O.S. - 3. African agricultural sustainable development and its ecological transition

Organized Session Proposal by IAERE

(Italian Association of Environmental and Resource Economists)

The Hidden Social Costs of Climate Change: Evidence on Climate Shocks and Child Mobility in Uganda

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JEL Classification: Q12, Q54, O15

Key-words: Climate change, agriculture, child abandonment, panel data switching endogenous regression model, Uganda.

Extended Abstract

Poverty in developing countries is a widespread phenomenon, and is particularly harmful for children, who represent the most vulnerable part of the population. Parents living below the international poverty line fight to provide basic sustenance for themselves and their children.
Poverty has been recognized as the main motivation for relinquishment (Smolin, 2007). Literature indicates that legitimate children are more likely to be abandoned by poor families during periods of economic crisis (Fuchs, 1984; Hunecke, 1987) or in response to food shortage (Food and Agriculture Organization, 1996; Fuchs, 1987; Guemple, 1979). Some theoretical and empirical studies investigate the determinants of national or inter-country children's adoption. Among others, Kuhn and Lahiri (2016) empirically test the predictions of their theoretical model showing that household income negatively influences child relinquishment whereas household size has a positive effect on the "supply" of children for adoption, while Medoff (1993) estimates the supply of adoptable infants applying the rational choice economic model of fertility. The author argues that women that relinquish a child have higher opportunity costs of motherhood with respect to women that decide to parent. In the empirical model he shows that the decision to leave a child in order to be adopted is positively influenced by women's education, marital status, religious affiliation and negatively affected by women's labour force participation, unemployment rate and the amount of the state's Aid to Families with Dependent Children.
Our paper aims to move a further step in understanding the drivers of children mobility in developing countries, choosing Uganda as a relevant case study. Our focus is on the potential drivers according to the existing literature on the choice of sending children away from home, but our research effort also aims at enriching the set of potential determinants by accounting for climate change shocks. Our analysis is articulated in three main steps: first, we provide a simple theoretical model, showing how child mobility may be the result of a "rational" household's choice, specifically when expected consumption falls below subsistence level. Second, we empirically investigate the determinants of household's choice of sending children away including climate related variables; finally, we assess the impact of child mobility decision on rural households' welfare. In this way, we try to identify an indirect channel through which climate related problems may affect households' welfare, namely by increasing the likelihood of sending children away to take place. Since households that choose to send children away may be systematically different from those choosing not to send and these

households' characteristics could be not fully observable, they may cause endogeneity issues. To handle endogeneity in nonlinear models, an endogenous switching regression model, based on the control function (CF) approach, should be employed (Wooldridge, 2010). Our empirical strategy is based on a methodology that combines a Mundlak–Chamberlain approach to account for time-constant unobserved heterogeneity and a control function approach to account for potential selection bias and endogeneity.

Two datasets are used in the analysis. Household longitudinal data are based on Uganda National Panel Survey (UNPS) program implemented by Uganda Bureau of Statistics, with financial and technical support of the Government of Netherlands, and the World Bank Living Standards Measurement Study – Integrated Surveys on Agriculture (LSMS-ISA) project. The UNPS is a multi-topic panel household survey that commenced in 2009/10 and continued for the years 2010-11, 2011-12, and 2013-14.

Individuals grouped in 6,896 households were included in the unbalanced panel built for the investigation. These nationally representative household surveys include detailed information on household demographic characteristics such as education, household size, sex and age of the household head and other data on household shocks and assets.

Our results show that several socio-demographic variables matter for the abandonment decision, including the presence of a single and female head of the household, the number of people in the household as well as the presence of rain-fed land and the adoption of improved seeds. Moving to our climatic variables, a larger mean temperature implies a larger share of child sent away, and the same holds with respect to indicators of extreme weather-related events: weather shocks and climate change trend are therefore a relevant variable in explaining child mobility. This suggests a possible route through which climate change may affect social welfare.

Finally, the second step of our empirical analysis shows that child mobility worsens households' income significantly. Comparing actual income (under child abandonment) with a counterfactual under the hypothesis that the same households did not abandon, we conclude that child mobility is not a fruitful strategy to improve farmers' welfare. Also, and more specifically, single and female heads households seem to be less affected by abandonment; at the same time, child mobility does not appear as a solution to (self-declared) climate shock.

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The "Good Farmer" as a driving force in the diffusion of innovation processes for sustainable rural development in Africa.

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Africa has the highest population growth rate in the world (fertility rate of 4.6 in 2019) with 2.2 billion people are expected by 2050 and more than 4 billion by 2100. Africa's growing population is becoming wealthier and more urban, leading to changes in the composition of diets, which will result in greater demand for higher value, processed foods. Many areas in Africa are currently affected by soil degradation (desertification, soil pollution, salinisation and acidification) and water scarcity (IPBES, 2018). The current situation will be exacerbated by climate change, which will further increase pressures on natural resources (soil and water) while reducing the area of arable land (IPBES, 2018). Thus, the development of the agricultural sector will be central in addressing the demographic, socio-economic and environmental challenges of many African countries.

The agricultural sector plays a key role in the economy of the African continent. About 45% of Africans (3.4 billion) live in rural areas and most of them are employed in the agricultural sector (about 40% of young Africans work in agriculture) (Sakho-Jimbira and Hathie, 2020), which represents on average 15% of the continent's GDP (OECD and FAO, 2016). Despite this, much of the sector is focused on the production of commodities for export to Western countries such as citrus, cocoa, coffee and cotton while many African countries are net importers of staple food items such as flour, rice and processed food products (IFPRI, 2018). The agricultural sector is strategic for the African continent and many political agendas and development program (Maputo Declaration, the African Union's Comprehensive Africa Agriculture Development Programme and the Agenda 2063 "The Africa we Want") identified the role of smallholder agriculture as fundamental for obtaining a fair and sustainable development of African agricultural sector.

Currently, one of the main problems of the agricultural sector in many African countries is the low productivity in both land use and labour which should instead be stimulated through the introduction of new techniques and technologies to enable both higher yields and a sustainable transition that is equitable and allows for the reduction of poverty and hunger that afflicts many areas of the continent (Benin et al., 2016; Badiane and Collins, 2016). Considering the close linkage of agricultural activities with the fragility of many African ecosystems, the development of the agricultural sector and rural areas must integrate an ecological and sustainable transition that considers all critical aspects in a multidimensional perspective (in a systemic approach that takes into account the social, economic, cultural and environmental aspects of rural areas) in order to allow for endogenous change unlike the Green Revolution of the 1960s. Examples of sustainable alternative practices to conventional rural development approaches which are based on an extractivist model with strong impacts on sustainability are varied, and all can be framed within the framework of agroecology (Altieri, 1991; Altieri and Toledo, 2011).

The highly multifunctional character of agroecological approach can support the socio-economic development of many rural communities on the one hand and allow for greater environmental conservation on the other. Due to its high adaptability and accessibility, the use of agroecological practices has developed strongly in Latin America with remarkable positive results (Altieri and Toledo, 2011). The dissemination that occurred in large areas of Latin America worked through peer-to-peer knowledge transmission following the "campesino to campesino" model (Holt-Gimènez, 2008) with farmers directly teaching other farmers in other communities, who in turn would become teachers in other communities, following a cascade model to cover vast rural areas across the continent. Such dissemination methods can be very effective where 'rurality' and traditional culture are very important, and where access to capital and high technology is limited, as in many African countries. Indeed, agroecological methods can be diffused through an adaptation of innovation and knowledge to the local context through a bottom-up approach, as opposed to implementing new techniques and technologies through a conventional top-down method.

In this framework, the understanding of how sustainable innovations (such as agroecology) spread among rural communities can be important for designing suited transition policies. As observed in many empirical studies, the diffusion of innovations usually follow specific patterns over time (U-shaped or sigmoid curves) in which innovators and the early adopters play a key role among the other members of the community less prone to structural changes (Rogers, 1983).

In this context, social norms and interactions among community members play a fundamental role in diffusion processes which are to various endogenous social aspects and unique local characteristics such as peer learning processes, social networks, imitation processes and shared norms. In such a framework of analysis, the production of shared meanings and ideas derives from "symbolic interactionism" according to which the individual and the society are identified as part of a dynamic and constantly interacting system in which the self is conceptualised as "a social structure that arises from one's social experiences" (Burton et al., 2008). Society itself is seen as composed of different groups or different communities, each with their own shared experience and specific symbolic understanding of the world. It is through interaction with these different social groups that the individual develops an understanding of the symbolic significance of behaviour for the group (Burton, 2004), which over time is internalised through the acceptance of a particular understanding of the world shared with other members and identified as their own.

Several social scientists have delved into this area of study by analysing the symbolic creation of farmers within their communities, but mostly in Western Countries highlighting as shared symbols and idealistic images can produce social behavior which can influence the adoption of sustainable practices within the community (Sutherland, 2013). Such symbols can create self-identity for both individuals and the community as well as generating a shared vision of a mythical figure of the "good farmer" who guides the actions of the farming community as a shared institution within the community (McGuire et al., 2013).

In this paper we analyzed the “good farmer” concept in a rural African context applied to a specific survey run in 2019 to 300 farmers in the Region of Nampula and Manica in Mozambique in which open questions were posed for the identification of the main characteristics on “what a good farmer is”. We used a text analysis to identify the main features in describing this mythical figure to understand how the “good farmer” concept is meant in rural African context while comparing it with the main results obtained in this type of literature applied to western countries. Then we considered the presence of some ideals of stigma, or other behavioral aspects in the "good farmer" myth which can be interesting for the diffusion (both reducing or increasing adoption) of sustainable innovation in Africa. Our preliminary results indicate that, even if a strong component of features are related to a "productive" vision as in western studies, an important part of the identification of the idea of "good farmer" is related to "communitarianism" and "mutuality". We then analyzed these main aspect in a policy agenda vision in order to produce some useful suggestions for policy makers and pratictioners of Ngos.

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The Adoption Determinants of Climate-smart Production Practices and their impacts on Farm Outcome in Uganda

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JEL Classification: Q12, Q54, Q56, C23.

Key-words: Uganda, climate-smart practices, farm performance, impact assessment, endogenous switching regression model.

Abstract

Recent evidence suggests that global climate change (CC) will increase the variability of rainfall, temperature, and the frequency of extreme weather events (IPCC 2014).
Climate change effects represent a "challenge" that Sub-Saharan agriculture has to face in the immediate future, being subject to relevant risks generated by the new meteorological conditions. Whilst such factors are likely to affect agricultural productivity, there is no doubt that the adoption of new technologies will play an important role in addressing CC challenges.
Agricultural production in many Sub-Saharan Africa countries is severely compromised. Due to CC the number of African food crises per year has tripled in the last three decades (FAO 2014). Production from rain-fed agriculture is reduced by up to 50% (IPCC, 2014).
Specific to Uganda, more than 70% of people are employed in agriculture, mainly on a subsistence basis (UBOS, 2015). Agricultural sector is dominated by smallholder farmers engaged in production of food and cash crops, horticulture, fishing and livestock farming, and contributing around 80% of the total agricultural output (NPA, 2015). Crop farming is rain fed, with limited irrigation. The low crop productivity is tied to climate related impacts (droughts, floods, rainfall variability), poor quality agro-inputs, diminishing soil fertility, poor land management and agronomic practices, disease and pests, coupled with high harvest and post-harvest losses (Uganda SPCR, 2017).
Food availability is a limiting factor especially in regions such as Karamoja, East Central and West Nile where frequent dry spells and lack of extension services affect production and productivity. Food insecurity represents a challenge for about 12% of the total population in the country (FAO, 2015).
Uganda is among African countries greatly affected by current climate change and variability. According the University of Notre Dame Global Adaptation Index, Uganda is ranked as the 27th most vulnerable and 25th least ready country to address climate change. In the last 50 years, the average temperature has increased of 0.28°C per decade and with January and February experiencing a warming trend with an average temperature increase of 0.37°C per decade. The frequency of hot days has increased, and rainfall has decreased, becoming unevenly distributed and less reliable (Uganda SPCR, 2017). Several climate projections for Uganda foresee an increase in temperatures, frequency and severity of floods and droughts and finally variability of rainfall. Specifically, the Uganda Climate Profile projects that the mean annual temperature across Uganda will increase between 1.2 and 2.3°C by 2050, and between 1.7 and 5.6°C by 2100. It also projects that the Heat Wave Duration Index (HWDI) will increase between 0.1 and 3.3 days per year by 2050 and between 0.8 and 71.1 days per year by 2100. Furthermore, most years will experience at least 30 consecutives dry days with some years experiencing up to 60 consecutive dry days by 2050 and 80 on occasion by 2100 (USAID, 2013).

Adoption of modern technologies is relevant for the adaptive capacity of a household (Barrett et al., 2004; Dercon, 1996; Dercon and Christiaensen, 2011). Ex ante mechanisms such as adaptation strategies might help rural households to maintain their food security, productivity and reduce the risk of poverty trap (Barrett 2005).

Despite several empirical studies, using a range of regression models, have already analyzed technology adoption and its impacts on farms' outcomes in a cross-sectional fashion (e.g., Di Falco et al., 2011; Läpple et al., 2013; Abdulai and Huffman 2014; Di Falco and Veronesi 2013; Teklewold et al. 2013; Kassie et al., 2015, etc.), few of them has considered farmers' adoption behavior in a panel structure to account for unobserved heterogeneity (Kassie et al., 2018). This study adds to the last group by identifying the determinants that affect farmers' decisions to adopt improved seeds and inorganic fertilizer in Uganda and how these technologies impact farmers' crop income and consumption. The voluntary choice of adopting or not adopting may be affected by individual self-selection. Adopters and non-adopters may be systematically different, and their decisions are based on their expected outcome. Inconsistent estimates arise when selection bias is not addressed. An upward bias may occur, for example, if only the most skilled or motivated farmers choose to adopt. To tackle endogeneity the instrumental variable methodology is not appropriate when the endogenous selection variable (adoption choice) is binary (Wooldridge, 2010). Applying the instrumental variable methodology, in a non-linear model, may indeed lead to the forbidden regression problem (Angrist and Pischke, 2008). The methodology proposed by Wooldridge (2010; 2015) to solve this issue is the control function approach, which generally, requires fewer assumptions than an instrumental variable methodology and is computationally simpler. Following Murtazashvili and Wooldridge (2016), we apply a control function approach based on a two-stage procedure. In the first stage, a selection equation is estimated by using a binary variable estimator such as a probit correlated random effects model. In the second stage, the outcome equation, conditional on the treatment (the adoption of climate-smart practices) is estimated by applying a correlated random effect model.

Using Mundlak devices, we apply the probit correlated random effects model for estimating the selection equation:

(1) $AD_{it} = 1[k_t + x_{it}\delta_1 + \bar{x}_i\delta_2 + z_{it}\delta_1 + \bar{z}_i\delta_2 + v_{it} > 0]$

where $1[.]$ is the indicator function equal to one if the statement in brackets is true and zero otherwise; k_t represents the time-specific intercepts; the vector x_{it} contains all the exogenous variables of the outcome equation and z_{it} includes the instrumental variables of the selection equation, such as climatic factors that are random from an economic perspective; $\bar{x}_i$ and $\bar{z}_i$ are the Mundlak devices. Finally, v_{it} is the usual error term, assumed to be normally distributed with zero mean and unit variance.

From eq. (1), we estimate a correction term of the outcome equation to account for the endogeneity of selection variable, that is the generalized residual function ($\hat{h}_{it}$). As underlined by Vella (1998), this term has two important characteristics: zero mean and no correlation with the explanatory variables of the probit model.

In the second stage, a correlated random effect model is estimated. Introducing Mundlak devices and estimated generalized residuals from the first stage, we may obtain the final and complete outcome equation:

(2) $\pi_{it} = x_{it}\beta_0 + AD_{it}x_{it}\gamma_1 + \bar{x}_i\rho_0 + AD_{it}\bar{x}_i\rho_1 + \xi_0\hat{h}_{it} + \xi_1 AD_{it}\hat{h}_{it3} + a_{it}$

where $\bar{x}_i$ is the Mundalk devices, $\hat{h}_{it}$ is the generalized residuals which account for the endogeneity of the selection variable, and a_{it} is the error term with $E(a_{it}|AD_{it}, x_{it}) = 0$. In this stage, since the estimated generalized residuals are included, the standard error should be adjusted through the bootstrapping procedure.

The analysis is based on Uganda National Panel Survey spanning from 2009 to 2014. These nationally representative household surveys consist of an unbalanced panel composed by 4,373 households.

Data include detailed information on household demographic characteristics such as education, household size, sex and age of the household head and information on household shocks and assets. These data at farmer level are combined with climatic variables, both temperature and rainfalls, collected by the Global Land Data Assimilation System (GLDAS) v2.1. GLDAS is a global gridded reanalysis dataset (Rodell et al., 2004a) with a spatial resolution of 0.25°*0.25° and 3-hourly temporal resolution.

Our findings suggest that in the selection equation, representing determinants of adoption, climate variability increases the likelihood of adopting climate-smart practices. This result is in line with Adego et al. (2019) where climate information plays a pivotal role in adopting adaptation strategies. Interesting findings are also in the outcome equations. In the case of farmers' crop income, the significance of the generalized residuals indicates that self-selection occurred in adoption. Thus, the adoption of climate-smart production practices may not have the same effect on the nonadopters, if they choose to adopt. Results on education appear to have differential impacts on adopters and nonadopters. Education significantly influences farmers' consumption for adopters, suggesting that a good level of education may increase the benefits of climate smart practices in terms of consumption. Farm size represents an important factor in explaining higher consumption and crop income for adopters and nonadopters. The positive signs for adopting and nonadopting farmers suggest that larger farms may obtain higher crop income and may increase the level of consumption than smaller farms. In conclusion, the estimated models suggest that farmers who adopted climate-smart practices would have gained lower crop income and would have reduced consumption if they had not adopted them.

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Trade of scarce water in Africa

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Abstract

The virtual water (VW) trade related to food is represented by the quantity of water consumed for the production of the crops exchanged on the international market. In assessing a country's water availability when entering the global VW trade, scholars consider only physical water availability, neglecting economic water scarcity, that indicates situations in which socio-economic obstacles impede the productive use of water. Economic water scarcity is to be considered beside physical lack of water availability in order to properly understand the role of water resources in the performance of agricultural practices and therefore in the livelihoods of the high share of the world population still directly or indirectly dependent on the agricultural sector (Molden 2007, Balasubramanya and Stifel 2020). Economic water scarcity is a situation in which technical and institutional capacities or financial resources are insufficient to supply adequate water quantities for human use (Molden 2007, Sullivan 2002, Molle and Mollinga 2003). If physical water availability is quantifiable in different ways, economic water scarcity faces the challenge of measurability. In Vallino et al. (2020) we explored whether the Integrated Water Resource Management Indicator could represent a useful proxy for measuring economic water scarcity. By observing the relation between the IWRM indicator and social and environmental dimensions we find that socio-economic development is not the only determinant of sophisticated water management levels. From a policy perspective, it emerged that high investments in water management institutions seems to be driven by necessity only in countries of very severe physical water scarcity. Moreover, despite strong climatic and economic differences, some relations between the IWRM indicator and agricultural production hold across countries. Advances in IWRM levels are associated to yield increase up to 13% and to unit water footprint decrease up to 20%. These improvements may decrease the negative effects of economic water scarcity on agriculture, that usually imply low performance and high inefficiency in water use. In the present work we apply the methodology developed in Vallino et al. (2021). We weight the global VW trade associated to primary crops with a newly proposed composite water scarcity index (CWSI) that combines physical and economic water scarcity (Damkjaer and Taylor 2017). Subsequently we build a focus on African countries, since they present the highest gaps between physical and economic water scarcity, and they are therefore suitable for disentangling the consequences of poor water management and governance from those deriving from strict physical lack of water resources. Moreover, African countries suffer the most from food security issues and therefore they are among the countries for which the study of food production and trade is more important (Saccone 2 2021). We analyze whether African countries are net importers or exporters of VW, and we compare the scenario with the one emerged from the application of the composite water scarcity weight. We quantify the gap created by the weight application in the country position with respect to the global virtual water trade. Preliminary results suggest that 27 African countries out of 47 are VW net importers. With the exception of countries of North Africa, those countries import VW mainly because they suffer from economic water scarcity. 16 of the net importers either increase or equal their position if the CWSI is applied, that suggests that all imported VW is scarce. This trend is dominated by physically scarce VW import. On the other hand, 10 of the net importers decrease their net import if CWSI is applied. They exploit others' water less than it appears without weight. For some of them the position decrease occurs because of economically scarce VW import, because for the physical scarcity dimension only, it would increase (e.g. Congo). 14 of the net exporters increase their position if the CWSI is applied. They export more water than it appears with no weight if composite scarcity is considered. This trend is dominated by economically scarce water. Indeed, for some of them physically scarce VW alone would indicate a net import (e.g. Mali, Tanzania, Madagascar, Niger, Cameroon, Togo, Ghana, Nigeria, Ivory Coast, Liberia). With the application of

the CWSI weight, some countries shift from being net VW importer to net exporter. The application of the CWSI allows one to quantify to what extent VW exchanges flow along environmentally and economically unfair routes, and it can inform the design of compensation policies.

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O.S. 4 Sustainability in the Italian agri-food sector: from production to reduction of waste

Organized Session Proposal by **CREA-PB and CREA-AN**

Introduction

Roberto Henke and Elisabetta Lupotto

The Italian Certifications of Sustainability for the Wine Sector

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Wine represents one of the most important products of the Italian agri-food system both for the value of the turnover and for the high weight on exports, having been the first Made in Italy agri-food product for many years. Traditional certification systems (PDO/PGI, Organic) are widespread within the sector, and more recently sustainability certifications evaluated through its threefold dimension (economic, environmental and social) are gaining increasing interest. The International Organization for Vine and Wine (OIV) has also defined the concept of sustainability in the wine sector already in 2004, and afterwards has developed and codified its general principles (2016).

Moreover, in recent years, the issue of sustainability has increasingly become part of societal needs expressed by citizen, influencing consumer behaviour and consequently also those of producers. In this context, the wine sector is among the most developed, as showed by different initiatives all around the world and by the two schemes currently in force in Italy for wines, wineries, and wine-growing areas: V.I.V.A. and Equalitas.

The case of Italian wine is particularly interesting, since the experience gained with the two existing standards, together with the recent developments of the CAP, driven by the EU's Green Deal and the Farm to Fork Strategy, have pushed the national government to the creation of a single standard on sustainability dedicated to the wine sector.

Law 77/2020 establishes the national certification system for the sustainability of the wine sector, as the set of production rules and good practices defined within a production disciplinary, based on the three pillars of sustainability. The disciplinary is designed as a synthesis of the main public and private projects of certification already in force in Italy: National Quality System of Integrated Production (SQNPI), V.I.V.A. and Equalitas.

The analysis of the experience gained in this sector of excellence is relevant, because it can be an important stimulus for other strategic sectors of the national agri-food system.

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Sustainability in the fisheries and aquaculture value chains

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In Italy, surrounded by the Mediterranean Sea, fish consumption is a cultural tradition belonging to the Mediterranean dietary pattern, well known for its healthy properties. Seafood is a precious source of high-quality proteins, vitamins, mineral elements and is the only significant source in the human diet of n-3 polyunsaturated fatty acids, known to play beneficial and protective roles towards cardiovascular, chronic and inflammatory diseases (Di Lena et al. 2016). Therefore, the consumption of fish products is important in a healthy human diet so that the most recent dietary guidelines agree in recommending their consumption at least twice a week (CREA, 2018).

Nowadays, the provision of nutritious and safe seafood is ensured by fisheries and aquaculture, called to meet the increasing consumers' demand for healthy fish in a context of declining resources (FAO, 2020).

This presentation introduces the major challenges that fisheries and aquaculture value chains must face in order to achieve sustainability goals. From harvesting to consumption, the different actors along the value chains are called to responsible practices and choices in order to maximize resource-efficiency and minimize losses and waste. A strategic management of fish products and by-products as valuable resources of energy and nutrients is crucial for the economic, environmental and food safety implications.

Furthermore, in the context of a global shortage of high-quality fish oil, demanded by the aquaculture and nutraceutical sectors for fish feed and human supplement formulations, an Italian case-study of recovery and valorisation of fish-processing by-products is reported. The output is a fish oil entirely of italian and sustainable origin, traceable and safe, with potentials to promote future business opportunities to local economies and contribute to the UN Sustainable Development Goals (Lucarini et al. 2020).

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Food waste and its socio-economic effects: different approach to face it

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Lower income for farmers and other actors in the supply chain, reduction in the availability of food, food insecurity and environmental impact are some of the consequences of food waste (FW). FW depends on numerous causes and takes on different dimensions and characteristics depending on the phase of the supply chain, the socio-economic context, the actors involved. In synthesis, they are associated with different food system patterns, undermines long-term resilience of the global food system by aggravating ecosystem damage.

Many initiatives have been put in place to affect causes of a technical, organizational, managerial nature, or to introduce mechanisms to recover and distribute food waste at charities and solidarity centers. Moreover, these initiatives are characterized by a Waste-focused approach and are often focused on just one segment of the supply chain, softening the waste reduction.

Other kind of interventions, based on a Food-focused approach, are characterized by the presence of food planning and overall strategies. They can be defined as food policy interventions, aimed at the governance of the different dimensions connected to food, including production, transformation, distribution, marketing, consumption, waste management, and based on a participatory approach involving all the actors at local level. Their objective is to design a sustainable and low waste food system, characterized by a significant reduction in the flow of food material leaving the food system, and a significant increase in the ratio between food consumed and food grown. This second type of interventions appears to have more significant and medium-long term sustainable effects.

The analysis of experience realized according to this approach is relevant, because it can provide useful elements for designing more effective interventions of Food Policy in the forthcoming EU programming.

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Sustainable dietary pattern for the achievement of nutritional and environmental goals in Italy

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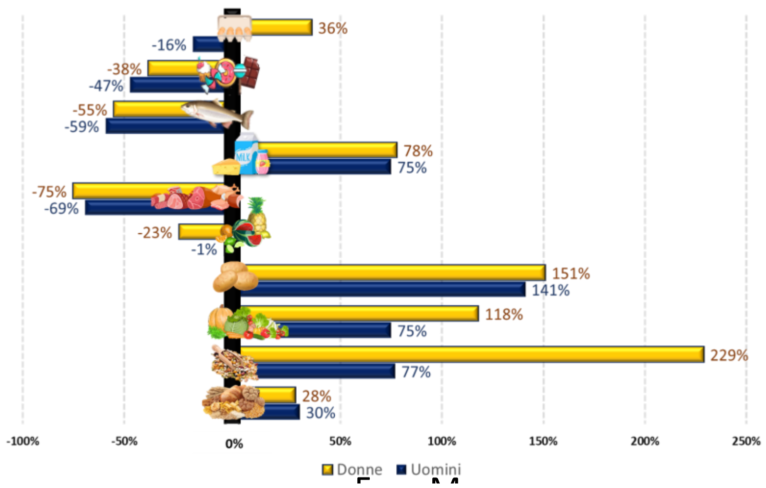
The integration of sustainability in all policies including dietary ones is essential to minimize mostly environmental challenges. Sustainable healthy diets are defined as dietary patterns that promote all dimensions of individual health and well-being; have low environmental pressure and impact; are accessible, affordable, safe, and equitable; and are culturally acceptable (FAO/WHO, 2019). These diets could be reaching through diet optimization, a mathematical approach that translate nutrient requirements into food choices while considering other food-related constraints, including example diet cost, consumption habits, and environmental impact (Gazan et al., 2018). Two studies were unique in combining three dimensions: nutrients, environmental impact in terms of greenhouses gas emissions (GHGEs), and cost and they demonstrate that using ecological and cost constrains would not reseat in diets with a higher cost, but rather these diets could be even more affordable (van Dooren, 2018).

A national study was carried out to define a healthy and sustainable diet model with low Greenhouse gases emissions (GHGE), fulfilling dietary requirements, and considering current Italian food consumption patterns (Ferrari et al., 2020). Linear programming as mathematical approach was used to develop new diet plans separately for males and females, aged 18–60 years (n = 2,098 subjects), to minimize GHGE.. Diets optimized resulted with the reduction in CO2eq emissions on 43% for males and 50% for females. The proposed optimized diets envisage a transition from a dietary model with high content of animal based foods (including meat and processed meat) to a diet rich in plant based foods such as fruit, vegetables, especially legumes and cereals (Figure 1).

Figure 1 - Change (%) of the food groups quantitites in the optimized diet. Adapted from Ferrari et al, 2020



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