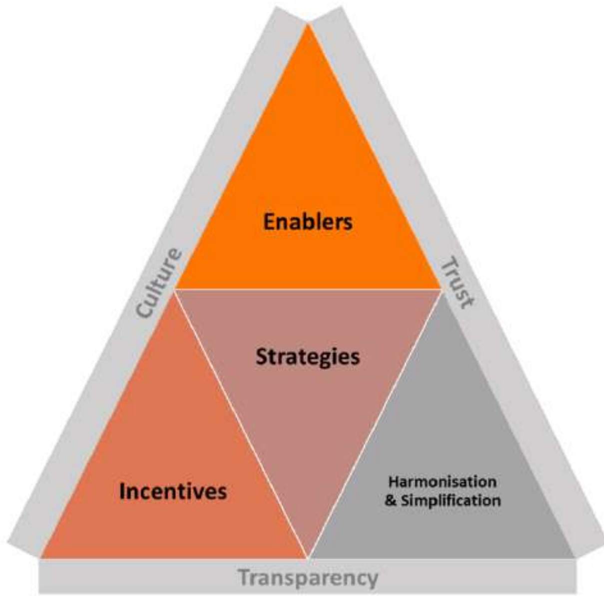

Figura 1: Fattori chiave per le sinergie (Kah e Gruber, 2019)

Il Living Lab di Manciano coinvolge una molteplicità di attori: le aziende agricole che conferiscono la materia prima, i caseifici che si occupano della trasformazione, il Consorzio di produzione del Pecorino Toscano D.O.P., differenti team di ricerca dell'Università di Pisa del campo veterinario, agrario ed economico, l'Istituto di Scienza e Tecnologie dell'Informazione "Alessandro Faedo" del Centro Nazionale di Ricerca (CNR), e infine i policy makers regionali che contribuiscono al dialogo per lo sviluppo di nuove strategie che incentivino l'innovazione del settore ovino e rafforzino la struttura delle aziende agricole che si basano sulle attività di allevamento e pastorizia.

Utilizzando l'analisi delle sinergie come chiave di lettura dell'ecosistema dell'innovazione del Living Lab di Manciano possiamo identificarne i diversi fattori chiave:

(i) I facilitatori (*Enablers*) sono le organizzazioni in grado di coordinare le attività degli attori dell'innovazione. I soggetti che facilitano le sinergie in quanto tali devono conoscere il sistema ed essere in contatto con tutti i soggetti interessati per essere in grado di coordinare le attività e di riunire gli attori. Stimolando la cooperazione, i facilitatori consentono di costruire un clima di fiducia che facilita la gestione della complessità del sistema dell'innovazione. Nel contesto del nostro caso studio è possibile identificare diversi soggetti riportati nella tabella 1 che supportano lo sviluppo di un ecosistema dell'innovazione:

Tabella 1 - Facilitatori del processo d'innovazione e nella creazione di sinergie tra gli attori del Living Lab

Facilitatori	**Attività**
Dipartimento di Scienze Agrarie, Alimentari e Agro-ambientali dell'Università di Pisa	Approcci partecipativi bottom-up per identificare le necessità di innovazione nel comparto ovino; coinvolgimento degli stakeholder che possono fornire soluzioni in essere o da sviluppare; coinvolgimento in progetti di innovazione in ambito europeo.
Dipartimento di Scienze Veterinarie dell'Università di Pisa	Trasferimento tecnologico; coinvolgimento nella sperimentazione di pratiche innovative cofinanziate da progetti regionali ed europei.
Istituto di Scienza e Tecnologie dell'Informazione "Alessandro Faedo" del CNR	Supporto allo sviluppo di piattaforme collaborative per la digitalizzazione dei dati e lo scambio dei flussi d'informazione lungo la filiera.

(ii) Le strategie (*Strategies*) devono definire gli obiettivi e le priorità che saranno perseguite utilizzando una varietà di strumenti e di fonti di finanziamento. Spesso tali strumenti di finanziamento operano già sulla base di strategie nazionali o regionali. Anche per quanto riguarda l'AKIS, l'UE ha previsto nella nuova programmazione l'obbligo di Piani Strategici Nazionali della PAC che fungono da quadro di riferimento a livello nazionale e regionale per tutti i sostegni per l'agricoltura e lo sviluppo rurale.
Nello specifico, la Regione Toscana si è assunta tre impegni specifici che coincidono con i principi dell'AKIS per lo sviluppo futuro dell'agricoltura, quali: essere più vicino all'impresa agricola; essere semplificanti; essere più competenti e connessi. Tali impegni si tramuteranno negli interventi finanziabili per sviluppare la diffusione della conoscenza; promuovere le conoscenze dei consulenti agricoli e rafforzare le loro interconnessioni all'interno dell'AKIS; sperimentare e adottare l'innovazione; migliorare l'innovazione interattiva transfrontaliera e transnazionale; promuovere un uso efficace delle tecnologie dell'informazione e della comunicazione per migliorare la condivisione delle conoscenze (Ministero dell'Agricoltura della Sovranità Alimentare e delle Foreste, 2023).

(iii) Nella creazione di reti multi-attore sono necessari incentivi (*Incentives*) per i singoli partner per ammortizzare le spese della costruzione delle reti e per lo sviluppo di progettualità da parte delle aziende agricole. Il Living Lab osservato ha beneficiato negli anni di risorse finanziarie che hanno influenzato il processo di digitalizzazione e incentivato lo sviluppo di reti di collaborazione come le misure del PSR 2014-2022 relative ai Gruppi Operativi, Progetti Integrati di Filiera (Pif), Progetti Integrati di Distretto (Pid), e Progetti Horizon per le attività di ricerca ed innovazione.

(iv) L'armonizzazione dei regolamenti e la semplificazione delle procedure (*Harmonization & Simplification*) sono importanti per non creare ulteriori complessità che possono scoraggiare la creazione di sinergie. In questa direzione il Regolamento Omnibus (Reg. UE 2017/2393) ha introdotto delle novità volte a snellire le norme finanziarie riguardanti anche l'accesso ai fondi del comparto agricolo.

Ci sono poi altri fattori come la trasparenza (*Transparency*), la fiducia (*Trust*) e la cultura (*Culture*), senza i quali la cooperazione e l'orientamento all'innovazione non sarebbero possibili. Infatti, l'introduzione di innovazioni digitali e di innovazioni tecnologiche nelle pratiche agricole comportano dei cambiamenti nel sistema socio-tecnico e socio-ecologico che in quanto tali sono il prodotto di interazioni sociali tra le persone, istituzioni, normative, tecnologie e ambiente (Jakku et al., 2019; Anderies et al., 2004). Inoltre, è essenziale non trascurare l'importanza della continuità nel tempo della collaborazione che contribuisce al consolidamento delle sinergie e alla creazione di cultura dell'innovazione, favorendo la creazione di capitale sociale e quindi il rafforzamento delle relazioni in grado di agevolare lo scambio di conoscenza all'interno di una rete multi-stakeholders.

Lo studio dei fattori abilitanti alla creazione di sinergie all'interno del caso oggetto di studio ci permette di osservare a livello macro una serie di dimensioni che contribuiscono a definire l'ecosistema d'innovazione. Tale studio pone le basi per un approfondimento futuro mediante un'analisi quali-quantitativa per l'identificazione della tipologia di relazioni e collaborazioni tra gli stakeholder del Living Lab. Questo contributo presenta delle importanti implicazioni sia dal punto di vista teorico che pratico. Infatti, offre una sperimentazione del framework relativo alle sinergie (Kah e Gruber, 2019) in un contesto specifico delineato da un caso studio italiano, fornendo un'evidenza empirica che può contribuire ad un uso ottimale dei fondi europei per l'innovazione in agricoltura. Studi simili in altri contesti potrebbero aiutare a sviluppare una panoramica più ampia su differenze e similitudini nello sviluppo delle sinergie nel contesto dei LLs.

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Atti del LIX Convegno SIDEA
Agricoltura, alimentazione e mondo rurale di fronte ai cambiamenti dello scenario globale: politiche e strategie per la sostenibilità e la resilienza
Marina di Orosei (NU), 21-22 settembre 2023.
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L'approccio living lab nella transizione ecologica degli allevamenti: il caso della montagna abruzzese

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Pascolo alta quota; Transizione ecologica; Allevamento sostenibile; Approccio partecipativo; Regione Abruzzo

INTRODUZIONE

Il tema della transizione ecologica degli allevamenti sta diventando centrale per il futuro delle società ed implica nuova conoscenza e costruzione di significati (Boogaard *et al.*, 2011) accanto alla gestione di aspetti tecnici, sociali ed economici legati ai processi di trasformazione delle strutture produttive come delle filiere nei sistemi locali. La zootecnia italiana dovrà affrontare, nei prossimi anni, processi di grande trasformazione in risposta alle sfide delle crisi ambientali e climatiche in linea con la strategia New Green Deal dell'UE.

In Italia, la modernizzazione della zootecnica e una problematica gestione delle quote latte, hanno concentrato in pochi territori di pianura (l'80% in Pianura Padana), sistemi produttivi intensivi basati sulla scala aziendale, concentrazione di capitali e di valore aggiunto e forte intensità produttiva (con crescenti rischi legati a: mutamenti climatici - siccità e alluvioni-; rischi igienico sanitari e ambientali). Il diffondersi di questo modello, e una cattiva distribuzione del valore nelle filiere dei prodotti di origine animale, hanno, spesso messo in difficoltà i sistemi di allevamento di più alta quota, che, hanno perso consistenza numerica -nelle strutture come nei capi allevati- e registrato una interruzione nel ricambio generazionale della professione. La difficoltà di vita nelle aree interne ha reso più incerto il futuro dei territori come delle attività produttive e più complessa la gestione delle risorse naturali da rischi di dissesto e di incendi.

Oggi, la crescente sensibilità della società ai temi del benessere animale, dell'etica dell'allevamento, della competizione dell'uso della terra tra il cibo disponibile per le persone e la produzione di alimenti per gli animali, apre una riflessione, tanto sulla continuità dei sistemi di produzione di pianura, quanto sulle opportunità di rilocalizzare nelle zone pascolative di alta quota le attività zootecniche, dove non competono con la produzione di alimenti a diretto consumo umano e assicurano servizi eco-sistemici (Bernués *et al.*, 2011).

In questa prospettiva emergono più domande su: come favorire la transizione ecologica degli allevamenti, come prevenire i possibili impatti delle produzioni animali e i rischi connessi all'evoluzione climatica nelle zone a più forte intensità produttiva, sulle possibili soluzioni, tra cui la rilevanza del riportare in quota l'allevamento e riorganizzare comunità di montagna.

Equità, giustizia, prosperità e sostenibilità sono questioni nuovamente urgenti da affrontare nei territori di montagna. Caratteristiche e ruolo dell'allevamento estensivo in termini ambientali, economici e socioculturali, sono state indagate (Milone, 2004) sebbene oggi costituiscano le fondamenta per una proposta condivisa di rinnovata consapevolezza sulla fragilità dei sistemi zootecnici e degli ecosistemi.

Per realizzare obiettivi di cambiamento sono necessari nuovi modelli di condivisione, codisegno e cogestione dei percorsi capaci di coinvolgere una pluralità di attori (Gamache *et al.*, 2020). La transizione degli allevamenti affianca aspetti tecnici e dinamiche socio-economiche la cui gestione richiede metodi di lavoro capaci di gestire, in modo dinamico e progressivo, processi multi-attoriali volti a creare nuovi scenari, visioni convergenti e rapidi processi di cambiamento capaci di anticipare le possibili crisi. Tra questi strumenti, l'uso dei living labs (LL) rappresenta un'opportunità di lavoro complessa ma anche potenzialmente efficace.

Nel lavoro abbiamo indagato se e come la metodologia dei LL possa favorire la transizione ecologica degli allevamenti applicandolo al caso studio della montagna abruzzese, un territorio tradizionalmente vocato alla zootecnia che, con il suo passato silente ma orgoglioso, può offrire un'esperienza pilota in risposta alle crisi in atto.

DATI E METODOLOGIA

Questa attività si lega al progetto PNRR Agritech che guarda al disegno di processi d'innovazione delle attività zootecniche. Il progetto ha una specifica task dedicata all'organizzazione di LL e, in questo quadro, è stato organizzato un primo LL in Abruzzo per realizzare un'esperienza formativa e di approccio partecipativo con gli attori del territorio e raggiungere gli obiettivi indicati.

Il LL è una metodologia adottata per facilitare la formazione di conoscenza collettiva dei problemi e delle soluzioni possibili, creare visioni convergenti e velocizzare i processi di trasformazione, ad esempio rendendo più efficaci le strategie di adattamento al cambiamento climatico (Gamache *et al.*, 2020). Sono dunque spazi per lo sviluppo di idee innovative (Edwards-Schachter *et al.*, 2012; Følstad, 2008) che promuovono il paradigma della co-creazione (Hagy *et al*., 2017) mediante approcci multidisciplinari e partecipativi (Mastelic *et al.*, 2015; Zavratnik *et al.*, 2019) che assegnano agli attori coinvolti un ruolo attivo nella discussione e richiedono, dunque, un'azione di animazione attenta. Come nella "Participatory Rural Appraisal" (Omondi, 2023), anche il LL mira ad abilitare e potenziare la cittadinanza -specie di gruppi con meno voce-, nel risignificare la relazione comunità-ambiente naturale, nella costruzione di visioni del futuro del territorio rurale più sostenibile (Zavratnik *et al.*, 2019) e nel negoziare le norme per la sua gestione (Gamache *et al.*, 2020).

La condivisione di conoscenze e l'interazione tra attori (Multi-actor approach) differenti è considerato tra gli approcci necessari per affrontare le sfide future nei sistemi forestali e agroalimentari (Brunori *et al.*, 2020; Contini *et al.*, 2020; Feo *et al.*, 2022). La transizione delle produzioni agrozootecniche alla sostenibilità chiede di supportare le persone nell'esplorazione di alternative al sistema prevalente, confrontandosi con i limiti della realtà particolare, connettendo iniziative diverse con pari obiettivi (Gamache *et al.*, 2020).

Il LL organizzato nella montagna abruzzese ha visto più tappe di lavoro, tra cui: visite aziendali nei territori delle aree parco e il dialogo con gli imprenditori; la realizzazione di un Focus Group (FG), con vari stakeholders di territorio; successivamente, un confronto politico con soggetti e istituzioni regionali per discutere contenuti e proposte operative emerse dal FG. Gli attori che hanno preso parte al FG sono stati allevatori, trasformatori, tecnici degli enti Parco e della regione Abruzzo, referenti delle associazioni allevatori, rappresentanti dei consumatori, tecnici delle organizzazioni professionali del mondo agricolo, amministratori locali, studenti e ricercatori. In base al proprio ambito di lavoro o di interesse, essi sono stati divisi in gruppi di lavoro organizzati su tre distinti temi:

1. Sostenibilità nell'uso delle risorse naturali e transizione ecologica degli allevamenti;
2. Nuove imprese e innovazione di processo, organizzativa e di prodotto;
3. Benessere e salute animale, igiene e salute delle produzioni.

In fase preparatoria si era organizzata una diagnosi socio-economica e demografica delle zone di interesse e di settore per aprire il confronto. Ogni gruppo è stato mediato da un facilitatore nel confronto e nel sostegno ai partecipanti nella costruzione di visioni convergenti sui temi della sostenibilità e della transizione ecologica degli allevamenti nella montagna abruzzese, partendo dallo stato dell'arte e pensando a delle possibili ipotesi di lavoro future.

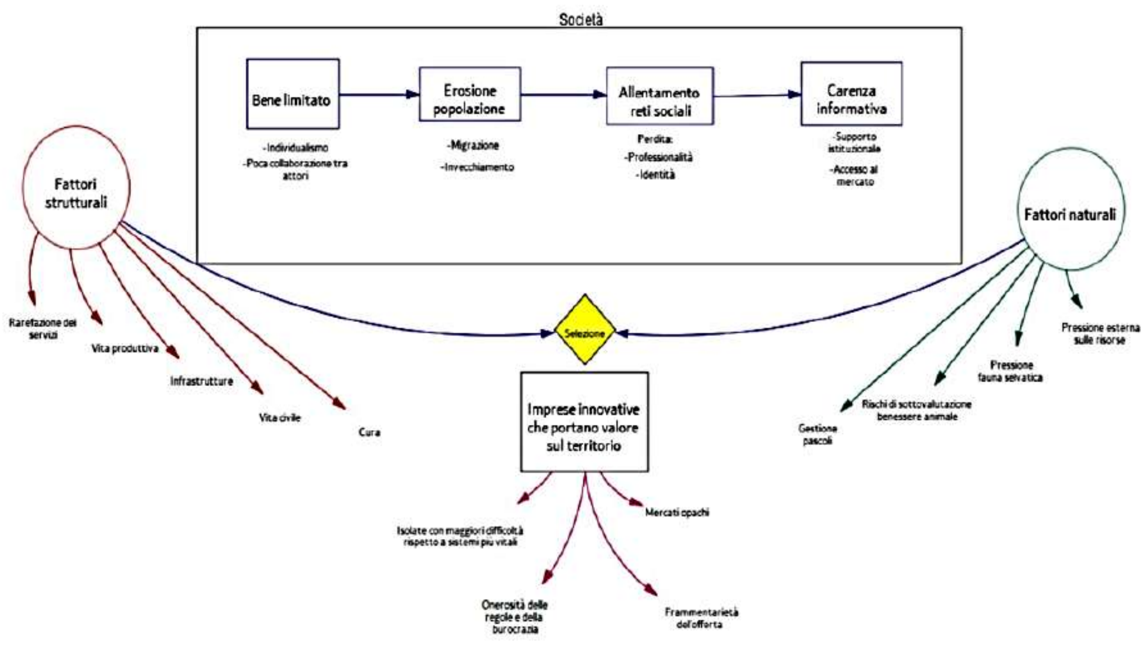
RISULTATI ATTESI

Le visite nelle aziende hanno restituito un quadro imprenditoriale estremamente dinamico e attento all'innovazione, nonostante le difficoltà derivanti dall'operare in un sistema non specializzato. Le attività dei gruppi tematici del FG, preventivamente pianificate nei tempi e nei contenuti, hanno consentito il confronto parallelo, secondo cinque tappe, segnate dalle seguenti domande-guida:

1. Dove andare e come leggere il futuro positivamente: "quale visione delineare per la zootecnia sostenibile del territorio montano abruzzese nel 2050?"
2. Da dove partiamo:" quali criticità riconosciamo (ambientali, economiche, politiche, scientifiche, relazionali)?"
3. Da dove partiamo: "quali risorse sono disponibili (naturali, economiche, politiche, scientifiche, relazionali)?"
4. Quali miglioramenti sono desiderabili? Come e con chi organizzarli?
5. Quale sentiero di lavoro possiamo immaginare per raggiungere gli obiettivi desiderati al 2050? Con quali azioni?

I contributi dei tavoli tematici sono stati riorganizzati sotto forma di mappe concettuali e sentieri di lavoro, poi restituiti nel momento di confronto più politico con le istituzioni. Una lettura delle dinamiche sociali che questi territori hanno vissuto dalla metà del '900 in poi, combinata a vari elementi di mercato, a fattori politici e culturali (Fig. 1) ha restituito: il progressivo allentamento delle reti sociali e produttive e una erosione dell'orgoglio professionale e di identità di territorio dei residenti rimasti; un sistema che, nel suo complesso, presenta l'allevamento come un'attività produttiva frammentata, isolata, che non collabora e che è messa alla prova, sia dalla burocrazia sia dal mancato pieno riconoscimento dei consumatori.

Figura 1 - Criticità condivise dai partecipanti ai tre gruppi tematici del FG



(Fonte: elaborazione discussione FG)

Nella Tabella 1 sono presentate le risorse disponibili individuate, tra cui: la vocazione autentica delle montagne abruzzesi, i sistemi normativi che delineano l'orizzonte di allevamento sostenibile cui aspirare, passando dalla valorizzazione della qualità di prodotti e patrimonio naturale, tra cui la disponibilità di risorse pascolative, oggi poco usate, tutto sostenuto dalla possibilità usare le reti informative del sistema istituzionale.

Tabella 1 - Le risorse del sistema della montagna abruzzese

Fattori culturali	**Fattori naturali**	**Fattori di mercato**	**Fattori normativi**	**Fattori infrastrutturali**
Autenticità	Pascoli	Nicchie mercato	Supporti policy	Dati e reti informative
Tradizione	Aree Parco	Potenziale di valorizzazione legato a natura	Gestione normativa	Reti di supporto
	Boschi	Nuovi gourmet	Gestione procedurale	
	Usi civici		Innovazione istituzionale	

(Fonte: elaborazione discussione FG)

Il FG ha prodotto una visione futura che vede tra gli elementi chiave della montagna abruzzese: l'attrattività per le nuove generazioni, il sostegno alle imprese, esistenti o nuove, la collaborazione e l'accoglienza tra attori dentro e fuori le comunità, la garanzia del benessere di ecosistema, animali e persone secondo un approccio OneHealth e OneWelfare. Per raggiungere questa visione sono state disegnate 6 strategie con le rispettive azioni. Gli esiti del FG presentati e discussi nel seminario finale, hanno visto la disponibilità istituzionale al confronto e alla co-progettazione del LL di tutti gli attori intervenuti, che hanno sottolineato gli strumenti di policy a supporto della progettualità (PSR e AKIS, FSE). Le due giornate, del FG e del tavolo istituzionale, sono state percepite come un'importante e inattesa occasione di confronto e una nuova opportunità di co-disegno delle coordinate di lavoro per il territorio. La complessità del tema della transizione dell'allevamento ha trovato nel LL, grazie a una mediazione terza, un terreno fertile per essere affrontata, legando i bisogni delle imprese e delle comunità, alle soluzioni che la ricerca può assicurare. L'esito del LL è stato il lancio di un possibile progetto pilota nazionale sulla produzione animale sostenibile nei territori di alta quota per uno scenario futuro possibile di transizione in cui ricomporre e integrare il ruolo di più strumenti tra cui, lo sviluppo di comunità, l'innovazione tecnologica e la valorizzazione della multifunzionalità zootecnica.

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Indicatori di sostenibilità sociale per le imprese agro-alimentari: definizione, tipi di KPI e loro utilizzo

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INTRODUZIONE
La sostenibilità sociale nel settore agricolo e agroalimentare è un concetto che, negli ultimi anni, sta guadagnando sempre più importanza. Uno dei più recenti e significativi riconoscimenti è avvenuto, a livello internazionale, con l'Agenda 2030 delle Nazioni Unite per lo Sviluppo Sostenibile quale elemento fondamentale nella pianificazione e nello sviluppo anche delle politiche agricole. L'Agenda 2030, adottata nel settembre 2015, ha riconosciuto, infatti, la sostenibilità sociale come uno dei tre pilastri fondamentali insieme alla sostenibilità economica e ambientale (C. Crepaldi, 2019).
Nel contesto specifico della Politica Agricola Comune (PAC) dell'Unione Europea, la sostenibilità sociale è stata rafforzata con la riforma 2021-2027 che ha introdotto un inedito terzo pilastro, chiamato "dimensione sociale", ponendo l'accento sulla promozione del lavoro dignitoso e sulla garanzia del rispetto delle norme europee in materia di diritto dei lavoratori. Questo inserisce la sostenibilità sociale nel settore agricolo e agroalimentare tra gli elementi formalmente vincolanti per l'assegnazione dei finanziamenti agricoli (Commissione UE, 2022). Anche alla luce di tale cambio di paradigma la sostenibilità sociale delle aziende agricole e agroalimentari ancor più necessaria richiede un'analisi delle performance aziendali.
Lo studio si propone di sviluppare una batteria di indicatori che consenta di misurare il livello di sostenibilità in chiave sociale delle pratiche aziendali.
Partendo da un'attenta review della sostenibilità sociale nel settore agricolo e agroalimentare, compresi gli indicatori e le linee guida esistenti a livello nazionale e internazionale, il quadro concettuale si articola in diverse fasi, tra cui l'analisi dei contesti e degli stakeholder, la definizione degli obiettivi di misurazione, la selezione degli indicatori, lo sviluppo della batteria, la sua validazione e test e, infine, l'applicazione e la diffusione dei risultati.
Successivamente, con l'utilizzo della batteria di indicatori, si procederà a misurare la performance di sostenibilità sociale di un campione di aziende agricole e agroalimentari nazionali.

I risultati dello studio sono orientati a fornire indicazioni a practitioner e policy maker utili al miglioramento delle performance delle imprese in tema di sostenibilità sociale, promuovendo un'efficace transizione verso modelli agricoli e agroalimentari più equi e responsabili.

METODOLOGIA

Preliminarmente alla definizione della batteria di indicatori è stata condotta un'analisi documentale delle politiche e dei programmi strategici promossi da istituzioni quali la Commissione Europea e organizzazioni internazionali, come l'Organizzazione delle Nazioni Unite (ONU), per comprendere il posizionamento e l'inclusione del concetto di sostenibilità sociale nel dibattito pubblico e nelle strategie politiche. Sono state considerate specificamente la Politica Agricola Comune (PAC) 2021-2027 e l'Agenda 2030 dell'ONU per lo Sviluppo Sostenibile. Inoltre, sono state esaminate direttive e regolamenti a livello europeo e nazionale che promuovono la sostenibilità sociale nel settore agricolo e agroalimentare (Direttiva UE 2014/95 recepita con Dlgs n.254 del 30 Dicembre 2016 in materia di rendicontazione non finanziaria), nonché le misure di incentivazione e supporto fornite dalle politiche pubbliche per incoraggiare l'adozione di pratiche sostenibili.
Particolare attenzione è stata dedicata all'analisi di certificazioni e sistemi di valutazione che integrano la dimensione sociale nella valutazione della sostenibilità aziendale, quali RSI, SROI, SCBA e SLCA. In riferimento alle certificazioni di qualità, intese come marchi applicati a prodotti o processi nella filiera agroalimentare che garantiscono il rispetto dei lavoratori coinvolti, offerti da agenzie e associazioni che si occupano di sostenibilità sociale, la pratica di successo individuata è la certificazione Fairtrade, realizzata da un'organizzazione senza scopo di lucro che promuove il commercio equo e solidale a livello globale.
Tra le organizzazioni impegnate nella costruzione di una rete di promozione di strumenti a supporto della sostenibilità sociale possiamo citare: Sustainable Agriculture Initiative Platform (SAI), Global Social Compliance Programme (GSCP), Global Reporting Initiative (GRI).
Queste organizzazioni stanno svolgendo un ruolo fondamentale nello sviluppo di linee guida e indicatori per misurare la sostenibilità sociale delle aziende agricole e agroalimentari. Tuttavia, è evidente che occorrono ulteriori sforzi per sviluppare linee guida e indicatori specifici che affrontano le sfide uniche del settore. L'implementazione di tali strumenti consentirà alle aziende di monitorare e migliorare le loro performance in termini di sostenibilità sociale, promuovendo un settore agricolo e agroalimentare più responsabile ed equo.
La letteratura è spesso nebulosa e ricca di ambiguità e contraddizioni in merito al concetto generale di indicatore. Gallopin (1997) dà una definizione generale e inclusiva: partendo dal concetto che gli indicatori non siano "valori" ma variabili, egli afferma che si tratta di "una rappresentazione operativa di un attributo (qualità, caratteristica, proprietà) di un sistema". Un indicatore fornisce informazioni sintetiche in modo che siano rapidamente comprensibili per chi lo deve interpretare.
Se è chiaro che misurare sia una parte fondamentale del processo di miglioramento continuo imposto dal concetto di sostenibilità è, tuttavia, meno chiaro quali misurazioni debbano essere rilevate e monitorate. Warhust (2001) afferma che l'obiettivo principale della misurazione sia la generazione di informazioni rilevanti per la definizione delle azioni future, ma, specialmente nell'ambito della sostenibilità, la mole di informazioni è enorme e caotica ed è difficilmente scomponibile in piccole unità informative, gestibili e immediatamente comprensibili. Gli indicatori di performance rappresentano, in questo senso, uno strumento potente e immediato per ridurre concetti ampi e complessi come la sostenibilità in termini numerici o misure descrittive in grado di guidare il processo decisionale. In poche parole, i KPI sono informazioni semplificate, sintetiche e comunicabili, che assolvono pertanto i requisiti di misurazione, gestione e comunicazione imposti dalla strategia per il perseguimento della sostenibilità.
Definire un indicatore non è immediato come si può pensare. Talvolta la sottovalutazione dell'indicatore conduce a un utilizzo non appropriato e a trascurare informazioni importanti che l'indicatore stesso può fornire. Per qualsiasi indicatore è possibile utilizzare diverse forme di metriche di performance. Le metriche,

piuttosto che gli indicatori, possono essere classificate in qualitative, se basate su una valutazione semantica, o quantitative, se si basano invece su dati empirici.
Sulla base della letteratura esistente, la scelta per l'individuazione degli indicatori è stata concentrata in due aree significative: risorse umane e territorio

RISULTATI

I risultati della ricognizione effettuata evidenziano, in prima istanza, una scarsa diffusione di organizzazioni che hanno istituito strumenti specifici per valutare la sostenibilità sociale delle aziende agricole e agroalimentari, ma, al tempo stesso, rileva best practice, fornendo un quadro ampio per l'elaborazione della batteria di indicatori.
Gli indicatori di sostenibilità sono indispensabili per le aziende, in quanto costituiscono uno strumento per misurare il successo delle strategie adottate, ovvero valutare le esternalità positive e negative prodotte dalla propria attività di un'impresa, cioè gli effetti esterni alla sfera di chi assume la decisione.
L'aspetto sociale della sostenibilità si concentra principalmente sulle condizioni di lavoro e sul rispetto dei diritti umani oltre che sulle relazioni dell'azienda con la società o con la comunità locale.
Le aziende hanno un impatto su grandi gruppi di persone, quali per esempio, i dipendenti, i clienti, i fornitori o gli azionisti. Questi subiranno, in maniera diretta o indiretta, le ripercussioni delle decisioni prese dagli organi direttivi dell'azienda. Per questo le aziende devono sviluppare un'attività etica e attenta nei confronti delle risorse umane.
Il lavoro svolto ha consentito l'individuazione di un cruscotto di indicatori, strettamente legati ai diversi standard disponibili. Individuate le principali aree, rilevanti per la sostenibilità sociale, si è proceduto con la selezione di almeno un indicatore appropriato per il monitoraggio delle prestazioni che l'azienda vuole raggiungere rispetto ad ognuna delle aree individuate e di seguito riportate:

1. Sicurezza e salute dei lavoratori
2. Disuguaglianza di reddito
3. Diversità, equità e inclusione
4. Istruzione e formazione dei dipendenti
5. Sostegno alla conciliazione tra lavoro e famiglia
6. Politiche per l'uguaglianza e la parità di genere
7. Contributo a migliorare le comunità
8. Innovazione sociale

Gli indicatori individuati, che saranno ampiamente illustrati, sono generalmente conosciuti come Key Performance Indicators (KPI) ovvero una misura quantificabile delle prestazioni nel tempo per un obiettivo specifico. Essi potranno rappresentare utili linee guida per il policy maker al fine di definire strumenti di policy mirati per il miglioramento delle performance aziendali e, più in generale, per una maggiore inclusività e resilienza delle aziende del settore.

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Promoting a long-term vision for rural areas: projects, initiatives and tools
Sessione organizzata da Daniela Storti, AISRe

Key words: innovation, multilevel governance, place-based policy

In June 2021, the Commission presented its 'Long-Term Vision' for rural areas. The document, traces in a comprehensive manner the critical issues and opportunities for Europe's rural areas, venturing on the thorny terrain of redesigning the governance model of the Union with the introduction of a rural pact and an action plan, which provides, among other things, the "rural proofing" for EU policies to be assessed from now on also in relation to their potential impact on rural areas.
The goal is to move towards the definition of a multi fund and multilevel framework to guide European rural policy action to facilitate the integration of all the different national and EU policy at local level, including the CAP.
This section intends to give an insight on the conceptualization guiding this new approach as well as on the good practices needed for its implementation. To this end the section will focus on one of the European initiatives implementing the new approach, on examples of projects that promote the Long term vision for rural areas as well as on the tools available for strengthening the institutional capacity of local actors.

Antigoni Papageorgiou, from remote, Panteion University of Social and Political Research Athens, from remote, Critical mass of innovation actors in revitalizing peripheral, non–urban areas: Insights from the COWORK4Youth Project

Ilaria Mariotti, DAStU-Politecnico di Milano, from remote, The role of collaborative spaces in promoting rural areas: evidence from Cost Action- CA18214 and CORAL-ITN projects

Serafino Celano, Independent Evaluator, Strengthening the institutional capacity of local actors in rural areas and production territories: the role of evaluation

Simone Sasso Fernando Merida Martin, JRC, from remote, The EC Startup Village Forum. Concept and analytical research

Daniela Storti, CREA, Social Innovation and youth participation in remote rural areas: evidence from a research action in Italian inner areas

Coworking spaces as mediators: resilient spaces and innovative practices in peripheral, non–urban areas

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The emergence of coworking spaces, fab labs, and other shared office facilities has been naturally connected to the urban metropolises and wider debates about creative economy and start-up entrepreneurship. Studies focus on their ability to conglomerate massive flows of freelancers, start-uppers, remote workers, digital nomads as well as financial capital from investors and corporations. Coworking spaces and the like contribute to innovation processes and assist in boosting urban innovation ecosystem as they connect local actors. They seem to speed up knowledge creation, cultural exchange, enforce local buzzes and develop global pipelines. They also participate in processes of urban regeneration and transnational gentrification as they raise the symbolic value of the neighborhood where they are
located. Over the last few years, we witness the proliferation of such spaces in peripheral and non – urban places outside of the creative city hype and the entrepreneurial discourses.
Scholars observe that such endeavours are characterised by their communal ethos and their strong ties with their local surroundings. The study conducts locally sensitive research examining the case studies of Megahub (Schio, Italy) and Starfish Foundation (Lesvos, Greece), informed by how local conditions and institutional contexts shape coworking practice and the initiatives implemented. It concludes by providing an understanding of these spaces as mediators of innovative practices that cultivate communitarian ties and by analysing the different functions of these spaces. Finally, it calls for policies that create the conditions and the structure to promote these new ways to act. Special attention needs to be paid to forms of entrepreneurship and innovation that are linked to peripheral areas as both have very specific characteristics strongly embedded to the local contexts.

The role of collaborative spaces in promoting rural areas: evidence from Cost Action-CA18214 and CORAL-ITN projects

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Key words: collaborative spaces, rural areas, innovation, community wellbeing

Abstract

The present paper briefly describes the main results achieved by two European projects: Cost Action CA18214 "The Geography of New Working Spaces and the Impact on the Periphery"[1] and CORAL Project, Horizon 2020 - Marie Curie -ITN-2020 (Marie Skłodowska-Curie Innovative Training Networks) "Exploring the impacts of collaborative workspaces in rural and peripheral areas in the EU"[2], focusing on the role of collaborative spaces in unpacking the potential of peripheral and rural areas.
With the term collaborative, the literature refers to (i) coworking spaces (CSs) and smart work centres; (ii) makerspaces, fab labs, open workshops; (iii) hackerspaces, living labs, and corporate labs; and (iv) coffee shops and public libraries providing formal and informal spaces for working (Akhavan, 2021). These several typologies can be referred to as third place (Oldenburg, 1989), straddling the 'first space' (home) and the 'second space' (office).
In 2020, the COVID-19 pandemic has rapidly altered the habits and lifestyle of every citizen worldwide and will have effects in the medium-long run. Knowledge-intensive activities (e.g., professional, scientific, technical activities, finance, and insurance; professional services; public administration; Barbieri et al., 2020) have massively undertaken remote working, which includes the following working arrangements: (i) teleworking, (ii) agile working, (iii) smart working, (iv) working from home (WFH) (ILO, 2020), and hybrid working (Eurofound, 2022).
While before the COVID-19 pandemic, the prevalence of remote working in EU countries was very heterogeneous (Sostero et al., 2020); in 2019, in northern Europe (Sweden, the Netherlands, Luxembourg, Finland and Denmark), 25% of employees worked remotely regularly or at least a few days per month. By contrast, the percentages were much lower in Italy, Cyprus, Romania, and Bulgaria. This diversity originates in certain structural factors typical of each European economy, such as company size, specialisation in knowledge- and innovation-intensive sectors, organisational culture, and regulatory frameworks (Vargas Llave and Weber, 2020). During the pandemic, there has been a significant increase in remote working in most EU countries. In Italy, for example, more than 40 percent of employees worked remotely. In absolute terms, according to the Osservatorio Smart Working of the Politecnico di Milano (2022), smart working workers in Italy increased from 570,000 in 2019 to 6.58 million in March 2020 (in full lockdown). In 2021 it decreased to 5.37 million, and in 2022 to 3.6 million remote workers. Forecasts estimate 3.63 million smart workers by 2023.
Specifically, the surge in working from home in the first pandemic waves, and more recently in hybrid working, and the growth of collaborative spaces like CSs are changing the geography of work (Florida et al., 2021; Mariotti et al., 2023). Coworking spaces (CSs) that use hybrid working models are now required because businesses look for flexible places, geographically dispersed, to be closer to their workers (Mariotti et al., 2023).
Although collaborative spaces, including CSs, are primarily located in large urban areas, in so-called 'creative' cities, where they can exploit the typical location patterns of service industries in urban areas (i.e., urbanization and localization economies; market size and potential; skilled labor force availability and business opportunities; transportation accessibility), during the COVID-19 pandemic a renewed attractiveness of medium-sized cities and peripheral areas occurred.
According to Gandini and Cossu (2021), collaborative spaces, and specifically coworking spaces experienced three waves: (i) initiatives launched as a reaction to the unstable labor market and rising

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[1] See: https://www.cost.eu/actions/CA18214; https://new-working-spaces.eu.
[2] See: https://coral-itn.eu/about-2/.

informality for freelance professional and the volatile labour market (antidote to precarity); (ii) entrepreneurial motivated coworking brands and their small community-led counterparts that were pushed out the cities by the big players; (iii) resilient space in non-urban environments, fusing business logic with social and political dynamics, and fostering social innovation and knowledge exchange platforms.

The CA18214 and CORAL European projects have investigated the case of European countries, finding an increase of collaborative spaces in rural areas during and after the pandemic.
The recent book by Akhavan et al. (2023) underlines the attractiveness of large urban areas and middle-sized cities toward new working spaces and collaborative spaces. If, during the first wave of the pandemic, collaborative spaces have been negatively impacted, in the following waves, they became more resilient (Gandini and Cossu, 2021), and several of them started accommodating remote workers and digital nomads looking for a workplace different from the home. Therefore, the growth of collaborative spaces has been triggered by the increase in market size and market potential location patterns. Leducq and Demaziere (2023) explored the effects of the Covid-19 pandemic on collaborative spaces in France, focusing on the Loire Valley (Tours, Orléans and Blois), on the fringes of the Ile-de-France region (Chartres, Dreux, Montargis, etc.) and in the rural areas of the southern part of the region. The authors claim that the collaborative spaces growth in these regions is due to (i) an increase in independent contractors and freelancers and (ii) the need for businesses to recruit and retain employees by giving them more options for working in "third places", close to home, as opposed to having to travel to corporate headquarters every day. Similarly, in Hungary there has been a substantial migration of people from urban centers to suburban and rural areas (Akhavan et al., 2023).
As concerns the Italian case, Mariotti and Lo Russo (2023) explore the location and characteristics of collaborative spaces in 2020, finding that compared to the year 2018, during the pandemic, collaborative spaces started also investing in peripheral and rural areas, and attracting remote workers and digital nomads. This new trend confirms that the dense networks of the inner city are not the only environment in which creative industries operate because of the complexity of their geography. In 2018 Italy hosted 549 CSs mainly located in urban areas because CSs tend to be knowledge-intensive places for creative people. In 2020 there were about 760 CSs, approximately one CS every 70,000 inhabitants. Compared to the year 2018, during the pandemic, CSs started also investing in peripheral and rural areas. Besides, almost 46% of CSs spaces in 2020 hosted digital nomads, and 75% remote workers.
Another interesting aspect to consider concerns the role of policy promoting collaborative spaces in peripheral and rural areas. In peripheral and rural areas collaborative spaces have been more widely used as policy tools to compensate for the lack of private initiative, which is due to the relatively low demand for such services in these areas. Indeed, collaborative spaces in rural areas and other parts of Europe are frequently subsidized and hosted in public converted buildings (Tomaz et al., 2022).
Since the emergence of collaborative spaces, many public administrations in Italy, especially at the local level, have recognised their public value, promoting them through policies that fall into three areas: (i) labour-oriented, (ii) social innovation, and (iii) local economic development policies (Mariotti & Pais, 2022). The last category includes the promotion of public coworking spaces. The Italian case is particularly interesting since the first cases of public intervention date back to 15 years ago, when the coworking phenomenon was still in its infancy. Yet, over time these experiences were gradually abandoned and were rediscovered, in different forms, only during the Covid-19 emergency.

Within this framework, the 'Long-Term Vision' for rural areas, proposed by the Commission well fits, as well as strategies like the Start-up village forum (Goodwin-Hawkins et al., 2023), which aims to support local authorities in unlocking equal socio-spatial opportunities for remote workers and the development potential of innovative ecosystems in rural areas (e.g., startup villages).

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Rafforzare la capacità istituzionale degli attori locali nelle aree rurali e nei territori della produzione: il ruolo della valutazione
(Strengthening the institutional capacity of local actors in rural areas and production territories: the role of evaluation)

Serafino Celano, PhD [3]

Long abstract

La definizione e attuazione di Strategie Territoriali (ST) è uno degli elementi fondanti di un approccio *place-based* alle politiche (Barca, 2011).

L'ambito territoriale di intervento - che può essere rurale, urbano o intermedio – è chiamato, con sue risorse, attori territoriali, dinamiche, etc., e con supporti sovralocali, a definire una sua **strategia territoriale** per la soluzione dei propri problemi e il soddisfacimento dei propri bisogni, a partire dallo sviluppo delle potenzialità inespresse dal territorio (risorse locali, capitale umano, beni naturali).

Mediante l'attivazione di metodi partenariali/inclusivi/di democrazia deliberativa, identifica una conoscenza non nota (conoscenza da esplicitare, poiché inespressa da parte degli attori locali, o da reperire esogenamente perché latente sul territorio) che include una risposta a domande di sviluppo e di innovazione. La conoscenza e l'innovazione possono/hanno bisogno di arrivare anche dall'esterno di questi luoghi, introducendo variabili di rottura delle dinamiche conservative locali. La cooperazione tra soggetti endogeni ed esogeni richiede di attivare meccanismi di *multilevel governance*.

A livello di attuazione, il territorio deve mostrare una capacità di coordinamento locale dell'attuazione e di controllo/monitoraggio/valutazione dell'efficacia delle azioni messe in campo.

Numerose evidenze ed esperienze pratiche di sostegno allo sviluppo di ST mostrano l'esistenza di criticità di definizione strategica per quei territori che meno sono stati in grado di mobilitare risorse organizzative, amministrative e di animazione del territorio, finalizzate a facilitare quei processi di produzione di conoscenza e di mobilitazione delle

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risorse locali che, abbiamo visto, sono essenziali per la definizione di strategie *place-based* e per un'interlocuzione matura e informata con i livelli sovra-locali.

I territori maggiormente deprivati dal punto di vista socio-economico e caratterizzati da maggiore marginalità sono il più delle volte proprio quei luoghi che presentano più alti livelli di decapacitazione dal punto di vista amministrativo e deliberativo e che, quindi, riescono con maggiore difficoltà a definire quadri strategici di cambiamento e a gestire efficacemente l'attuazione.[4] È evidente, d'altra parte, il maggiore successo di situazioni in cui è stato possibile organizzare efficacemente, oltre che le istanze regionali e centrali della governance, anche quelle locali.

In generale, appare evidente che, laddove si è proceduto in direzione di un rafforzamento della governance locale dei processi, essa si è articolata in varie soluzioni, quali, ad esempio, la cooperazione con strutture e agenzie territoriali esistenti (p.e. GAL attivi nell'ambito dello sviluppo rurale), l'acquisizione di Assistenza Tecnica dedicata alla definizione formale della ST, la costituzione di strutture dedicate.

Si manifesta sempre di più il fabbisogno, pertanto, di intervenire, a favore delle coalizioni locali, sui due importanti *building block* della dimensione strategica (sviluppo di una visione del futuro di un luogo e capacità di conoscere e agire) e della governance (capacità, specie nelle aree non urbane, di coordinamento attraverso diversi livelli di governo e di coinvolgimento attivo e non rituale degli attori del territorio) (European Commission. Joint Research Centre., 2022).

Un aspetto particolare di intervento di capacitazione che può efficacemente agire nel rafforzamento della *strategic dimension* e della *governance* consiste nell'incrementare il livello di conoscenza delle coalizioni locali rispetto alle proprie questioni territoriali e di configurazione locale – in quanto soggetto programmatore - attraverso la valutazione: si tratta, cioè, di attivare e facilitare, nelle coalizioni locali, la loro capacità valutativa, mettendo, da parte delle istanze sovralocali di sostegno, a loro servizio risorse e competenze e mettendole in grado di formulare domande ed esigenze cognitive, agendo come "clienti" delle valutazioni.

Nel 2023 il Sistema Nazionale di Valutazione della politica di coesione (SNV) e la Rete dei Nuclei sta sperimentando un particolare sostegno alle Amministrazioni titolari di programmi 2021-2027 e i loro partenariati nell'elaborare i Piani delle Valutazioni (PdV) secondo le previsioni regolamentari e gli orientamenti nazionali. In questo ambito, è in atto un accompagnamento finalizzato a definire le modalità con cui creare, all'interno dei PdV, uno spazio (risorse, tempistiche, etc.) da tutelare in vista della precisazione, organizzazione e realizzazione di attività valutative per le coalizioni locali secondo diverse

[4] Una simile complicazione è quella che oggi, in generale, si riscontra con riferimento ai comuni interessati ad iniziative relative allo Sviluppo Urbano Sostenibile o all'attuazione del PNRR: carenza nel dimensionamento di risorse umane e materiali, assenza di visione di "progetto" e gestione delle varie operazioni come "pratiche" in carico ai diversi dipartimenti, con le specifiche priorità, programmazioni e difficoltà operative.

modalità suggerite. Per ciascuna modalità il "cliente" della valutazione è sempre la coalizione locale.

Tali modalità - che partono dallo sguardo della coalizione locale intenta a definire e migliorare la propria funzione strategica territoriale - si mostrano efficaci nel migliorare visione e consapevolezze dei soggetti locali e spesso contribuiscono a rafforzare un "effetto coalizione", nel richiamare i vari attori locali a indirizzare, insieme, le domande valutative.

Un'interessante modalità sperimentata è la *valutazione locale* (Tagle & Celano, 2018), che costruisce l'oggetto di valutazione sulla base dell'identificazione degli interventi che su un determinato territorio sono stati rilevanti per le questioni di interesse della coalizione locale.

Le valutazioni locali sono finalizzate a comprendere come le politiche che si svolgono sui territori, prevalentemente definite a livello sovralocale, hanno influenzato le questioni che stanno a cuore alle coalizioni locali e su cui loro stesse lavorano: richiedono un forte impegno dei soggetti locali - che hanno evidenziato e motivato le questioni e formulato le domande - e consentono di rintracciare politiche, interventi e regolazioni che hanno avuto un ruolo nel configurarsi, anche nel tempo lungo, delle questioni di interesse sul territorio e cercano di apprezzarne il contributo. Indagano e meglio definiscono le questioni territoriali di partenza e offrono conoscenza alle coalizioni locali e consapevolezze agli attori sovralocali.

Un esempio specifico dell'uso della valutazione a partire da una domanda proveniente da una Strategia Territoriale è rappresentato dallo studio *La ripresa del distretto calzaturiero di Casarano in Sud Salento. Rapporto di valutazione locale*. [5]

La ricerca valutativa ha preso le mosse da una specifica esigenza conoscitiva nata durante il lavoro di ascolto e coinvolgimento portati avanti dalla Strategia d'Area *Sud Salento – Capo di Leuca* (SNAI), ed ha beneficiato di un apporto di impostazione e formulazione di domande da parte di una rete informale di imprenditori locali e sindaci dei Comuni impegnati nella Strategia d'Area.

Si è potuto far luce su un interessante fenomeno di resilienza evolutiva (Boschma, 2015): la ripresa su basi completamente rinnovate di un antico distretto calzaturiero che,

[5] Lavoro di valutazione realizzato con il supporto del Progetto SI.VALUTA a valere sul Programma Operativo Nazionale Governance e Capacità Istituzionale 2014-2020, da Gianfranco Viesti (coordinatore), Veronica Notaro e Benedetta Parenti, fra gennaio 2021 e luglio 2022. Daniele Morciano ha partecipato, in una fase intermedia, al gruppo di lavoro. Alessandra Esposito, Giuseppe Lucio Gaeta e Stefano Ghinoi hanno sostenuto il gruppo nel lavoro di analisi. Il lavoro è stato svolto con la supervisione di Laura Tagle (NUVAP-DPCoe) e Serafino Celano (responsabile Iniziativa Valutazione Locale – Team ASSIST). Disponibile in https://www.valutazionecoesione.it/valutazioni/valutazione-diretta.html.

all'indomani di una crisi drammatica, reagisce alla desertificazione manifatturiera e riesce a trasformarsi in una nuova piattaforma produttiva, con ripresa dell'occupazione e forti incrementi di valore aggiunto.

La valutazione ha potuto rispondere in maniere positiva alla domanda di salienza e fondatezza (*Che tipo di fenomeno è? È importante per il territorio e le persone che lo abitano? Può rappresentare l'occasione di un diverso posizionamento strategico del distretto nel contesto internazionale? È un fenomeno transitorio o sta nascendo una nuova e moderna piattaforma industriale caratterizzata da alto valore aggiunto, regolarità e pieno inserimento nel contesto internazionale?*), operando una vera scoperta di una diversa modalità di configurarsi di un "territorio della produzione" e fornendo alla coalizione locale l'occasione e la possibilità di proporre più consapevolmente la questione nell'agenda delle politiche territoriali.

Dal punto di vista del rapporto del fenomeno indagato con le politiche e le regolazioni, la valutazione ha potuto dare interessanti risposte alle domande più propriamente valutative (*Che rapporto c'è con le politiche e le regolazioni presenti e passate? Cosa ha avuto un ruolo? Cosa ha facilitato/ostacolato? Che domanda emerge verso le politiche pubbliche? Come accompagnare e completare un processo virtuoso di innovazione e crescita occupazionale? Quale ruolo per la Strategia Territoriale?*), incrementando significativamente la conoscenza e la capacità (strategica e valutativa) della coalizione locale, ora maggiormente in grado di operare scelte di programmazione consapevoli e di formulare domande circostanziate alle politiche sovralocali.

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The EC Startup Village Forum. Concept and analytical research

The European Commission's renewed commitment to rural communities and their development is clearly expressed in different documents and action plans that have been designed and are already under implementation. Research and Innovation play pivotal roles in achieving the main goals of this joint commitment of the EC, the Member States, the European Regions and their municipalities.

Two EC's strategic frameworks reflect the desire to enhance the development capacity of rural areas through research and innovation. First, the **Long-Term Vision for the EU's Rural Areas** (LTVRA), recognises the enabling role of innovation to empower citizens and entrepreneurs in rural areas to seize these opportunities offered by current societal, environmental and digital transformations. Secondly, **the New European Innovation Agenda** (NEIA) aims to strengthen the European leadership in disruptive technological innovations to accelerate the green and digital transitions and reduce the innovation divide across territories. Both approaches stress the relevance of the **Startup Villages Forum** as a driver to harness the opportunities offered by rural areas and contribute to the overall European wellbeing and development.

The Forum intends to promote knowledge exchange and cooperation activities and to work as an open and inclusive space where institutions and stakeholders can meet, discuss and shape actions for startup-driven innovation in rural areas.

The specific objectives of the Startup Village Forum initiative are to foster the **creation or enhancement of innovation-driven ecosystems in European rural areas**. A Startup Village is a way to re-imagine what rural villages can be and do, highlighting the **roles that innovation and ambitious entrepreneurship can play in strengthening rural areas**. By tapping into markets beyond their local spheres and inserting themselves into broader production networks, Startup Villages can play a significant role in strengthening rural areas. The Territorial Development Unit of the Joint Research Centre (JRC) has been working on conceptualising the Startup Villages and identifying the enabling factors needed for them to act as a game changer in the face of rural decline.

The first result of this effort is an already published ***science for policy report***[6] which draws upon the scientific literature to develop the Startup Village concept, explore enabling factors, and outline the Startup Village Forum's facilitating role. In this report a Startup Village, is defined as:

A place (or a network of small places) that embraces innovation and entrepreneurship as a way to unlock development potential and support wellbeing in rural areas. By combining local place, people, and purpose with external knowledge, resources, and markets, the Startup Village strives to provide favourable conditions for ambitious entrepreneurs and innovative ecosystems to flourish. (Goodwin-Hawkins et al., 2023)

The document introduces five key conceptual building blocks of a Startup Village as follows: **innovation**, **entrepreneurship**, **rural space**, **multiple scales**, and **ecosystems**. While each building block has an established literature, but understanding their interactions is crucial. Tailoring and testing connections and causal relationships between different concepts and blocks through empirical examination remain vital. The paper considers the baseline requirements for targeting support and resources and introduces a readiness level framework for progressing villages from envisioning change, through experimenting, to demonstrating and sharing learning. The work elaborates on the pivotal role played by the ecosystem building block in enabling innovation and entrepreneurship. It offers an approach that links the resources and institutional elements that ecosystems need with the multi-scalar networks necessary for effective rural development.

This requires proactive design to combine locality with connectivity. **Both entrepreneurs and institutions in rural areas require support to build capacities**. While ecosystems can support entrepreneurs, institutions must

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[6] See Goodwin-Hawkins, B.; Guzzo, F.; Merida Martin, F. & Sasso, S., *Startup Village Conceptualisation*, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/998554, JRC132646.

also be equipped to support these ecosystems. The paper outlines the main capacities needed and emphasizes the role of knowledge exchange. Finally, the paper addresses the future for the Startup Village Forum. The **Startup Village concept is not intended to be a standalone initiative**, but it serves to connect knowledge and stakeholders, **complement existing initiatives**, and catalyse joint endeavours. The annual Forum thus has an important role as a coordination space across the quadruple helix, where learning can be shared and motivation renewed. To turn the vision for Startup Villages into actionable and tangible accomplishments, it is crucial to build sound conceptual foundations, based on existing theories and evidence. Additionally, it is important to put forward an agenda for future research and knowledge exchange.

The Startup Village Forum has already organised two high-level events, in 2021 and 2023. Along with this high-level events, the JRC has organised several workshops where diverse stakeholders from different villages, regions and EU Member States discussed key topics around rural revitalisation, including depopulation, aging, economic diversification, stakeholders' engagement or multilevel governance. The outcomes of these events have provided valuable insights into the challenges faced by the rural areas.

Moreover, they have shed light on the new opportunities arising from **technological, social and economic changes that can help reverse the negative trends observed in rural territories**. Some of these results are already codified in the above mentioned science for policy report while many others have contributed to shaping the on-going research agenda the JRC.

This agenda encompasses a range of components designed to analyse Startup Villages from various perspectives. The initial phase of analysis has been centred on examining **illustrative examples of Startup Villages**, their context, enabling factors, ecosystem dynamics, stakeholders' engagement and roles, as well as associated public policies and lessons learnt. For this purpose, the JRC has selected cases four relevant cases for in-depth studying those topics. These cases are the Subequana Valley in Italy, Petreştii de Jos and Ciurila in Romania, Angra do Heroísmo in Portugal and, Kočevje in Slovenia. They are towns and villages (or group of villages) of different sizes, with a variety of rural typologies, with different stakeholders leading the processes (including municipal public administration in two of the cases, intermediate organizations, and civil society), and different levels of readiness for developing in rural innovative entrepreneurship.

Additionally, the JRC is currently conducting two specific studies. The first study investigates **human capital and innovation ecosystems,** aiming to identify effective policy practices and ways to collaborate among different actors to attract and retain talents in rural areas and maximize their potential. This study will showcase successful examples, highlighting relevant public or private initiatives as well as public-private collaborations for innovative entrepreneurship.

The second research line focuses on **new indicators and metrics for rural innovation**. This effort aims to define new approaches for measuring rural innovation. It will delve into existing efforts and future possibilities for developing and improving rural innovation metrics, and examine the potential impact that different definitions of rural innovation can have in terms of policy design.

Together with these analytical efforts, the JRC has launched the **Startup Village Mapping Tool**. This initiative is conceived as a participatory exercise, where **municipalities voluntarily provide information on their competences and potential** to be or to become a startup village through a questionnaire crafted by the JRC. The questions allow to gather information on the institutional and geographical characteristics of rural villages, their enabling conditions for promoting innovation and entrepreneurship, the performance of their innovative startups, their institutional capacity and the degree of internal and external connectivity of their innovation ecosystems. This on-going exercise is providing valuable information on the geographical distribution of Startup Villages within EU rural areas and their degree of development.

The ongoing work of the JRC's Territorial Development Unit on the Startup Village Forum forms part of a **wider and emerging line of action on the rural dimensions of territorial development**. In particular, **two relevant complementary activities,** which are also framed within the Long Term Vision for the EU's rural areas, are currently being developed:

- The **RURAL OBSERVATORY.** This initiative aims at improving data collection and dissemination concerting EU rural areas. It provides relevant statistics, indicators and analyses based on data from multiple sources and at the most appropriate territorial granularity, covering the economic, social and environmental dimensions. Its objective is to improve the comprehension of rural areas and it serves as an important source of information for "rural proofing" (i.e., to evaluate and assess the impact of

EU legislative initiatives on rural areas, and provide evidence for policy making in relation to rural areas development). Launched on 15 December 2022 in collaboration with DG AGRI, the Observatory is available in 24 languages (through machine translation).

- The RURAL TOOLKIT. This initiative, developed in collaboration with DG REGIO and DG AGRI, will provide methodological support and guidance on funding opportunities for rural development initiatives. The Rural Toolkit is being designed as an interactive online platform within the Rural Vision website. It also serves as a comprehensive guide for rural actors (including local authorities and stakeholders) to identify the EU funding opportunities offered by the 2021-2027 budget to promote the revitalisation and integrated local development of rural areas. The Toolkit will also provide inspirational examples on how to effectively utilize and combine different funding opportunities.

Collectively, these two initiatives, along with the SVF, outline the contribution of the Territorial Development Unit to the objectives of the Long Term Vision for the EU's Rural Areas.

Social Innovation and youth participation in remote rural areas: evidence from a research action in Italian inner areas

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Keywords

Rural development, Innovation, sustainability

INTRODUCTION

This contribution focuses on the transformative potential of innovative approaches in addressing one of the main rural challenges: to create opportunities for young people living in rural areas by supporting their empowerment. This work focuses on the results of two action research projects carried out by CREA in collaboration with the Association Riabitare l'Italia and a wide network of partners, "Giovani Dentro" and "Giovani Pastori". The first projects investigated quality of life, job opportunities, needs, aspirations, and challenges of young people living in remote rural areas. The second one was a pilot training and mentoring project consistent with the needs identified in the first research phase. The use of peer education for training allowed for an informal exchange of knowledge and skills between course participants and livestock farmers from the target areas.

What territories are we talking about?

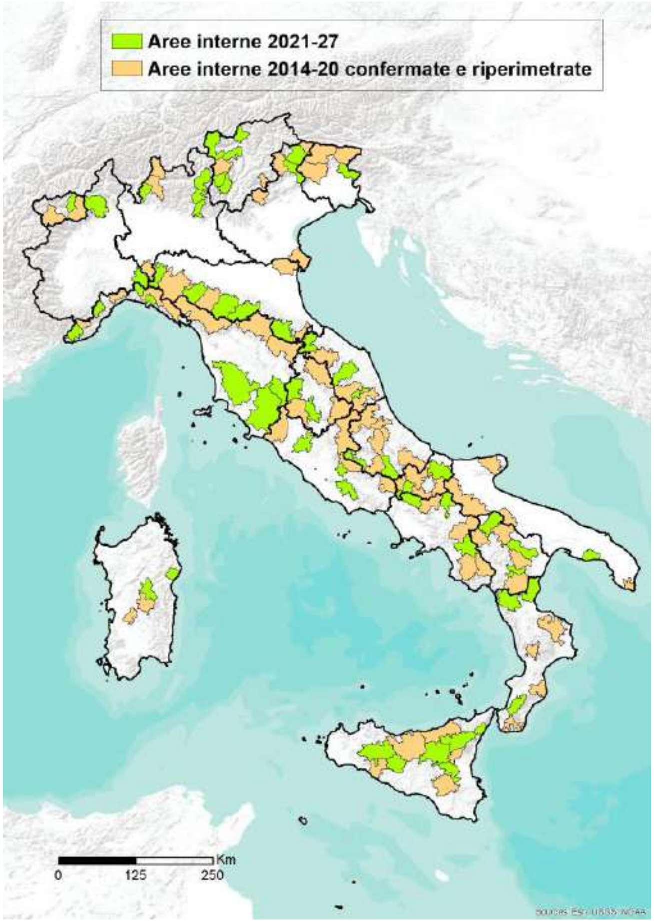
The aim of this contribution is to give a new insight on the concept of rural innovation with specific reference to youth participation in Italy's Inner Areas (IA). IA are territories distant from main service centers (education, health and mobility) as identified by the National Strategy for Inner Areas in Italy.

It is an integrated place based policy developed to tackle depopulation and low access to services in remote areas, launched in 2012. Four of the European Structural and Investment Funds (ESF, EMFF; EAFRD; ERDF) were combined with national funding to support local strategies pursuing local development and service innovation in 72 intervention areas.

The National Partnership Agreement for future cohesion policies has already foreseen the continuation of actions initiated with SNAI under PO5 through support for territorial strategies in inner areas that will be financed by regional programs for the period 2021-2027. The vital contribution of the European Agricultural Fund for Rural Development (FEASR) will be secured

through coordination mechanisms between the two programming areas, to be implemented at the local level.
There are 123 Project areas (67 from the 2014-20 programming period, 56 selected in this programming period). These are areas subject to greater risks of depopulation, in which agriculture still plays an essential role, rich in environmental and natural resources, largely mountainous.

Figure 1 - Italy's Inner areas



Source: Crea elaboration on *data from Dipartimento Politiche di Coesione*

Why a focus on social innovation

In the last decades there has been an increase in social innovation research in many fields including the rural development area. Systematic literature review and conceptualization attempts (Rösing Agostini, M. et. al., 2017) link the SI to areas such as institutional theory; social movements theory; power and multi-actors perspective and "*identify three theories, three distinct ways to think about social innovation: (1) as a form of social value creation, capture, and distribution; (2) as a polysemous concept that creates networks of meaning necessary in cross-sector collaborations; and (3) as striving for institutional change" (Logue D., 2020) .*
In 2000 was created a Forum on Social Innovations (SI) by eleven organisations from six OECD countries, to facilitate international dissemination and transfer of best policies and practices in social innovation. In 2020 OECD launched, within the Working party on rural policy, a project on

Innovation in rural areas and as part of this project a survey on policy and programmes relevant in understanding the innovation processes in rural areas. Main findings from this study point at the importance of social innovation in remote rural areas-

In this framework "*Social Innovation is defined as innovations concerning conceptual, process or product change, organisational change, and changes in financing, and can deal with new relationships with stakeholders and territories. Social innovation deals with improving the welfare of individuals and community through employment, consumption or participation, its expressed purpose being therefore to provide solutions for individual and community problems*".

Our hypothesis is that social innovation has a great significance in fostering sustainable development in remote rural areas. Social innovation is a multifaceted concept that involves novel solution to address societal challenges trough a transformative action, often leading to increased community involvement and empowerment. Also, agriculture is a central component of rural life and social innovation has played a crucial role in transforming farming practices. Organic farming and community-supported agriculture are examples of rural social innovation.
It is important to emphasize the transformative potential of agricultural social innovation in promoting sustainable rural development. Social innovation can enable rural communities to add value to their agricultural products (Lucatelli, Luisi, Storti., 2023). It also allows improved participation of young people in community changes, creating an anchorage to "places" and overcoming the sense of disorientation that leads many young to leave small towns in rural areas. It allows recapturing the dimension of the relation with the food, with the land of the practices and the actions, with the relation between individuals and with the ecosystems.

The field work and the construction of a new knowledge on rural youth

In 2021 the Association Riabitare l'Italia launched *a research on rural youth in Italy "Giovani dentro", in partnership with CREA and the Italian National Rural Network, the CPS (University of Torino), Gran Sasso Science Institute, Eurac Research and the Youth Observatory of the University of Salerno, with the contribution of Fondazione Vismara and CoopFond*.
The project investigated young people's motivations for staying in rural and mountainous areas and their needs of support. The target was on young residents in Italian Inner Areas (18-39 years old).
The research was realized in three main stages:

- ✓ **A quantitative survey** on a national representative sample (1000 respondents + social media sample: 2000 respondents)
- ✓ **A qualitative survey, with individual interviews** (300 interviewees).
- ✓ **Focus groups (40 participants)** with stakeholders living in Inner Areas of 4 regions (Lombardia, Piemonte, Abruzzo, Sicilia) with a focus on training, youth activism, agriculture, and social innovation.

The profile of young people emerging from the research points out at a change in direction. They are highly educated and are oriented to stay by planning their lives and work there. The survey shows that 41% have attended or are attending university; 54% have spent time outside their municipality for work experience.
The hope to stay, is quantified by the representative sample survey: 67% of young respondents to the survey are oriented to stay. Main reason to stay are natural environment and quality of life (79%) and human relationship (67%).

Results show a low level of participation to association but high level of engagement in community care. This result may indicate the emergence of new concepts of participation rooted in community engagement.
Furthermore, it is prevailing the perception of nature as a pristine environment where one can find one's balance (59%). Main motivation to work in agriculture is the desire for contact with nature and a simple lifestyle (34%), suggesting a greater closeness to ecosystems of young people approaching agriculture (greater sustainability).
Focus groups further investigated the motivation for returning to land and youth participation. Results point out at a growing interest towards shepherding and agriculture, as a lifestyle choice not only as a source of income (agroecological perspective). It seems that the relations between producers and ecosystems are changing, with a rapprochement of the human farmer to the cultivated and farmed species (a closeness that had been lost with industrialization) that produces greater sustainability.
Also the value of the relationship between farmers is at the center of many innovative experiences involving young people we encountered in our research action, such as that of the cooperative Terra di Resilienza or the rural hub Vazapp. These experiences, in which the drive to cooperate is rooted in new models of sociality, foreshadow a true cultural revolution, and require new keys to interpretation.
Young people do not generally apply for policy incentives and have low access to bank credit, but they seek interaction with institutions, associations, projects. They often intercept the action of local networks and social and agricultural cooperatives, that are producing a change in farming communities through the sharing of practices, the use of organic farming techniques and the initiation of forms of mutualism capable of improving the wellbeing of the community and building a more supportive local economy. In these experiences it is central the recovery of traditional practices (with the grafting of new knowledge and high sustainability profiles on both the environmental and social fronts).
In response to these trends, it is necessary to invest in the capacitation of young people through training and assistance actions consistent with their needs, identifying resources for activating local projects in favour of youth. More specifically there is a need for:

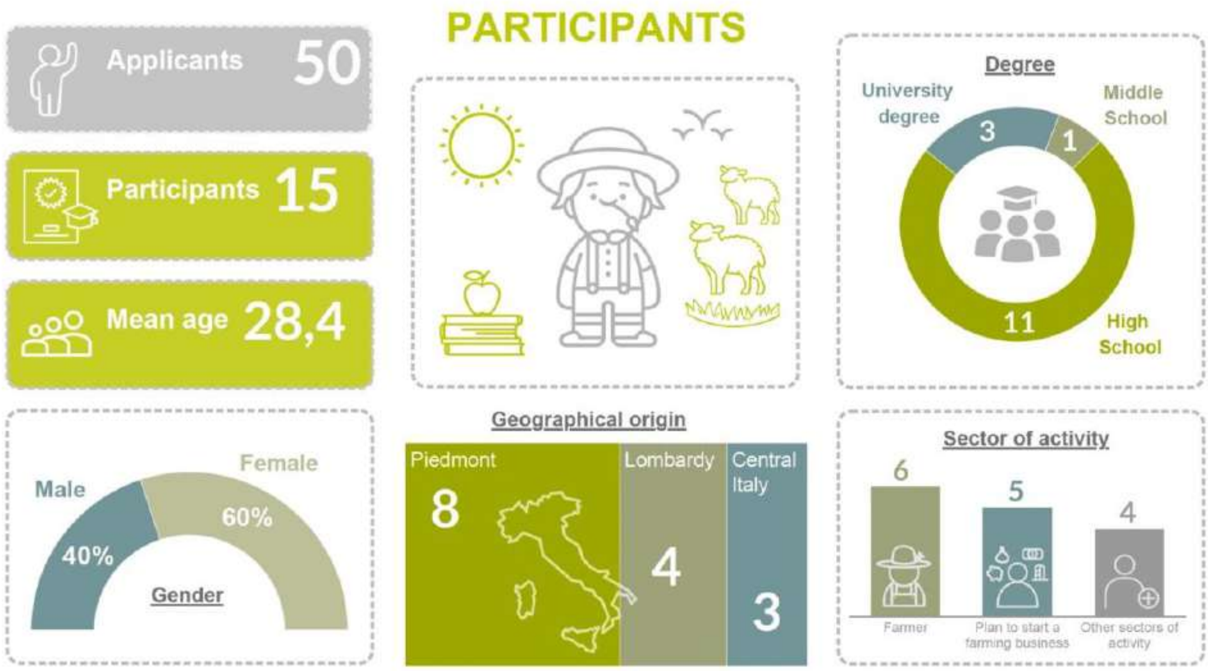
- Training and mentoring initiatives aimed at encouraging young people to remain in remote rural areas, tailored to address specific aspects and technical knowledge relevant to the particular sectoral paths they are interested in;
- places to compare and share operational practices and knowledge;
- project facilitation, guidance, and support for (micro) enterprises;
- support for accessing land and rural assets for agricultural production.

A School for young shepherds

In response to the context set above we decided to start a School for Young Shepherds, to develop and test a tailor-made model, based on peer education and participatory didactics and design, to facilitate knowledge transfer between local farmers and young shepherds in remote rural areas. We choose to focus on shepherding because of the growing interest about grazing livestocks farms that emerged from our previous research ("Giovani Dentro"). This trend, connected mainly to the low costs of starting a business in this sector, is consistent with trends from 2020 census data on agricultural farms showing that the sheep and goat sector is expanding with an increase in farms of 35% for goats and 10,5% for sheep (cattle farm are decreasing by 23,5%) (CREA, 2022).

Our target audience consists of young people residing in Italy's mountainous regions, and our perspective is not solely limited to a specific sector but emphasizes the vital importance of revitalizing and repopulating inner areas. The project focused on 3 pilot areas in Piemonte and Lombardia Region, with the intent of addressing opportunities for young people (in terms of access to land, market opportunities, networks, financing). We received 50 applications from which were selected 15 participants.
The School for Young Shepherds is an action-research project developed and executed with a place-based perspective, engaging local stakeholders in the three selected pilot areas to address local opportunities for young shepherds, particularly in terms of access to land, market opportunities, networks, and financing. It is promoted by the ***Association Riabitare l'Italia*** *and* ***CREA within the Italian National Rural Network*** in interaction with a wide network of public and private partners (AGENFORM, NEMO; CREA_ZA, University of Torino, Rete Appia) and with the contribution of Fondazione Cariplo. It also has involved local stakeholders from the 3 pilot areas in a variety of activities, from the design to the training and mentoring stages of the project. Training was delivered in collaboration with local farmers adopting participatory didactics with the facilitation of CREA researcher and Agenform trainers.

Figure 2 – Participants



The school offered mentoring and training (80 hours in presence and 40 hours in remote) linked to the needs of extensive livestock farming in marginal areas. In presence training was delivered from 25th of September 2022 to 7th of October 2022 in Valle Stura di Demonte (Cuneo Province) while mentoring and remote training (40 hours and 16 remote learning sessions with relevant actors on aspects such as circular economy, agro-ecology, eco-systemic services, etc.) were delivered from November 2022 to July 2023. In the mentoring phase the students were asked to present their farm activities and their project related to shepherding (study plans, employment project)
Research and in-depth study of the three target territories selected in the project were finalized between November 2022 and April 2023. In the final stage (May - July 2023), students participated in face-to-face roundtables and focus groups held in the three pilot areas. These sessions provided

them with a platform to engage with local stakeholders, fostering collaborative and supportive relationships.

Results and Lesson learnt

This contribution provides valuable insight on young people participation in the innovation processes affecting local communities in the most remote rural areas. Evidence from the research underscores the relevance of livestock grazing as an activity capable of maintaining a productive, environmental (e.g., biodiversity), and a social presence in mountainous regions, and identify the interest of young people in returning to agriculture as having a high potential for social innovation.
The School for Young Shepherds, developed in response to this context, is an example of how to enhance rural and social innovation while helping young people to fulfil their projects. Our experience with the school implementation has garnered positive feedback from both students and local stakeholders, indicating its success in assisting young individuals who reside in or aspire to live in mountainous regions in realizing their projects. This success can be attributed to customized training and mentoring as well as the establishment of informal networks that connect school students with local farmers, communities, public institutions, research centers, and associations.
Two main features that contributed to achieving these results include:

- the adoption of a multi-scalar and interdisciplinary approach in developing the initiative. This approach was co-designed by the Association in collaboration with local communities, public institutions, cooperatives, training and research centers at both national and regional levels;
- the implementation of participatory and experiential approaches aimed at facilitating knowledge exchange.

In May, the School will be launched in Sicily's Madonie region. While this edition primarily targets young people from the Madonie Mountains, it is also open to young individuals from other regions and countries who are interested in residing and working in this mountainous area. The school here aims to trigger innovative processes of land recovery for the benefit of the trained young individuals. It will be implemented in collaboration with the mayors and the Administrative Union of the area, in synergy with the strategic vision outlined by this region as part of the National Strategy for Inner Areas.
The key lesson learned here is the importance of leveraging these experiences to enhance the effectiveness of public policies for innovation and research in supporting rural communities. This can be achieved by investing in human capital development, particularly through the empowerment and education of young individuals. To this end it is necessary to innovate the relationships between local communities, public institutions, universities, and research centers and to move towards a new collaborative approach (co-planning).
Indeed, local development is not purely an endogenous process entrusted to local forces and their ability to intercept resources, but rather a collective effort that necessitates active engagement from various stakeholders at different levels.

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