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Keynote article

Proximity economy and local food chains for the regeneration of inner areas

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Abstract. The ecological transition and food and energy crises have revealed the issue of inner areas which, despite their vulnerabilities, seem to have become strategic in Italy. The renewed attention to inner areas highlights their potential for food and energy production and the need for a multidimensional sustainability approach to address issues of depopulation and resource waste. The paper aims to contribute to the debate on these topics and to stimulate research on territorial analysis and policies, also in virtue of the new awareness of the potential of inner areas, rich in human, cultural, natural and economic resources. To find a solution to the economic and social revitalization of these areas, it is necessary to leave the mainstream of global competition and take different paths, based on the enhancement of local resources and the direct involvement of citizens/consumers through the promotion of a model of "proximity economy". Within this logic, foods from minor supply chains in fragile areas can become the driver for a proximity economy model based on cooperation, participation, reciprocity, inclusion and the sharing of created value.

Keywords: inner areas, proximity economy, rural development, transformative policies.
JEL codes: Q18, Q19, O18.

HIGHLIGHTS:

- The ecological transition and food and energy crises have brought out the strategic role of inner areas.
- An interpretative analysis of the national territorial dynamics and policies must stimulate a reflection on possible, innovative lines of action in favour of a proximity economy model to regenerate internal areas.
- The proximity economy can represent a perspective for the economic and social revitalization of inner areas.

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1. INTRODUCTION

Inner areas[1] seem to have suddenly become strategic. The ecological transition and food and energy crises (triggered by the Russian-Ukrainian conflict) need their important contribution. The unsustainable overcrowding of urban areas needs the territories of the inner areas. If inner areas regenerate, life quality improves for everyone, also enhancing the wide heritage of resources they hold (natural, forest, environmental, landscape, historical, cultural, food, etc.).

However inner areas are the most fragile areas of the country, risking economic and social desertification as a result of the widespread decline in human activities and services, as well as the unstoppable and growing phenomenon of depopulation, which takes young people away and leaves behind an aging population increasingly in need of support and assistance, with a welfare system that has also weakened in accordance with an approach strongly oriented towards efficiency and accounting (Barbera *et al*., 2022; Locatelli *et al*., 2022).

In 2012, the Minister for Cohesion proposed the National Strategy for Internal Areas (SNAI – Strategia Nazionale Aree Interne), aimed at halting the economic and demographic decline of these realities. This Strategy has been implemented through different initiatives in "pilot areas" in all Italian regions. After an initial phase of enthusiasm and expectations, following the first disappointing results achieved, the attention paid to this policy has decreased, emphasizing its failure (Interlandi and Famiglietti, 2022).

The Ukraine war suddenly brought this issue back to the forefront, at least in the debate among experts, as an apparently incomprehensible paradox was discovered: our country's threatening external dependence on strategic resources, such as food and energy, which has had very strong economic and social repercussions, against a widespread and under-utilisation of such resources' production potential in inner areas. In this sense, the inner areas can make a contribution to lighten the external dependence in the availability of strategic resources.

The Italian government's choice to attribute to the former Ministry of Agriculture also the competence on "Food Sovereignty", although not expressly declared, seems to arise from the awareness of the aforementioned paradox. Such a choice, made by a developed country, suggests the awareness of the great productive potential of these areas (in terms of food and energy), marginalized by a territorially unbalanced development model.

This renewed attention to inner areas, within a vision of sustainability, rekindles the debate on a theme of great impact, territorial rebalancing, which is not just a north-south issue, but also concerns the relations between urban, and rural areas of the country. The spotlights are on the emergence of depopulation, the waste of resources, the sustainability of an extractive economic and social model, which has drained resources in some areas (inner areas) concentrating them in others (urban and coastal). As the statistics show, nowadays both areas have problems of unsustainability, due to desertification for inner areas, and excesses of concentration for urban areas (ISTAT, 2021).

This study aims to contribute to the debate on the above-mentioned topics, proposing an interpretative analysis of the national territorial dynamics and policies, in order to stimulate a reflection on the prospects that models of proximity economy can have in the valorisation of local supply chains and markets and in the creation of value in rural territories. But also on the possible contents of a line of action in favour of food sovereignty in our country for concrete initiatives in order to restore a future to territories otherwise condemned to abandonment under the burden of depopulation and economic desertification. The aim is also to stimulate scholars, in particular agricultural economists, to deal with territorial analysis and policies and orient their research paths on critical questions for the future of our country.

With this objective, the paper is organized as follows: after a framework of the dynamics of economic and territorial development, the perspectives of the long-term strategy for rural areas are analysed and a model of the proximity economy for regeneration of inner areas and their real transformative development is proposed.

2. ECONOMIC DEVELOPMENT AND TERRITORIES

Among the many elements characterizing the dominant economic-social model developed in our country

[1] They are defined as "significantly far from the centers of supply of essential services (i.e. education, health and mobility), rich of important environmental and cultural resources and highly diversified by nature and centuries-old anthropization processes", *Strategia Nazionale per le Aree Interne: definizione, obiettivi, strumenti e governance*, 2018. ISTAT, on the other hand, defines as "inner areas" a predominant part of the Italian territory that is characterized by a spatial organization based on "minor centers", often small towns that can only guarantee residents limited access to essential services. According to ISTAT, the new mapping of inner areas which classifies Italian municipalities as *Pole*, *Belt*, *Intermediate*, *Peripheral* and *Ultraperipherical*, shows that they are located mostly in the regions of Southern Italy (44.8% of the national total): overall there are 1,718 (67.4%) municipalities that are part of them, especially in Basilicata, Sicily, Molise and Sardinia (all over 70%). More than 13 million people live in Italian inner areas, less than 23% of the population, with a population density of 75.7 inhabitants per sq Km, ISTAT (2022), Focus *La geografia delle aree interne nel 2020: vasti territori tra potenzialità e debolezze.*

since the second world war is the structural tendency to a spatial concentration of economic and social resources, as a result of the asymmetric relationship between urban areas-inner areas, which saw the former in a position of absolute dominance from every point of view and the latter subordinates (Terluin, 2000; Dwyer *et al.*, 2002; Van der Ploeg *et al.*, 2000; Marotta and Piazza, 2021).

Urban areas have historically been places of attraction/concentration of economic activities, population, services and infrastructure. Economic agents considered them as places in proximity to the market, with good availability of services and infrastructure, while for citizens they were places of job opportunities, where personal fulfilment and improvement of life quality were easier.

In contrast, inner areas represented the other side of the coin, the areas where the transfer of human and economic resources originated. A massive exodus that has led to today's delays, characterized by depopulation, an ageing population, rarefaction of economic activities, services and infrastructure, with only one sector that presides over the territory, agriculture, in organizational and business forms divided into a framework of inhomogeneity, where significant productive realities coexist with realities in great difficulty.

Using a simplified interpretative scheme, the urban areas, in the transformative dynamics of the economy and society, have found their initial mechanism of virtuous development, increasingly distancing the other (inner) areas, in a model centred on two fundamental elements: the crowd and speed. The first represented two important reference values:

- *economic value* – the crowd has meant a large market space, significant segments of demand for goods and services that have attracted economic activities and infrastructure, transforming the areas of concentration in places of identity, economic and social vitality;
- *political value* – the crowd was, and remains, also the expression of the breadth of the electoral base, the catalyst of the attention of policymakers and, consequently, the priority destination of policies.

Speed represents the dominant mode of measurement of the lead time required for economic events, the dissemination of knowledge and innovations, social and personal relationships. It is the determinant of the "life cycle" of human activities in every sphere (economic, social, relational, political, religious, etc.), making every human acquisition fluid, unstable and short-lived (Bauman, 2011). It is the driving force that encouraged the continuous regeneration of market demand, contributing to the positive dynamics of the economy and society.

On the other hand, rarefaction and slowness are evident in inner areas as diametrically opposed processes. These territories have been relegated by the capitalist market economy to a role functional to the development model of the most susceptible areas, undergoing a resource draining process that has led to a territorial context of widespread "rarefaction" of economic, social and political processes, resulting in a generalized "slowness" in the evolutionary dynamics of economies and local communities. In this case, rarefaction and slowness have been the determining factors of the delays detected in today's statistics. Such delays will not find solution within the dominant model, which will continue to be inspired by the crowd (market) and speed (new opportunities for growth).

The territorial polarization between concentration and rarefaction, speed and slowness, has been joined by another functional type, concerning the economic and market power between the productive sectors and between the economic agents operating along the supply chains. A process that has led over time to:

- the industrial and service sectors to distance the primary sector significantly in terms of wealth production;
- the downstream sectors of the food supply chains to grab increasing shares of the created value, leaving farms insignificant and decreasing parts, thus making them increasingly fragile and, in less susceptible areas, unlikely to survive.

Progressive agriculture weakening, compared to the rest of the economy, follows a historical trend determined by Engel's law, according to which the share of food expenditure compared to the total consumption is reduced to the increase in income. In other words, as income increases, the non-agricultural sectors receive a relative stimulus from greater and increasing demand over time, compared to that received by agriculture. It is a kind of natural law that sees agriculture losing in the dynamics of economic development. This aspect represents one of the main reasons behind the historically recognized support to this sector in our country and in the European Union (i.e. Common Agricultural Policy).

The asymmetric distribution of value along the food supply chains is explained, instead, by the excessive fragmentation of farms and, consequently, the supply of agricultural commodities, the lack of adequate organizational models of the latter and the low diffusion of contractual models to protect them (Brunori *et al.*, 2016; 2020; Ciliberti *et al.*, 2022; Bonanno *et al.*, 2018). Farms are *price takers* and suffer from the market power of processors and food distributors.

The two mentioned polarization processes, belonging to capitalist development (obviously there are also others, but they are relatively less relevant to the issues addressed here), are the main drivers that have led to the depletion of the inner areas, leaving agriculture in conditions of increasing fragility to be the mainstay of these areas.

After decades of unlimited growth, driven by the intense exploitation of natural resources, where crowds and speed represented the two main sources of value, leading to the domination of urban areas, today those same two sources of growth (crowd and speed) can be counted among the causes of the main factors of unsustainability of the dominant model of economy and society.

The crowd, seen as widely including activities concentration, in fact, represents the root cause of many forms of unsustainability. The growth of waste, food waste, CO2 emissions, noise pollution, epigenetic diseases, congestion in mobility, the disruption resulting from the imbalance in supply and demand for work in urban contexts, are all factors of crisis due to the pattern of concentration and crowd. In this context of structural perspective changes, speed, powered also by the digital revolution, has made fluidity the dominant category of every relational form (economic, social, personal), generating instability, uncertainty, fears.

The Covid-19 pandemic has given a final blow to this model. The crowd and speed (of the urban-centric system) in the economic model of concentration and unlimited exploitation of resources have created the conditions for the spread of the pandemic. Thus, in a couple of decades, the crowd and the speed, from engines of urban development, have become causes of unsustainability and alienating lifestyles, from which "post-modernity" discomfort and hardships originate.

Such deep changes in the scenario led to new sensitivities among citizens regarding the issues of the environment and its relationship with health, emissions into the atmosphere and climate change, the relationship between food and health, social exclusion, the many and diversified forms of pollution linked to the concentration (crowd), the need for spaces of slow socialization and liveability, etc. In essence, in this phase of "modernity" and "rapid revolution", the awareness that the crowd and speed are becoming sources of alienation and discomfort and that well-being and quality of life need large and safe spaces, clean natural resources, relational slowness and resilience. This awareness has suddenly flooded with new light the neglected and excluded areas of the old model (the inner areas), which turn from "non-places", from which to emigrate, into spaces of opportunity, "identity places", where it becomes possible for territorial communities to build local economies generating tangible and intangible values (Nazzaro *et al.*, 2021) and "places to live" also through new forms of experiential tourism and/or new residents attracted by a better life quality. In other words, to paraphrase Rossi Doria, the "flesh is fraying" and "the bone is becoming more entrenched".

Precisely with regard to the fragility of inner areas, the ongoing war in Ukraine has highlighted further paradoxes and risks of the current development model:

- the market crisis, caused by the shortage of various agricultural and agri-food products, which adversely affects the purchasing power of families, already affected by the systemic crisis, seems incomprehensible in the face of large areas of the country (inner areas) kept unproductive due to their poor competitive power in global markets.
- the energy crisis, with strong inflationary pressures, despite large areas of the country (inner areas) with enormous potential, in terms of environmental resources (sun, wind and water) useful for the production of energy from renewable sources (wind, photovoltaic and hydroelectric).

Basically, the logic of profit and efficiency, exacerbated by neoliberalism and globalization, has made territories with significant natural resources uncompetitive, increasing the country's dependence on external sources. This is now posing a serious threat to food sovereignty and democracy, as evidenced by the war in Ukraine. Food sovereignty is a recent topic that has gained international recognition in opposition to the liberalization of food markets under the free-market push of the WTO, following the Marrakech agreement (1994)[2], which also included the agricultural agreement. The concept of food sovereignty was first introduced during the international conference of the "Via Campesina"[3] coalition in Tlaxcala, Mexico, in April 1996, in opposition to the concept of "food security". The critique of the "Via Campesina" movement is based on the fact that

[2] The Marrakesh agreement was signed in Marrakesh on April 15, 1994. The agreement marked the birth of the World Trade Organization (WTO), which came into effect on January 1, 1995. The Marrakesh agreement, the final act of the *Uruguay Round*, developed from the General Agreement on Tariffs and Trade (GATT) and expanded by adding sections relating not only to trade in goods but also to: services; agricultural, textile and health sectors; the strengthening of intellectual property rights; the elimination of barriers to free trade in goods; and the resolution of international disputes.

[3] The "Via Campesina" is an international movement founded in 1993, which brings together millions of small and medium-sized farmers, landless people, women farmers, indigenous people, migrants and agricultural workers from around the world. Its goal is to defend sustainable small-scale agriculture as a way to promote social justice and dignity, in strong opposition to multinational corporations. It includes about 150 local and national organizations in 70 countries across Africa, Asia, Europe and the Americas, representing 200 million farmers.

«the definition of "food security" (FAO 1996)[4], by not considering the origin of food, sets up an open model in which the availability of the product is determined by exchange with foreign countries, which has led to the gradual "privatization of food security" in the hands of multinational corporations», dramatically displacing local and national productions in developing and underdeveloped countries. The concept of "food sovereignty" was subsequently adopted and ultimately formulated in the "Nyéléni Declaration" of the International Forum on Food Sovereignty held in Mali in February 2007, which saw the participation of over 500 delegations of peasant movements and civil society organizations from 80 countries.[5]

Food sovereignty – historically born to claim the "food democracy" of local producers, giving "priority to local and national economies and markets" in developing and underdeveloped countries, crippled by food neoliberalism – has become, and is becoming, a priority also in developed countries, where for years underlying economic and social difficulties, due to the structural crisis resulting from the globalization of markets, have exploded with the war in Ukraine, which suddenly highlighted the vulnerabilities of these countries due to dependence on foreign strategic resources such as food and energy. Thus, even in the developed West, failures of the theory of productive specialization and comparative advantages underlying neoliberal policies have been experienced, opening up unprecedented spaces for national policies that are more attentive to reducing dependence on external strategic resources. This change in political and institutional vision reopens perspectives for minor supply chains[6] and for agricultural production areas located in inner areas. The revitalization of these territories and supply chains can, in fact, contribute to securing the country's strategic resources and, at the same time, reconsider the economic development model, as mentioned before, towards a substantial polycentric territorial rebalancing (between urban and inner areas).

In the light of these scenarios and, above all, of this latest recently implemented institutional change, it appears possible today to undertake paths to promote new models of development in inner areas, oriented towards food sovereignty and democracy, transformative regeneration of local communities and local food chains and markets. In this regard, one possible option could be explored by implementing models of proximity economy and experiential tourism, which will be discussed later. An option through which it is possible to enhance the great heritage of food, natural and landscape resources present in inner areas, which represent the conditions for ensuring a better quality of life for local populations, but also for urban ones, to the extent that significant contributions for the effectiveness of ecological transition can come from these areas.

The aforementioned changes are leading to an increased awareness that inner areas and their minor supply chains can become strategic resources for the country, capable of providing effective responses to the new demands of citizens regarding quality of life, food security and, more generally, sustainability and individual and social well-being. They are able to deliver productions that loosen the grip of external dependence on strategic products which, as precarious geopolitical balances have shown, can have serious repercussions on national economies in the case of war.

3. A NEW MID-LONG-TERM VISION OF INNER AREAS

The explosion in demand for quality of life in urban areas can find its answers in the inner areas. A change of perspective in territorial relations, which can be defined as epochal, however, as we will see later, represents a potential path that requires significant choices, political will, participation, and, above all, a substantial change in territorial development policies. An interpretive analysis follows of the main dynamics that have affected inner areas in recent decades, which frame the main topic of this study, namely the regeneration of minor supply chains and inner areas.

[4] "Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO 1996).

[5] "Food sovereignty is the right of peoples to nutritious and culturally appropriate food that is accessible, produced sustainably and ecologically, and the right to decide on their own food and agricultural systems. It puts those who produce, distribute and consume food at the heart of food systems and policies, above the demands of markets and corporations. It defends the interests and integration of future generations. It offers us a strategy to resist and dismantle neoliberal trade and the current food regime. It provides guidance for food, agricultural, pastoral and fisheries systems to be managed by local producers. Food sovereignty prioritizes local and national economies and markets, favors traditional family farming, fishing, and animal husbandry, as well as the production, distribution, and consumption of environmentally, socially, and economically sustainable foods. Food sovereignty promotes transparent trade that can guarantee a decent income for all peoples and the right for consumers to control their own food and nutrition. It ensures that the rights of access and management of our lands, territories, water, seeds, livestock, and biodiversity are in the hands of those who produce the food. Food sovereignty implies new social relationships free from oppressions and inequalities among men and women, peoples, races, social classes, and generations. (…)" (Food Sovereignty Forum, 2007).

[6] The minor supply chains referred to, are poorly structured, in which mainly only the agricultural phase is developed.

When referring to inner areas and agriculture, it should be noted that we are not referring to homogeneous territorial realities and agricultures. Each agricultural system (agri-food supply chain) is distinguished by its own specificities, which are biunivocally connected to the reference territories, each of which expresses its own potentialities. Therefore, it is necessary to be aware of the presence of "plurality of rurality and agricultures" or a mosaic characterized by the coexistence of many different rural areas, agricultures, farms, supply chains and different organizational models, where diversity means different criticalities and potentialities. In essence, we are facing a sort of "economic, social, and organizational biodiversity" within which there are:

- *developed rural areas*, that boast successful and prestigious supply chains, in which farms and other economic agents operate with good market positioning and local institutions that are very sensitive to food supply chain dynamics;
- *intermediate rural areas*, consisting of irrigated plains that produce commodities under competitive conditions and with local institutions that are somewhat aware and attentive;
- *rural areas with significant structural constraints* (i.e. depopulation, aging, etc.) in which we find so-called minor supply chains, that is, poorly structured supply chains, mainly engaged in traditional crops and livestock farming, with limited competitive positioning on regional, national and global markets.

In short, a positive correlation emerges, with ample empirical evidence, between the strength of territories in terms of productive and organizational potential, the quality of institutions[7], and the good competitive positioning of farms and agri-food supply chains (Hirschman, 1981; Raimondo *et al.*, 2020).

Inner areas fall within the third type of rural territories defined above. These are realities with strong structural constraints, weak institutions and the presence of minor supply chains that strenuously resist the risk of abandonment. However, in these inner areas, food supply chains play an extremely important role as territorial presidiums, as a testimony of local traditions and cultures, as guardians of the landscape and biodiversity. And today, the ongoing war strongly emphasizes their lack of productive contribution to the national market, which could have alleviated the market crisis we are experiencing. The productive capacity of minor supply chains, if supported and organized, could have significantly compensated for external dependence, avoiding productivity temptations (increasing yields in the usually already overexploited areas) that would end up aggravating sustainability problems, loss of biodiversity and climate change.

The transformative regeneration of the more inner areas and the economic revival of minor supply chains represent a challenge that must be necessarily won if we really want to contribute to the maintenance of biodiversity and mitigation of climate change, and at the same time, to the strengthening of food security in terms of less dependence on the outside. An obligatory path that, moreover, would also open up concrete prospects in the direction of a change in the economic and social paradigm towards more inclusive and fair forms that put people and territories at the centre.

Today, inner areas have all the characteristics to respond to the new demands of society (Marotta and Nazzaro, 2020; Pinto *et al.*, 2020; Pollermann *et al.*, 2020; Storti *et al.*, 2020). There have been many socio-economic transformations that have affected agriculture, including in these areas, as an attempt to recover spaces of "resistance" in a competitive arena that excludes areas with "structural fragility". Despite being "fragile", internal agriculture is nonetheless interpreting modernity by following interesting lines of evolution:

- *product diversification*, opening up the farm to new activities related to the primary one, such as agritourism, processing and direct sales, which bring urban citizens closer to the world and traditions of farming, to the cultural matrix that underlies our modernity;
- *product differentiation*, towards a significant strengthening of the link between products and their production territories (Identity Products); products that incorporate cultures, traditions and informal knowledge specific to their places of origin, towards which citizens are increasingly attentive, sometimes as destinations for new forms of tourism;
- *agriculture multifunctionality*, linked to extensive production models that generate positive externalities such as a healthy environment, clean natural resources, scenic beauty, protection of biodiversity, social inclusion, etc. A set of "public goods" characterizing the new agriculture, greatly appreciated by citizens but not adequately recognized by the market, and thus supported by the Common Agricultural Policy (through the direct payments instrument), (Cecchi and 2003; Van der Ploeg *et al.*, 2002; Van Huylenbroeck *et al.*, 2003; Marotta and Nazzaro, 2020).

[7] The issue of institutional deficit, both qualitative and quantitative, has led, according to Hirschman's studies since the 1970s, to unifying analytical tools and policies applied to different territorial and productive realities in terms of development dynamics, with the consequent dissatisfaction of citizens and communities, expressed through participatory criticism or radical detachment.

These evolutionary lines have not been homogeneous in terms of intensity and content, but in any case, thanks to them, some inner areas have turned from places of (only) production to (also) spaces of consumption and enjoyment, offering goods and services capable of satisfying the growing demand for well-being and quality of life of citizens, especially urban ones (Marotta and Nazzaro, 2011). These are contained realities, not generalized, but they represent models to be followed in order to regenerate and revitalize all the internal realities of our country.

Therefore, the transformations mentioned have revealed a new perspective that can open up interesting paths of territorial regeneration and social innovation, in response to new citizen sensitivities and demands. To make this perspective concrete, a reorientation and better targeting of territorial policies is necessary.

In our country there's a strategic line which assigns inner areas development to the EAFRD (European Agricultural Fund for Rural Development), while entrusting the much richer ERDF (European Regional Development Fund) and ESF (European Social Fund) with the responsibility of acting predominantly in favour of the development of urban areas, that is, places with a large population and electoral base. Therefore, since the EAFRD cannot intervene in the development and improvement of contextual conditions (i.e. establishment and strengthening of the non-agricultural productive fabric, infrastructure of the territory, provision of services to people and businesses, strengthening of social capital and capacity building, etc.), general economic policies that should have filled the gaps in inner areas have been very scarce and ineffective. The inner areas issue has been always seen as almost exclusively within the scope of rural development policy, without taking into account that this policy has tools that allow it to act only on the agricultural sphere and related territorial aspects, but not on contextual variables.

This has been a blinkered view that has exclusively favoured the crowd, leaving the structural constraints of these areas unresolved, which, moreover, as previously stated, were caused precisely by the urban-centric logic pursued since the 1950s. Thus, nowadays there's a model in structural crisis (the model of crowd and speed) that cannot be rebalanced and compensated for by other territorial model positive dynamics (the model of rarefaction and slowness), as these have been left without strategic contextual policies. In this policy inconsistency, we find the reasons why we still talk about potential, vision and medium-to-long-term prospects today, while reiterating that there are now quite significant cases at the national level, where such visions are beginning to take concrete form autonomously from the bottom up (Bours *et al.*, 2022).

The concentration/territorial polarization of development seems, therefore, no longer viable and, since no investment has been made in areas other than urban ones, the prospects appear critical. It is no longer possible to continue pursuing a model that concentrates resources and policies in areas where the main constraint to development is represented by congestion. It is necessary to decongest such areas by shifting attention and policies to areas of rarefaction. In other words, it is necessary to overcome the "concentration model" in favour of a "distributed model" from polarization to polycentrism.

This is a medium-to-long-term political-cultural revolution, which can no longer be postponed. A policy that retraces, at least partially in reverse, the processes of exodus of the last seventy years, by moving economic activities, services, infrastructure and population from areas of crowd to those of rarefaction, in order to decongest the former, leading them towards a better quality of life, and to strengthen the latter, transforming potential into concrete development actions. A polycentric model that brings benefits to both territorial realities.

In 2012, under pressure from the European Union, the focus on the criticalities and constraints of inner areas in our country increased, leading to the launch of the National Strategy for Inner Areas (SNAI), with the aim of curbing depopulation. In the light of its already several years of implementation, such a policy is not very effective. SNAI aims to resolve the lack of essential services (school, health and mobility) in advance and at the same time to launch local development plans. To date, only a few selected areas have seen the start of cooperation between municipalities to address the shortage of services, while the line of action relating to development plans remains poorly explored. The inadequacy of this policy lies in the fact that it considers only the lack of essential services as the cause of depopulation, and not also, and perhaps above all, the lack of opportunities for qualified employment. Furthermore, it is being experimented with in only a sample of territories, when the critical issues are widespread in many national inner areas, which are expanding over the years, as shown by some recent reports[8]. Young people leave mainly in search of work

[8] At the end of January 2023, the "Report on the Inner Areas – focus on the provinces of Avellino and Benevento" was presented by Confindustria Campania – Piccola Industria, in collaboration with the University of Sannio, which reported a demographic decline of around 40,000 people over five years and about 12,000 in the last year, as a result of a marked worsening of both migratory and natural balances. It is very likely that this level of depopulation is common to several other national contexts.

commensurate with the skills and expectations acquired through their degrees, to which the issue of service shortages is also associated. Therefore, to change the future of inner areas it is necessary to substantially reverse the course through a holistic approach to development that, starting from the wealth of natural and food capital, implements paths of social innovation oriented towards ecological transition; paths of circular economy and transformative regeneration of local economies, also oriented towards community welfare, in order to create jobs and therefore retain young people in the area.

The vision for inner areas presented here has also recently been relaunched by the European Union. In June 2021, it published a communication entitled "A long-term Vision for the EU's Rural Areas – Towards stronger, connected, resilient and prosperous rural areas by 2040". It is a guideline document that outlines the key actions to be taken in order to revitalize the development of rural areas, supporting them in addressing the major global challenges of our time, such as sustainability, climate change, economic and social disparities, food sustainability, etc. Among other things, the EC Communication strongly emphasizes the model of neo-endogenous, "place-based" development (Community Led Local Development (CLLD)), aimed at strengthening the integrated bottom-up development of rural areas (Saracu *et al.*, 2019; Pollermann *et al.*, 2020).

In recent years, institutional attention to the development of fragile areas has increased, also due to the structural economic crises that have occurred. Alongside this, there has been a scientific debate that frames the territorial development delays, and therefore the inner areas, within the broader context of the systemic crisis of the economy and society (Carrosio *et al.*, 2017; Carrosio, 2019; Lucatelli, 2015; Pinto *et al.*, 2020; Marotta and Piazza, 2021). This renewed awareness suggests that the discussion on overcoming the crisis cannot ignore the territorial reading of development dynamics. In other words, the necessary transition to a new model of economy and society cannot be addressed only from a vertical perspective, connected to different sectors of the economy and/or canonical social areas, but must be framed in a territorial perspective, including all those spatial realities that are currently excluded in a new vision of development. Otherwise, there is a risk of changing the model (to an ecological-digital one) but not solving some of the historical problems of our country, such as inequalities and territorial disparities that would continue to characterize economic, social, environmental and territorial dynamics as unsustainable.

With this awareness, the next section presents a development path for inner areas and minor supply chains, called "proximity economy and experiential tourism", consistent with the EU's *Long-term vision* and the UN's 2030 Agenda.

4. ECONOMY OF PROXIMITY AND INNER AREAS' TRANSFORMATIVE PROCESSES

As previously mentioned, it is necessary to push for a cultural and political transformation. The focus of this change is represented by the awareness of the problems and a modern and sustainable vision of politics, understood as action in the service of society and territories. Today, the conditions for a change of vision such as the one just mentioned all seem to be there. The sensitivity of citizens to development issues has grown significantly and a critical and responsible awareness has matured, so the prospect of being able to change scenarios no longer seems like a utopia.

The first awareness is that the inner areas today represent an extraordinary heritage of human, cultural, natural and economic resources and can contribute significantly to the solution of the many problems posed by the great challenges of our times. But these contributions can only be realized if we manage to reverse the trends in these areas, triggering transformative and regenerative processes that aim at a human, economic, social and institutional revitalization. The central issue then is to understand – while following the guidelines of the EU "vision" – what is the most effective path to undertake to make transformative and regenerative processes truly concrete and effective, especially in the most fragile territories where minor supply chains operate and do not have a *chance* in the markets of global competition.

The theoretical and political-economic mainstream has led to a "conventional agri-food model", based on individual and/or supply chain innovation, functional to achieving competitive positions on markets by enterprises, supply chains and territories. Consistent with this model, several territorial realities, characterized by productive excellences and adequate economic and organizational structures, have had, and continue to have, success on national and international markets. However, alongside such competitive and successful areas, as previously mentioned and as confirmed by the socio-economic indicators generally used for territorial analyses, there is also another wide rural world that, in the "global-local" opposition, is significantly disadvantaged, experiencing economic setbacks associated with a constant erosion of its most valuable resource: human capital. For this area of rurality, albeit in a framework of systematic diversity, there is a substantial exclusion from positive

development dynamics. Dynamics that, moreover, the more recent evolution of the economic model (globalization) has made "non-territorial", transforming areas that were once places of wealth production and development of social and economic relationships into "non-places" that young people do not want and cannot inhabit.

In such a rurality, which is rich in resources but losing out economically and politically, the majority of inner areas are found where minor food supply chains survive, those that do not have the typical conditions to compete on national and global markets (economies of scale, productive/organizational efficiency, market power, etc.). The "conventional mainstream model" is not applicable in these fragile territorial realities because the objective and subjective preconditions for its implementation are lacking (company structure, organizational model, contextual conditions, human capital, etc.). To find a solution for the economic and social revitalization of these areas and supply chains, the mainstream of global competition must be left and different paths followed based on the development of local resources and models of direct citizen/consumer involvement.

An important contribution in this regard comes from scientific research, which proposes alternative new models based on social innovation. Such models are functional to a re-territorialization of development that is transformative and regenerative of territorial ecosystems, oriented towards rebuilding "places" where it is nice to live, work and be happy. Places that also become market spaces, in which all actors, including those who operate on the demand side (citizens/consumers), live an experiential involvement that creates value.

In the scientific literature, in the agri-food field, Marotta *et al.* (2020) proposed the model of the "portfolio of values", which interprets the short supply chain as an experiential involvement of producers and citizens in the enjoyment of the (material and immaterial) values of rurality. The authors define the "territorial portfolio of values" as "the set of material and immaterial value chains, representative of territorial identity that local actors organize and make accessible to citizen-consumers, through an experiential involvement that creates shared value".

In the economic-territorial literature, Jeannerat and Crevoisier (2010) propose a model called "territorial stage setting" as an organizational model of actors, objectives and activities that contribute to transforming productive resources into a *particular representation/configuration of experiential activity*, and consumer resources into an experiential involvement that generates value.

In both models, reference is made to the concept of the experiential market, understood as a mode of purchase and/or consumption conceived as an experience lived in the places of production of goods and/or services. 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.

The proximity economy is inspired by the above models and, in particular, by the concept of territory as a contextual space of production and purchase/consumption. In fact, the proximity economy refers to an organization of production aimed at selling its products and services to the citizens of its own territory and that closest to it and, simultaneously, a demand for these products expressed by the local and closest communities. For food this means that producers organize themselves to sell in the same production territories and in those closest to them, and local communities purchase and consume food from their own territory and/or that closest to it (the reference can be to a homogeneous territorial area, a province, a region). This concept is often expressed as the "re-territorialization" of food.

On the supply side, producers organize themselves individually, practicing sales formulas through their own sales points, and/or collectively, participating in so-called farmers' markets. Both forms of direct sales are already widespread in all Italian regions, although they have not always been successful. Now is the time to propose new formulas based on models of social innovation, such as the creation of collective entities by local producers for the management of permanent and exclusive points of sale of local foods, which could be defined as "Small Organized Distribution of Local Food". This would be located in smaller centres (rural villages) or in medium-small towns that are rebuilding new functional ties with the surrounding countryside, or in peri-urban areas, and once consolidated as a model of food supply, could find their economic, social and cultural function even in the provincial and regional capitals, or in larger cities.

Essentially, the creation of a collective organizational model represents a further step in rationalizing and consolidating "local food systems"[9], involving all stages related to food, from production to commercial valorisation. The citizens/consumers in a given geographical area can find all the agricultural products and minor supply chains of the reference territory. These are products that do not have the competitive strength to face the challenges of global markets; products obtained through extensive, sustainable and inclusive production techniques, thanks to minor supply chains that resist in their activities, safeguarding fragile territories.

[9] Cfr. Article 13 of the Unified Text on Agriculture, Legislative Decree of May 18, 2001, no. 228, refers to "Food Districts."

These products are both representative and connectors of natural, anthropic and cultural ecosystems, towards which citizens express growing interest both to practice a healthy diet and contribute with their consumption/purchase to supporting the development of fragile territories that play important roles for the overall sustainability of the system. They incorporate local cultures and traditions, constituting real ambassadors of the reference territory, with a strong potential as tourist attractions.

The tourist option is the other important opportunity linked to the valorisation of local food in a logic of proximity economy. Making local food known and promoting it in the territories closest to the places of production ends up stimulating the wide latent demand for rurality and bringing citizens, as tourists, to the places of origin of the food. Obviously, the reference is not to generic and/or mass tourism, but to specific segments, fuelled by citizens with particular sensitivity towards natural ecosystems, local traditions and cultures, local products, slow lifestyles and relationships, historical-cultural heritage of rural villages, landscape and biodiversity, shaped by minor supply chains that resist as the only custodians of fragile territories. It is a cultured tourism, sensitive to sustainability issues, seeking an authentic experience through the consumption and purchase of food that has a story to tell, which is the expression of a set of material and immaterial values; a purchase/consumption experience for which there is full availability to recognize its market value. This gives satisfaction to producers who see a *premium price* recognized for their food, and to tourists who experience moments of authentic relationships in healthy natural environments, savouring sensations of well-being and cultural enrichment.

Territories undertaking the path of proximity food and experiential tourism must first organize production, but also the reception of tourists who will be attracted by the offer of experiential moments related to local food. In this context all actors in the territory are called to be protagonists: agricultural producers, artisans, operators in the restaurant and hospitality industry and local institutions. The entire local community becomes a food community, organized to offer citizens an experiential involvement that creates shared value. Local and proximity food becomes the common thread of a territorial organization, of a generative and transformative social innovation that sees production agents, citizens, local institutions and tourists as protagonists in the same territory (see Legge 1 dicembre 2015, n. 194, "Disposizioni per la tutela e la valorizzazione della biodiversità di interesse agricolo e alimentare").

In this model, the territory is as a sort of "stage" on which the offer of local food and other resources is represented and on which different actors (producers, communities and non-resident citizens) act (perform) together, collaborating and experiencing experiential involvement that generates shared value. It is a "territorial stage setting" (Jennerat and Crevoisier, 2010) that becomes social innovation, organizational model and, at the same time, the driving force of a transformative regeneration of the territorial ecosystem, of the local community and the minor food supply chains. Such supply chains could never have the strength, even if supported by policy, to compete in global markets, but on their own territorial stage, they can play a leading role without the threat of global competition. The culture and knowledge embodied in the local food of minor food supply chains become like a protective belt compared to global, standardized, a-territorial food that has no story to tell. In a logic of proximity market, the food from minor supply chains in fragile areas can become the *driver* of local development based on cooperation, participation, reciprocity, inclusion and sharing of created value. This development involves local producers, the entire local community and tourists, in an alternative model to the competitive mainstream, based on social innovation that implements the principles of civil economy to promote a food that can be defined as *civil food* (Di Iacovo *et al*., 2014; Di Iacovo *et al*., 2017).

The proposed model of proximity economy cannot be applied in all inner areas that suffer from economic and social fragility. Its applicability requires certain minimum conditions, such as the presence of semi-structured productive supply chains (minor supply chains) that have strong historical territorial roots, the presence of artisanal activities, natural capital and local public institutions (local authorities) and private ones (cultural associations, third sector, etc.) sensitive to local development issues. It is necessary that there are minimum prerequisites to stimulate, also through targeted policies, a local social capital capable of implementing the necessary social innovation for the success of a model of civil proximity food.

The scenario outlined for the development of minor food supply chains in fragile inner areas requires targeted policy support and a collective bottom-up approach (Community Led Local Development (CLLD)), as defined in the EU's *Long-term Vision*. This approach is promoted by Rural Development Programmes (RDP) both in support of Local Action Groups (LEADER approach) and in the context of cooperation measures (Measure 16). Both instruments (Leader and Measure 16) require innovative implementation compared to the previous programming period (2014-2020), including in terms of types of eligible actions, in order to meet the

potential demand for policy and provide concrete development prospects for inner areas. This should be done with the awareness that their underdevelopment, as has been repeatedly mentioned, does not help achieve the 17 UN Sustainable Development Goals and denies access to fundamental rights to resistant local communities.

Providing solutions for minor supply chains in fragile territories is the most important challenge for Italian regions in the current phase of rural development programming and EU structural funds. This means having a greater and full awareness of the needs of these areas and, above all, recognizing that their satisfaction cannot be achieved by following traditional intervention logic but requires effective collective approaches, significant social innovation and the decisive contribution of context policies (ERDF and ESF).

5. CONCLUSIONS

The analysis of territorial imbalances, among urban and inner areas, conducted in this study showed an incomprehensible paradox of Italian development. For decades urban-centric policies have been implemented, draining substantial resources from inner areas, causing a double unsustainability: urban areas suffer from excess concentration and overcrowding, while inner areas suffer from economic and social rarefaction. The former live at fast paces with homogenized and alienating behaviour styles and significant waste of strategic resources and unsatisfactory quality of life levels; the latter hold underutilized strategic resource assets and environmental conditions that would allow a better quality of life, but few people are benefiting from them.

The flow of resources from inner to urban areas is continuing and has even assumed considerable dimensions. This will dangerously accentuate imbalances, further worsening conditions in both the starting and destination territories. The SNAI, as implemented, does not seem to have produced effective results, while interventions for development under the economic policy context have been scarce. Development action is left exclusively under the domain of policies in the EAFRD field (agriculture and rural development policy); while policies for the much better equipped (in terms of resources and tools) ERDF (European Regional Development Fund) and ESF (European Social Fund) are very scarce.

The situation is unlikely to evolve without a substantial cultural and political change, with the definition of policies with new contents, capable of regenerating local communities through the involvement of all economic, social and institutional actors in a holistic, collective and socially innovative development approach oriented towards horizontal subsidiarity. A neo-endogenous development model, "place-based" (Community Led Local Development (CLLD)) aimed at strengthening integrated bottom up development of inner areas, accompanied by significant technical assistance intervention by the Regions, to fill the deficits of local institutions, which are called to a role of innovative protagonist, without having the necessary human resources, skills and organization, will not produce lasting results.

Regarding policy contents, it is evident that these cannot ignore context characteristics, but in a differentiated way, depending on local vocations, they must still revolve around an integrated model that brings together the susceptibilities of agriculture, craftsmanship, tourism and natural resources. In the study, the model of proximity economy and experiential tourism was explored. Other models can be proposed, starting from the integration of knowledge from a multidisciplinary and interdisciplinary perspective.

The proximity economy and experiential tourism model proposed in this paper represents an important social innovation for inner areas where, as is known, the individual approach to development policies still prevails. In view also of the thrust of the "Long-term vision for rural areas" towards integrated development policies, the implementation of this model could be realized through the LEADER initiative (Cf. CAP Strategic Plan, SRG07- Cooperation for local development and smart villages, areas of reference cooperation for local food systems, local supply chains and markets and cooperation for rural tourism), alongside an intervention of territorial technical assistance to fill the deficit of social and institutional capital in the inner areas. A second line of action could be a national one, within a wider relaunch of SNAI[10].

Food sovereignty can become an important tool to define and implement specific and targeted policies towards an effective enhancement of inner areas' production systems and to give substance to the proposals formulated here; specific policies such as, for example, "minor supply chain contracts" and policies to promote proximity economy models in all national internal areas.

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[10] See Special Committee of the Parliament; Special Committee on Internal Areas in the Regional Councils of Campania and Tuscany.

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Research article

Food security beyond global warming: economic and policy perspectives from Uganda

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Abstract. Climate change has severe and pervasive impacts on natural systems and affects many aspects of human life. Increasing temperatures and alterations in the regimes of precipitations are adding pressure to global agricultural systems, which are already struggling to respond to expanding global demand for food. This directly translates into additional risks for poor people living in developing countries who already face precarious food security conditions. Focusing on the case of Uganda and using household data from the National Panel Survey merged with climatic data from the US National Oceanic and Atmospheric Administration, this paper explores the link between climate change and households' food insecurity. By applying a generalized ordered logit model, this work provides quantitative evidence about the impact of climate variability on food and nutrition security of clustered food consumption groups of smallholder farmers. Among the different socio-economic and environmental variables affecting the households' food security conditions, time and cross-sectional variations in the regime of precipitations play a crucial role. The results highlight that adaptation programmes aimed to reduce climate-induced food insecurity and improve coping abilities of rural communities should be site-specific and involve local communities with the aim of considering the specific risk exposure of the different agro-ecological areas.

Keywords: climate change, food and nutrition security, smallholder farming, generalized ordered regression, East Africa.
JEL codes: O13, P48, Q18.

HIGHLIGHTS:

- Climate-induced effects on food production risk exacerbating the already precarious livelihood and food security conditions of people living in Uganda.
- Socio-demographic characteristics as well as agricultural activities based on crop diversification and mixed crop-livestock systems have an important influence on household food security.
- Time and cross-sectional variations in precipitation regime play a crucial role.
- Policy interventions should be site-specific and based on the involvement of local communities.

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1. INTRODUCTION

Climate change is widely recognized as the most important global environmental problem, the scientific evidence of which is unequivocal (Pachauri *et al.*, 2014). More than other major economic sectors, agriculture is particularly affected by weather alterations because it is climate-sensitive and highly dependent on natural equilibriums. Increases in temperatures, rainfall variations and growing frequency of extreme weather events are adding pressure to agricultural systems, which are already struggling to respond to increasing food demand due to global population growth (FAO, 2015). These risks are unevenly distributed and are usually greater for people living in developing countries because of their socio-economic vulnerability, poor agricultural production systems, and diffuse food insecurity (Collier *et al.*, 2008). This is particularly true in Sub-Saharan Africa, a region mostly exposed to climatic drivers whose alteration risks exacerbating the incidence and severity of extreme weather events (Collier *et al.*, 2008) with unavoidable consequences in terms of food and nutrition insecurity (Campbell *et al.*, 2016). In such vulnerable contexts, severe climate variations might affect food systems in several ways, ranging from direct effects on crop production, livestock and fisheries, to changes in markets, food prices and supply chain infrastructures (Gavagnin, Zolin, 2016). With reference to crop production, climate change simulations combining all Sub-Saharan regions suggest consistent negative effects on major cereal crops, with yield losses ranging from 2% for sorghum to 35% for wheat by 2050 (Ebi *et al.*, 2014). Climate shocks can also exacerbate livestock activities and grazing systems with the following negative impacts (Ebi *et al.*, 2014; Hopkins, Del Prado, 2007; Solomon *et al.*, 2007; Smucker, Wisner, 2008; Galvin, 2009; Thornton *et al.*, 2009; Dougill *et al.*, 2010; Ifejika Speranza, 2010): (i) rangeland degradation; (ii) increased variability in access to water; (iii) changes in land tenure; (iv) fragmentation of grazing areas; (iv) lack of opportunities to diversify livestock; (v) immigration of non-pastoralists into grazing areas; and (vi) changes in herbage quality and pasture composition. The negative impacts of climate change not only affect the food production, but also influence the farmers' income, food accessibility, food supply, and food security (Murniati, 2020).

Such climate-induced effects are projected to be particularly severe in East Africa due to the interactions of multiple factors such as a fast-growing population, extreme poverty, violent conflicts, poor infrastructure, overdependence on rainfed agriculture, and a severe food insecurity situation. Most rural households living in these regions face precarious livelihood conditions due to political and social instability, economic constraints and poor access to resources and infrastructures. Declining soil fertility, low crop yields and livestock losses caused by climatic variability risk exacerbating the already precarious livelihood and food security conditions of local people (Kristjanson *et al.*, 2012; Jayne *et al.*, 2006; Rufino *et al.*, 2013; Wichern *et al.*, 2017). In Eastern Africa, since 2005 the number of undernourished people has increased, reaching a peak of 133.1 million people in 2018, while the prevalence of severe and moderate food insecurity resulted respectively equal to 25.9% and 62.7% of the total population. (FAO, IFAD, UNICEF, WFP and WHO, 2019).

Focusing on the case of Uganda and using household data from the National Panel Survey merged with climatic data from the US National Oceanic and Atmospheric Administration, this paper explores the link existing between climate change and households' food insecurity. Specifically, it aims to answer the following research questions: (i) what are the main socio-economic and environmental factors affecting households' food security? (ii) to what extent can climate change affect food security?

Much research has been conducted with reference to the link existing between climate change and agricultural productivity (Chipanshi *et al.*, 2003; Knox *et al.*, 2012; Tingem *et al.*, 2008; Ayinde *et al.*, 2011; Nastis *et al.*, 2012; Calzadilla *et al.*, 2014; Bandara, Cai, 2014), but only a few of them analyse the direct and indirect impacts that climate change has on food security dimensions (Esham *et al.*, 2017), especially at household level. Furthermore, the majority of studies analyse climate change effects on food security considering just the perception of farmers towards weather alterations as an indicator of the on-going climate change (Mekonnen *et al.*, 2021). However, this approach appears limited since it is strongly connected to personal opinions which do not always reflect the actual weather modifications. Hence, the main goal of this study is to provide a more objective perspective by empirically assessing the role played by temperature and precipitation changes on food security. For that purpose, indicators of climate variability were introduced into a rigorous econometric model applied using national household's data from different agro-ecological zones. The robust results obtained could contribute to the existing literature and can be used to define and adjust policies aimed at reducing food insecurity and vulnerability in developing contexts.

The paper is structured as follows. Section 2 provides a description of climate change dynamics in the study area. Section 3 illustrates the data used in the

analysis. Section 4 presents the conceptual framework and methodologies applied. Results are described and discussed in Section 5. Conclusions and policy implications are provided in Section 6.

2. DESCRIPTION OF CLIMATE CHANGE DYNAMICS AND IMPACTS IN UGANDA

The study analyses the case study of Uganda, a landlocked country located in the Eastern part of the African continent. It is characterized by diverse climate patterns due to the country's unique biophysical features. Rainfall varies throughout the country, with patterns ranging from "bimodal" (with a first rainy season occurring from March to June and a second from September to December) to "unimodal" (with a unique rainy season occurring from March to October). This last climatic condition characterizes the northern region, which forms one quarter of the country and lies outside the tropical belt (World Bank, 2021). Such patterns are also influenced by the action of El Niño Southern Oscillation phenomena, which are principal driving forces of intra-annual to inter-annual rainfall variability. These natural equilibriums are however altered by the on-going global warming. Time series analyses show that average temperatures in Uganda have increased by 1.3 °C since the 1960s, with hot days increasing by an average of 8-6 days per month (World Bank, 2021). Uganda has also experienced statistically significant changes in annual precipitations. Since the 1960s, seasonal rainfall has been characterized by decreases of 6.0 mm per month, per decade (McSweeney, Lizcane, 2010). However, the incidence of such changes in precipitation patterns varies within the country. Specifically, over the past 20 years, western, northern and north-eastern regions have experienced an increase in the frequency and magnitude of long-lasting extreme events like drought periods and flooding (World Bank, 2021).

Considering the high-emission scenario, monthly temperature in Uganda is expected to increase by 1.8 °C for the 2050s and by 3.7 °C by the 2090s. At the same time, the percentage of rainfall occurring from heavy precipitation events is anticipated to increase, which would also escalate the risk of disasters such as floods and landslides (USAID, 2012).

All these projected changes risk further compromising the productivity of the agricultural sector, which plays a crucial role in Uganda's food security and economic prosperity. Projected heat stresses, reduced water availability and watershed re-charge and increased frequency and intensity of extreme weather events are likely to contribute to reductions in the national production of food crops such as cassava, maize and groundnuts. More in depth, water stresses lead to shortening of the crop reproduction stage, reduction in leaf area and closure of stomata to minimize water loss, reducing crop yields (Adhikari *et al.*, 2015). Increased heat and water scarcity can also alter the occurrence and distribution of pests, and stress livestock and fishery activities, resulting in disrupted livelihoods and significant economic losses (Walter *et al.*, 2010; Kimaro, 2013; Bett, 2017; Rahimi, 2021).

Such unstable agricultural and food production may have negative implications not only in terms of food availability and access, but also with regard to food utilization, by reducing the variety and number of foods used as micronutrients' sources, influencing decisions to grow crops of different nutritional value, and/or altering the nutritional content of specific foods (Burke, Lobell, 2010). Moreover, climate change may increase the incidence of infectious diseases thereby increasing the caloric requirements of affected populations, reducing the body's absorption and utilization of essential nutrients, and then increasing the overall nutrition needs (World Food Programme, 2012).

All the aforementioned climate-induced consequences risk exacerbating the already precarious food security conditions of people living in Uganda. Indeed, despite the majority of the population in this country having an acceptable food consumption score, 17.6 million people are undernourished, while about 12% continue to be chronically food insecure, don't have an adequate energy intake and can't afford a diversified diet (FAO, IFAD, UNICEF, WFP and WHO, 2019).

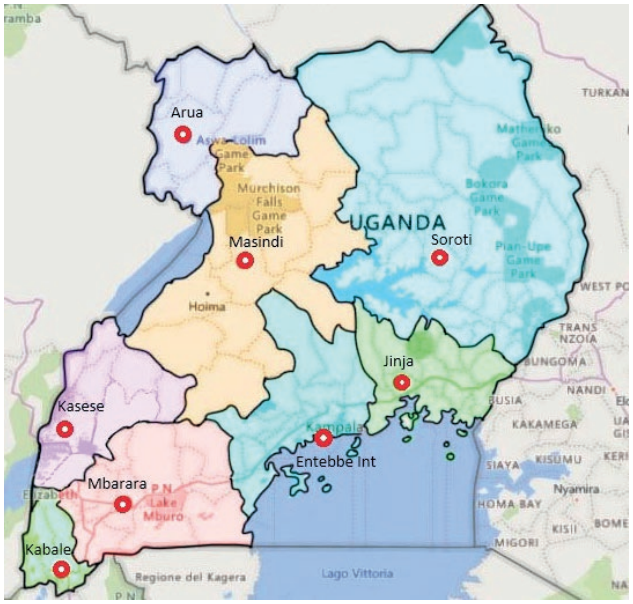
3. DATA AND STUDY AREA

For the purpose of this study, we used a combination of household and climatic data obtained from two different sources. Household data were extracted from the Uganda National Panel Survey (UNPS), referred to the 2013/2014 cropping seasons[1]. They were collected from a sample of 3,123 households equally distributed in 101 districts and covering all the country regions: Central, Eastern, Western and Northern (Uganda Bureau of Statistics, 2014).

Using the UNPS data, we selected demographic and socio-economic information including: household

[1] The UNPS data were collected in Uganda from September 2013 to August 2014, as part of an household survey commenced in 2009/2010 and supported financially and technically by the Government of Netherlands and the World Bank Living Standard Measurement Study – Integrated Surveys on Agriculture (LSMS – ISA) project (UBOS, 2014).

Figure 1. Geographical distribution of districts and weather stations in Uganda.



members' demographics (i.e. age, gender, marital status, level of education or formal schooling, health); life conditions (i.e. household incomes, welfare conditions and food security); and agricultural activities (i.e. region, crop land area, crop and livestock inputs). With the aim of computing and introducing climatic variables in the analysis (i.e. median absolute deviation of temperature and precipitation), historical data of rainfall and temperature made available from the US National Oceanic and Atmospheric Administration (NOAA) were also used. The following weather stations have been considered: (i) Arua; (ii) Entebbe International; (iii) Jinja; (iv) Kabale; (v) Kasese; (vi) Masindi; (vii) Mbarara; and (viii) Soroti.

The geographical distribution of sampled districts and weather stations is shown in Figure 1.

4. CONCEPTUAL FRAMEWORK AND METHODOLOGY

4.1. Conceptual framework

The academic and political debate surrounding food security measurement is ongoing, due to its multidimensional aspects (Cafiero *et al.*, 2014; Bertelli, 2019). Several indexes are defined to capture part of this multidimensionality through food supply quantification at country level, as well as food consumption characterization and nutritional outcome measurement at household or individual level. Cafiero *et al.* (2014) proposed a framework to classify food security indicators in the following two categories: (i) indicators based on the concept of food consumption adequacy (e.g. Prevalence of undernourishment, Household Dietary Diversity Score and Food Consumption Score); and (ii) indicators based on experience-based food security scales (e.g. Household Food Security Survey Module, Household Food Insecurity Access Scale, Latin American and Caribbean Food Security Scale, and the Food Insecurity Experience Scale).

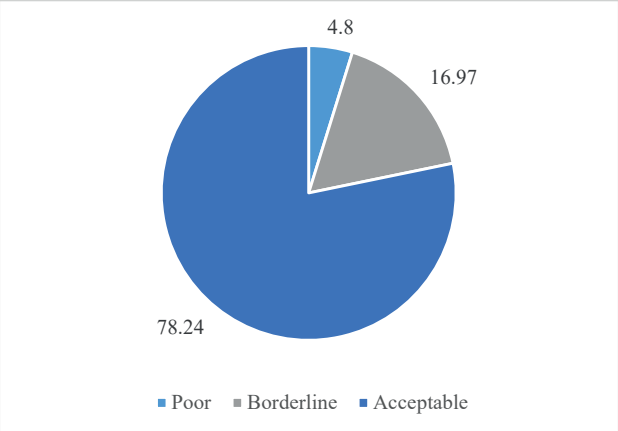
For the purpose of this study, we decided to adopt an approach based on food consumption adequacy. Specifically, we selected the Food Consumption Score (FCS) as a proxy for the households' food security level because it allowed us to capture both quality (dietary diversity) and quantity (number of foods consumed) perspectives of nutrition security. FCS is defined as «the frequency-weighted diet diversity score calculated using the frequency of consumption of different food groups consumed by a household during the 7 days before the survey» (World Food Programme, 2008). It aims to capture aspects such as dietary diversity, frequency of food group consumption, and nutritional value of food (Leroy *et al.*, 2015). Such an indicator allows food security to be summarized by summarizing the three aspects reflected in the food frequency data: (i) dietary diversity; (ii) frequency of food group consumption; and (iii) nutrition value of food (Cafiero *et al.*, 2014).

We computed the FCS following the Food Consumption Analysis guidelines published by the World Food Programme (2008): (i) we considered a list of 62 foods that were indicated by farmers as being consumed in the previous 7 days; (ii) we classified food items in 9 groups; (iii) we computed the score by multiplying each food group frequency by related food-group weights (reflecting the caloric density and macronutrient content of foods) and then summing these scores into one composite score; (iv) we categorized the selected households as having a poor (0-28), borderline (28.5-42), or acceptable (< 42) food consumption profile[2].

Following this procedure, we obtained the food consumption groups shown in Figure 2. Despite most households (about 78%) showing an acceptable food consumption level, about 17 and 5% were characterized as borderline and poor respectively. This estimate confirms the results obtained by the FAO (2016), which identified

[2] The thresholds adopted to classify sampled households in these food consumption clusters were set according to assumptions of dietary patterns. In particular, since the households in the sample were found to have a high frequency of sugar and oil consumption (mean consumption of which was equal to more than 7 times per week), it was necessary to use the alternative cut-offs of 28 and 42.

Figure 2. Food consumption profile of respondent households (% of households).



24.8% of the total population as being unable to meet their minimum dietary energy requirements. Such food group clustering was used in the study to build a three-category dependent variable.

4.2. Econometric model

An ordered logit model was initially considered to identify factors affecting the household level of dietary diversity, food frequency and relative nutrition value. This econometric model is widely used in the literature to perform analyses where the dependent variable is represented by the food consumption score (Lokosang *et al.*, 2011; Aweke *et al.*, 2020; Hilemelekot *et al.*, 2021). It is commonly presented as a latent variable model where *y* is defined as the observed ordinal variable and y* as a continuous unmeasured latent variable ranging from -∞ to ∞ and having various thresholds points.

In this study, the continuous latent variable y* is equal to:

$$y^*_i = x'_i\beta + \varepsilon_i \quad (1)$$

where *i* is the household observed, *x* is the set of socio-demographic, economic and climate – related independent variables (see Table 1), β is the kx1 vector of unknown parameters and ε is the random error. The observed dependent representing the food consumption score y is determined by the following model:

$y_i = 1$ if $y^*_i \leq \omega_1$ *Poor food consumption profile*
$y_i = 2$ if $\omega_1 \leq y^*_i \leq \omega_2$ *Borderline food consumption profile*
$y_i = 3$ if $y^*_i \geq \omega_2$ *Acceptable food consumption profile*

where ω_k, or cut-points, are unknown parameters to be assessed. Estimates are obtained by maximizing the log likelihood function for each category of y. In our case as the dependent variable takes on the value 1,2 and 3, there are two cut-points ω_1 and ω_2.

The sign of the parameters **β** can be immediately interpreted as determining whether the latent variable (y*) increases or decreases with the regressors. If β_i is positive, an increase in x_i (or, in the case of dummy variable, the presence of the specific characteristic x_i) increases the probability of being in the highest category (acceptable food consumption profile) and decreases the probability of being in the lowest categories (poor and borderline food consumption profiles) (Cameron and Trivedi, 2010).

In the ordered regression model, both coefficients and cut-points are usually estimated using maximum likelihood (Williams, 2006). After this estimation it is possible to identify the underlying probability that y will take on a specific value (Scott Long & Frees, 2014):

$$\Pr(y_i = k) = \Pr(\omega_k \leq y^* \leq \omega_{k+1}) \quad (2)$$

where

$$P(y_i^* > \omega_k) = \frac{\exp(aX_i' - k_j)}{1 + \exp(aX_i' - k_j)} \qquad k = 1,2 \quad (3)$$

Based on the parallel line assumption, in the ordered logit model, the relationship between any pairs outcome category is assumed to be equal. Specifically, the thresholds have to be fixed for all explanatory variables. However, this assumption resulted violated in the ordered logit model implemented for the purpose of this study (the Brant test of parallel regression assumption resulted statistically significant). To address this problem and avoid biased estimates, a generalized ordered logit/partial proportional odds model was used.

By applying this econometric model, the probability of having y* larger than a specific threshold can be specified as (Williams, 2006):

$$P(y_i^* > \omega_k) = \frac{\exp(X_{1i}' b_1 + X_{2i}' b_{2j} - k_j)}{1 + \exp(X_{1i}' b_1 + X_{2i}' b_{2j} - k_j)} \qquad k=1,2 \quad (4)$$

where b_1 is a vector of parameters of variables that follow the parallel line assumption (X_{1i}) and b_{2j} is a vector of parameters of variables that vary across different food consumption profiles (X_{2i}).

In order to indicate how different factors affect the response variable on the underlying scale, marginal effects were estimated as follows:

$$\frac{\partial \Pr(y_i = j)}{\partial x_w} = \{F'(\alpha_{j-1} - x'_i\beta) - (\alpha_j - x'_i\beta)\} - \beta_i \quad (5)$$

This provides information on the impact that changes may have on the average probability of having some food consumption profile.

5. RESULTS AND DISCUSSIONS

5.1. Description of variables

The independent variables used in the econometric model are described in Table 1. Households' demographics provide information about family members as well as gender, age, marital status, and education level of the household head. Descriptive statistics indicate that sampled smallholder farmers are mostly middle-aged, male, monogamous and with (at least) a primary education level.

A second variables group includes physical and economic assets such as: (i) income; (ii) size of cropland used; (iii) livestock ownership (measured using tropical livestock units[3]); (iv) use of organic and chemical agricultural inputs; (v) use of improved varieties; and (vi) crop diversification. The introduction of this last variable is based on the assumption that an increasing number of cash and food crops can have both direct and indirect impacts on the food security status of the household. Indeed, while an increase in the production of cash crops can determine an increase in the agricultural income of the household (economic food access), a greater variety of food crops can directly affect the diversification of the diet adopted by family members. In the construction of the variable, we tried to represent the wide range of agricultural products produced in Uganda such as coffee, tea, sugar, cotton, tobacco, plantains, corn, beans, cassava, sweet potatoes, millet, sorghum and groundnuts.

A third variables group considers environmental and climatic factors such as household geographical location and climate. Since in developing countries like Uganda meteorological stations are sparse and climate data at micro-level are scarce (Demeke *et al.*, 2011), the study uses both subjective and objective measures of climate variability. Specifically, the subjective indicator considers households' perception of extremes such as drought periods and flooding events occurred in the preceding agricultural season. Furthermore, we included in the analysis the observed rainfall data from nearby weather stations illustrated in Section 3. Finally, considering long-term climate variability, the Median Absolute Deviation[4] (MAD) of both temperature and precipitations was computed and included in the analysis with the aim of detecting the riskiness of temperature and rainfall variations. This indicator represents a measure of statistical dispersion based on the absolute deviations from the median of the distribution (Howell, 2014).

5.2. Interaction effects and regional comparisons

With the aim of conducting more in-depth analyses on the effects climate variations have on household's food security, we defined interaction terms[5] combining the regional location of households with time and cross-sectional climatic variations. Given the strong variability existing among the different geographical regions in terms of timing and regularity of rainfall patterns, and taking into consideration the crucial role water availability has for rural farms, we decided to build interaction terms by involving climatic variables connected with precipitations. Using analysis of variance (ANOVA) to detect the existence and significance of the interactions, we defined the interaction terms involving the regional location of the households with median absolute deviation of precipitation as well as the average precipitation level occurred in the last agricultural season.

5.3. Results

The results of the econometric analysis are shown in Table 2.

a) Households' demographics

With reference to the gender of households' head, results show that an acceptable food security profile is negatively connected with male headed households (the probability of having an acceptable food consumption profile decreases by 7.4%). This result seems not to be in line with part of the literature that considers female-headed households among the hardest hit by hunger (Jones *et al.*, 2017; Kassie *et al.*, 2014; Tibesigwa, Visser, 2016). In contrast, a growing body of evidence in international development found no significant differences in food security condition between male and female-headed households (Mallick, Rafi, 2010). In this regard, our results provide support to the literature that considers the

[3] Tropical Livestock Units (TLU) are computed converting to a common unit the number of livestock heads of different animal species. Conversion factors used are: cattle = 0.7; sheep= 0.1; pigs=0.2; chickens=0.01 (FAO, 2009).

[4] In the presence of distributions with heavier tails, MAD is a robust statistic and is more efficient than variance or standard deviation, being more resilient to outliers in the dataset.

[5] An interaction describes non-causal associations and occurs when an independent variable has a different effect on the outcome depending on the value of another independent variable (Cox, 1984).

Table 1. Independent variables: names, description and measurement units.

Variables name	Description	Mean	St.Dev.
Demographics			
Household head male	Dummy, =1 if the household head is male, 0 otherwise	0.690	0.463
Household head age	Age of household head in years	47.223	15.435
Household head marital status	Categorical variable illustrating the marital status of the household head,		
	=1 if household head is monogamous,	0.559	0.497
	=2 if household head is polygamous,	0.195	0.397
	=3 widows or not married	0.246	0.431
Household head educated	Dummy, =1 if the household head attended at least primary school, 0 otherwise	0.832	0.374
Family members	Number of household members	6.033	2.940
Physical and economic assets			
Cropland area	Size of land under cultivation in acres	3.130	3.964
Organic fertilizers	Dummy, =1 if the household uses organic fertilizers, 0 otherwise	0.117	0.322
Chemical fertilizers	Dummy, =1 if the household uses chemical fertilizers, 0 otherwise	0.061	0.239
Pesticides	Dummy, =1 if the household uses pesticides, 0 otherwise	0.142	0.349
Improved varieties	Dummy, =1 if the household uses improved varieties, 0 otherwise	0.224	0.417
Livestock	Tropical Livestock Units (TLU)	1.197	2.644
Crop diversification	Number of crops cultivated in the last agricultural season	4.970	2.644
Income	Amount of family income (USD)	22.992	216.045
Environmental and climatic context			
Geographical region	Categorical variable illustrating the geographical location of the household,		
	=1 if household is located in the Western region,	0.258	0.438
	=2 if household is located in the Central region,	0.219	0.414
	=3 if household is located in the Eastern region,	0.254	0.436
	=4 if household is located in the Northern region	0.268	0.443
Urban area	Dummy, =1 if household is in an urban area, 0 otherwise	0.136	0.343
Variability of precipitation	Mean Absolute Deviation of precipitation considering the long-term period 1995-2013 (mm)	26.65	24.659
Variability of temperature	Mean Absolute Deviation of temperatures considering the long-term period 1995-2013 (°C)	0.717	0.581
Mean rainfall	Average district rainfall occurred in 2013 and obtained from the nearby weather station (mm)	43.599	47.681
Perception of erratic rainfall	Dummy, =1 if farmers perceived drought events in the last 12 months, 0 otherwise	0.282	0.450

increasing importance of women at household and community levels as a significant determinant of better agricultural and development outcomes, including increases in farm productivity, progresses in family nutrition and improvements in the level of child undernourishment and child mortality (Farnwortha, Colversonb, 2015; Scanlan, 2004; Sraboni *et al.*, 2014; Zhou *et al.*, 2019).

With reference to the marital status, households whose head is monogamous or polygamous are more likely to be food secure than households managed by individuals who are widowed or not married. This is probably due to the precarious socio-economic conditions underlying this last status, which is more common among female-headed households (Verma, 2001).

We found that households managed by an educated head are characterized by a higher level of food security (the probability of having an acceptable food consumption profile increases by 8.8 percentage points). This result is in line with the literature and confirms that education plays an important role in ensuring food security and improving nutritional status (Keenan *et al.*, 2001; Smith *et al.*, 2017). Educated farmers utilize their knowledge to improve agricultural production and seek alternative livelihood opportunities with the aim of enhancing its resilience to climate change and improving food systems (Mwaura, 2017).

The increasing number of family members is positively associated with a high level of food security. Since family size is considered a proxy for labour availability, this result confirms that large families whose members work in the field could benefit from an increase in total agricultural and food production. On the other hand, a large number of family members could be linked to different sources of income that can support the household economic access to food.

b) Households' physical and economic assets

Size of plots available (expressed in acres) is found to be related to a high food security level. The avail-

Table 2. Results of generalized ordered logit regression model.

Food Consumption Score (Acceptable vs. Poor – Borderline)	Coeff. (Std. Err.)	Marginal Effects (Std. Err.)		
		Poor	Borderline	Acceptable
Household's demographics				
Household head male	-0.515***	0.018***	0.056***	-0.074***
	(0.174)	(0.006)	(0.019)	(0.025)
Household head age	0.005	0.000	-0.001	0.001
	(0.004)	(0.000)	(0.000)	(0.001)
Household head monogamous	0.509***	-0.018***	-0.056***	0.074***
	(0.189)	(0.007)	(0.021)	(0.027)
Household head polygamous	0.431**	-0.015**	-0.047**	0.062**
	(0.197)	(0.007)	(0.021)	(0.028)
Household head educated	0.610***	-0.022***	-0.067***	0.088***
	(0.157)	(0.006)	(0.017)	(0.022)
Family members	0.060***	-0.002**	-0.007***	0.009***
	(0.023)	(0.001)	(0.002)	(0.003)
Household's physical and economic assets				
Cropland area	0.056*	-0.002*	-0.006**	0.008**
	(0.029)	(0.001)	(0.003)	(0.004)
Organic fertilizers	0.246	-0.009	-0.027	0.035
	(0.240)	(0.009)	(0.026)	(0.035)
Chemical fertilizers	1.107***	-0.039***	-0,121***	0.160***
	(0.413)	(0.015)	(0.045)	(0.060)
Pesticides	0.005	0.000	-0.001	0.001
	(0.201)	(0.007)	(0.022)	(0.029)
Improved varieties	0.400**	-0.014**	-0.044**	0.058**
	(0.163)	(0.006)	(0.018)	(0.024)
Livestock	0.305***	-0.011***	-0.033***	0.044***
	(0.063)	(0.002)	(0.007)	(0.009)
Crop diversification	0.059**	-0.002**	-0,006**	0.008**
	(0.028)	(0.001)	(0.003)	(0.004)
Income	0.001	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
Environmental and climatic context				
Eastern region	-1.333**	-0.065*	-0.066	0.131***
	(0.581)	(0.034)	(0.064)	(0.064)
Central region	-0.625	-0.063*	-0.048	0.112***
	(0.399)	(0.033)	(0.046)	(0.039)
Northern region	-1.413***	-0.039	0.017	0.022
	(0.461)	(0,035)	(0.047)	(0.045)
Urban area	0.171	-0.006	-0.019	0.025
	(0.177)	(0.006)	(0.019)	(0.026)
Variability of temperature	-0.110	0.004	0.012	-0.016
	(0.164)	(0.006)	(0.018)	(0.024)
Perception of erratic rainfall	-0.002	0.000	0.000	0.000
	(0.136)	(0.005)	(0.015)	(0.020)
Region # Variability of precipitation				
Western region # Variability of precipitation	-0.004	-	-	-
	(0.020)	-	-	-

Food Consumption Score (Acceptable vs. Poor – Borderline)	Coeff. (Std. Err.)	Marginal Effects (Std. Err.)		
		Poor	Borderline	Acceptable
Eastern region # Variability of precipitation	-0.065	-	-	-
	(0.094)	-	-	-
Central region # Variability of precipitation	0.001	-	-	-
	(0.021)	-	-	-
Northern region # Variability of precipitation	-0.032**	-	-	-
	(0.026)	-	-	-
Region # Mean rainfall		-	-	-
		-	-	-
Western region # Mean rainfall	-0.027**	-	-	-
	(0.012)	-	-	-
Eastern region # Mean rainfall	0.103	-	-	-
	(0.153)	-	-	-
Central region # Mean rainfall	0.000	-	-	-
	(0.011)	-	-	-
Northern region # Mean rainfall	0.035***	-	-	-
	(0.017)	-	-	-
Cut point 1	2.517			
	(0.425)			
Cut point 2	-0.525			
	(0.414)			
LR $chi^2(27)$	236.53			
Prob > chi^2	0,0000			
Pseudo R^2	0.0930			
AIC[1]	2,367.67			

* significant at 10%, ** significant at 5%, *** significant at 1%.

[1] The Akaike information criterion (AIC) is a measure of fit that can be used to assess models. This measure uses the log-likelihood, but adds a penalizing term associated with the number of variables. Such a measure tries to balance the GOF versus the inclusion of variables in the model. The AIC is computed as follows: AIC = -2 x LL + 2*p* (Lord *et al.*, 2021).

ability of large plots of land probably allows farmers to expand their agricultural activities and increase food production. At the same time, an increasing number of crops cultivated in the field positively influences the food security status of the household. This result confirms that, in subsistence-oriented agricultural systems, a diverse agricultural portfolio allows a more diversified and nutritious diet. At the same time, in market-oriented households, an increase in the number of cash crops can determine higher agricultural incomes and then improvements in the economic food access.

The use of chemical fertilizers is found to be statistically significant and positively related with a high level of food security (with an increase in the probability of having an acceptable food security profile equal to 16%). Increased inorganic fertilizer use can lead to immediate and important increases in yields, especially in contexts where the adoption of traditional soil-fertility-maintenance techniques and organic fertilizers are often ineffective (Emmanuel *et al.*, 2016). For yields increase and fertility maintenance, chemical fertilizer application is considered the least-cost solution because of the limited supply and low nutrient levels of organic inputs (e.g. manure) and the limited crop residues available for mulching (Abdoulaye and Sanders, 2005)

Not surprisingly, the adoption of improved varieties is positively associated with a high level of food security, confirming that such agricultural technology can significantly increase household crop production and income, enhancing the household's chances of escaping poverty and food insecurity (Kassie *et al.*, 2011).

Livestock ownership is found to be positively related with high food security levels (with an increase of one TLU, the probability of having an acceptable food consumption profile increases by 4.4%). This result could be linked with the role of livestock activities, which represents a direct source of food (meat and milk) for the household members and are also an important source of income.

Furthermore, it is demonstrated that farmers specialized in crop production are more vulnerable than those in mixed crop-livestock systems (Tibesigwa *et al.*, 2015).

c) Environmental and climatic context

With reference to the environmental and climatic aspects, results show that households' food security conditions vary greatly across the country. Specifically, it is clear that the smallholder farms located in the Northern and Eastern regions have a lower probability to be food secure with respect to those located in the Western areas. This result confirms the most precarious conditions affecting rural communities living in such regions, which are characterized by food deficits due to unfavourable socio-economic and agro-ecological conditions. (Wichern *et al.*, 2017). The precarious situation of the Northern region is particularly evident considering also the climatic variables. Indeed, the parameter estimate for rainfall variability measured by the long-run median absolute deviation is found to be statistically significant and negatively associated with acceptable levels of food security of local households. The Northern region in general, and the Karamoja area in particular, is characterized by changeable and unreliable precipitations during the rainy season. Despite dry periods being considered a natural occurrence in these territories, long-term climatic trends show that their frequency and intensity seem to be exacerbated by the on-going climate change (Jordaan, 2015). The pivotal role of precipitation in this region is also confirmed by the variable representing the average rainfall occurred during the last agricultural season (during 2013). This variable was found to be statistically significant and positively connected with higher levels of food security. This result confirms that, in those territories with a semi-arid climate and prolonged drought periods, an increasing occurrence of precipitations can have positive effects on food production and then on food security (Demeke *et al.*, 2011). On the other hand, in the Western region of Uganda, the incidence of increasing rainfall occurred in 2013 was found to be statistically significant and negatively connected with acceptable food security levels. This result could be due to the incidence of the exceptional flooding event that occurred in May 2013, which is considered the worst since 1966 (Boyce *et al.*, 2016). Specifically, between the 1st and 5th of May 2013, heavy rains caused flooding that submerged 9 sub counties of Kasese District. Houses and infrastructures were destroyed, causing enormous damage to the livelihood conditions of local populations. This result confirms that, although in some cases a moderate increase in rainfall can bring benefits in terms of agricultural production and food security to areas with a predominantly arid climate, in some other contexts extreme precipitations and flooding events can cause enormous damage and adversely affect livelihood, health and food safety.

Although not statistically significant, the long-run temperature variability and its negative coefficient provide important insights. Specifically, an increase in the median absolute deviation of temperatures determines a decrease in the probability of being food secure equal to 1.6%. This result could be due to the fact that higher temperatures increase suitable conditions for crop diseases and pest infestations such as blast and bacterial leaf blight in rice, aflatoxin in maize, fungal and viral disease in banana, and coffee rust in coffee trees (World Bank, 2021). Such temperature-induced effects on food production appear however not significant and/or determinant with reference to the case study illustrated here.

The role of the climate variables illustrated above is also confirmed by the results obtained by dividing the sample according to geographical areas and using parallel econometric models (Appendix).

Surprisingly, the variable illustrating the perception of erratic rainfall appears to be not statistically significant. This result demonstrates that the perception of farmers can often be biased by a subjective perspective, which is not always adherent to the real weather situation. Using the farmers' perception as unique proxy for climate change is therefore not always effective and may lead to conclusions that are not entirely objective and in line with the reality.

6. CONCLUSIONS

This study provided quantitative evidence and conceptual insights of factors determining smallholders' food and nutrition security in a context characterized by increasing weather variability and climate change. The food consumption score index was used to define the households' food security profile, while a set of climatic variables were introduced in the analysis to detect the incidence that climate variability has on food and nutrition security.

Results confirm that socio-demographic aspects like gender, education and marital status of the household head, as well as family size, can have a determinant role in the food security level of households. Furthermore, variables mainly connected to agricultural productivity, such as the existence of mixed crop-livestock systems, the use of improved seeds and chemical fertilizers, and the adoption of agricultural systems based on crop diversification have a pivotal role in the improve-

ment of household food and nutrition security. Among the environmental and climatic variables, variations in the regime of precipitations (both in a long- and short-term perspective) seems to be particularly important in the definition of food security. However, the effect of erratic rainfall seems to be strongly connected with the geographical location of the smallholder farms. Such results suggest that policy actions and adaptation programmes should be site-specific and designed taking into consideration the specific risk exposure of the different agro-ecological areas. In order to generate ad-hoc policies based more on the different exposure of Uganda regions to climate change, it will also be necessary to involve local communities, which are currently excluded from strategic decisions and policies formulation (Ampaire *et al*., 2017). Furthermore, the communication between national, district and community levels should be improved to allow for greater responsiveness to local needs, climate emergencies and food crises.

To address food insecurity caused by climate variability and improve smallholder farm's resilience, it is also important to adopt an approach based on absorptive, adaptive and transformative capacity measures. Indeed, while the absorptive and adaptive capacity measures are based on the ability to minimize the exposure to shocks and make informed choices about strategies to adopt, transformative capacity actions are focused on system level conditions that are necessary to create long-term resilience (Ansah *et al*., 2019).

Results obtained in the study also suggest that, at farm level, adaptation strategies may be achieved by implementing various sustainable practices such as: (i) crop diversification; (ii) inter-planting (mixed cropping); and (iii) planting drought-resilient crops (Al Dirani *et al*., 2021).

Even if the paper focuses on the case of Uganda, the methods used could be easily replicated in other countries. Results could be of interest for the international community because they may apply to many developing countries with a similar structure of smallholder agriculture and food and nutrition security problems, as well as climatic drivers and agriculture framework.

Limits to the validity of our results exist. Although the multidimensionality of the FCS allowed nutritional aspects of food security to be considered, it tends to overestimate the frequency of food secure units compared to some other food security indicators (Lovon, Mathiassen, 2014). This implies that the results could be biased by food insecurity incidence underestimation. Such an element is also confirmed by the low percentage representing households with a poor food consumption profile. Furthermore, dietary energy content is used in FCS to define food categories. However, the energy content of certain food combinations is not necessarily the best way to capture adequacy regarding nutritional value (Cafiero *et al*., 2014). Further researches could therefore involve the use and comparison of different food security indicators in order to provide more evidence to support the thesis discussed in the present study.

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APPENDIX

Table A.1. Results of generalized ordered logit regression model, by region.

Food Consumption Score (Acceptable vs. Poor – Borderline)	Western		Eastern		Central		Northern	
Household's demographics								
Household head male	0.062		-0.282		-1.446	***	-0.675	***
Household head age	0.007		0.001		0.005		0.004	
Household head monogamous	0.368		0.321		0.717	*	0.655	**
+Household head polygamous	0.389		0.214		1.241	**	0.525	
Household head educated	0.315		0.212		0.954	**	1.041	***
Family members	-0.003		0.117	***	0.062		0.037	
Household's physical and economic assets								
Cropland area	0.097		0.162	**	0.119		-0.027	
Organic fertilizers	-0.174		0.384		0.321		13.087	
Chemical fertilizers	-0.126		2.296	**	1.233		12.919	
Pesticides	-0.304		0.397		-0.208		0.136	
Improved varieties	0.701		0.045		0.581		0.415	*
Livestock (TLU)	0.743	***	0.230	**	0.142		0.340	***
Crop diversification	0.032		-0.028		0.150	**	0.099	
Income	0.012		0.000		0.000		0.002	
Environmental and climatic context								
Urban area	0.415		0.414		-0.159		0.159	
Variability of precipitation	0.001		-0.640		-0.001		-0.027	*
Variability of temperature	0.030		-6.269		-0.046		-1.379	
Mean rainfall	-0.033	**	1.036		-0.001		0.010	***
Perception of erratic rainfall	0.276		-0.337		-0.354		0.213	
LR $chi^2(27)$	82.080		67.47		62.01		85.29	
Prob > chi^2	0.000		0.000		0.000		0.000	
Pseudo R^2	0.132		0.097		0.138		0.115	
AIC	583.39		670.61		429.06		700.31	

* significant at 10%, ** significant at 5%, *** significant at 1%.

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Research article

Examining financial inclusion-agricultural productivity connection in south asian countries: evidence from FMOLS and DOLS approaches

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Abstract. The main purpose of this paper is to examine the impact of financial inclusion on agricultural productivity in South Asian countries from 2004 to 2018. By following the Human Development Index method, we construct a multidimensional time-varying financial inclusion index to measure the level of financial inclusion. The long-run elasticity of financial inclusion on agricultural productivity is examined by using the FMOLS and DOLS approaches. The empirical results confirm that financial inclusion has a positive impact on agricultural productivity. Furthermore, the interaction term between financial inclusion and human capital is positively associated with agricultural productivity. These results suggest that South Asian countries can increase agricultural productivity by improving the coverage of financial inclusion in the long run.

Keywords: financial inclusion, financial inclusion index, agricultural productivity, FMOLS and DOLS.
JEL codes: O43, G21, Q14.

HIGHLIGHTS

- The study examines the impact of financial inclusion on agricultural productivity using a sample of seven South Asian countries during the period 2004-2018.
- A multidimensional Financial Inclusion Index (FII) was constructed to measure the level of financial inclusion.
- Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) methods were employed.
- Empirical results confirm that financial inclusion has a positive impact on agricultural productivity.

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1. INTRODUCTION

Around the globe, the agricultural sector is and will remain a key component in the achievement of the Millennium Development Goals. Agricultural production must increase to 70% by 2050 to feed the world, despite population expansion, climate change and rapid urbanization putting pressure on available cultivable land (Food Agriculture Organization, 2009). Furthermore, according to the Global Agriculture and Food Support Program (GAFSP) and World Bank (2007a), agricultural growth is many times more effective than other sectors of the economy in reducing poverty. It also increases agricultural income and gives rural residents the buying power they need to purchase manufactured goods. Moreover, financial inclusion has also been one of the instruments in reducing poverty over time (Gurley, Shaw, 1955; Goldsmith, 1969; Cull *et al*., 2014; Park, Mercado, 2015; Omar, Inaba, 2020). The effect of financial inclusion on agriculture is also well acclaimed by some studies (Laha, Kuri, 2014; Fowowe, 2020; Atakli, Agbenyo, 2020). The availability of finance leads to increased agricultural productivity and higher incomes for farmers. As a result of this, hunger of the poor is reduced, and they are able to escape poverty traps (Nathan Associates, 2015).

Schultz (1980) states that «Most of the World's poor people earn their living from agriculture, so if we knew the economics of agriculture, we would know much of the economics of being poor». Agriculture is the backbone of many South Asian economies. It supplies food and jobs to the rapidly increasing population and still contributes significantly to overall economic growth. Despite increased focus on industrial growth, agriculture remains a substantial contributor to the country's Gross Domestic Product (GDP). The overall significance of the agricultural sector is also strong in South Asian countries, where it makes a major contribution to GDP and is a major source of jobs (SAARC, 2014). The agricultural sector contributes roughly 20% of GDP in India, Bangladesh, Pakistan and Bhutan, as well as 33.1% in Nepal. In India, Bangladesh and Pakistan, the agricultural sector hires roughly half of the total workforce (ILO, 2015), 31% in Sri Lanka (CBSL, 2015), and the highest (i.e., 65.6%) in Nepal. So, these statistical data indicate the significance of the agricultural sector in absorbing these countries' growing labour force. An increase in agricultural productivity will promote and facilitate industrial growth in a variety of ways. It allows the agricultural sector to supply labour to the non-agricultural sector while also meeting the non-agricultural sector's food demand. It allows the agricultural sector to provide low price food to industrial workers, thus increasing industries' profitability (Kuznet, 1961). Furthermore, the Food and Agriculture Organization (2022) has identified a number of factors that affect agriculture growth and productivity, including the environment, productive human capital, GDP, agricultural fertilizer, capital use, trade openness, industrialization, and agricultural terms of trade etc. Despite this, an inclusive financial system is one of the influencing factors for agricultural productivity. Financial inclusion allows farmers to invest in and adopt new innovations in the agricultural sector, which helps to increase productivity. It provides money to helpless farmers to purchase agricultural inputs such as fertilizers, pesticides and seeds, which increase agricultural productivity. Therefore, the affordable costs of formal financial services are important to increase agricultural productivity.

Many researchers believe in a positive linkage between banking products and productivity (Awunyo-Vitor *et al*., 2014). In addition, various researchers (Sial *et a*l., 2011; Baffoe *et al*., 2014; Chandio *et al*., 2016a; Chandio *et al*., 2016b) studied the effect of agricultural finance on agricultural productivity in Pakistan and Ghana, and their studies showed that agricultural finance had a favorable effect on agricultural productivity.

Empirical research on the linkages between financial inclusion and agricultural productivity in South Asian economies is scarce and very limited. To the best of the authors' knowledge, there has been no study on the topic till now. Few pieces of research have been conducted in South Asian countries to find out the influence of agricultural credit on agricultural production/productivity (according to Table 1). However, most of these studies were conducted for specific individual countries. The pieces of research have not examined the influence of financial inclusion on agricultural productivity. With this motivation, the aim of this study is to examine the impact of financial inclusion on agricultural productivity in South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Pakistan and Sri Lanka).

The study contributes to the existing literature in the following ways. *First*, it has investigated the impact of financial inclusion on agricultural productivity in South Asian countries using Pedroni cointegration to check the long connection among study variables. *Second,* the Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) approaches have been adopted to show the long-run connection between financial inclusion and agricultural productivity for the period 2004 to 2018.

The rest of the article is organized as follows: Section 2 contains a review of the literature. Section 3 pre-

sents materials and methods (statistical and econometrics). Section 4 explains empirical results and discussion. Section 5 gives the conclusion, policy recommendations and limitations.

2. LITERATURE REVIEW

2.1. Nexus between agricultural finance, financial inclusion (FI) and agricultural productivity

It is impossible to underestimate the importance of credit in agricultural production. Feder *et al*. (1989) examined agricultural finance and farm performance in China based on farmers survey data. According to their findings, the availability of credit may have a positive impact on agricultural productivity because farmers who are short on money may use lower levels of agricultural inputs in their production activities.

Various researchers studied the effect of agricultural finance on agricultural productivity in different nations around the globe and their studies evidence that agricultural finance had a favorable effect on agricultural productivity (Table 1). As a result, agricultural productivity can be increased by ensuring that credit is available when it is required, thus allowing farmers to buy agricultural inputs such as fertilizers, pesticides, high-yield seeds and advanced agricultural equipment. In addition, increased agricultural productivity and income of farmers are linked to the availability or accessibility of finance. According to Nathan Associates[1] (2015), financial inclusion can have a two-fold effect on agriculture: *first*, it can *increase agricultural productivity*. Credit delivery makes it easier to buy agricultural inputs and hire workers and machinery, which can help to increase agricultural productivity. *Second*, available finance makes it easier for farmers to diversify their livelihoods and raise their profits.

A recent study was conducted by Magezi, Nakano (2020) which examined the effect of microcredit on agricultural productivity based on baseline survey data in Tanzania. They estimated the intention-to-effect and Local Average Treatment Effect (LATE) of microcredit. According to their findings, increasing banking products access alone may not be enough to boost small-scale farmers' agricultural productivity because other factors (i.e., total land holding, value of household assets, years of schooling of household head, and age of household head) are also responsible for agricultural productivity. Fowowe (2020) examined the association between FI and agricultural productivity for 2010-2011, 2011-2013, and 2015-2016 in Nigeria. He used simple panel data estimation and his empirical results reveal that FI has a positive influence on agricultural productivity. Atakli, Agbenyo (2020) used Ghana Living Statistical Survey data and multiple regression models. Their results confirm that FI has a positive association with agricultural productivity. Magazzino *et al*. (2021) investigated the relationship among credit access, output and productivity in the agricultural sector for a large set of countries from 2002 to 2012. They used an artificial network approach. Their empirical results show that credit access significantly affects agricultural production in developing countries and productivity in developed countries. Chandio *et al*. (2022) examined the impact of financial development on agricultural production in China from 1989 to 2016. They used an autoregressive distributed lag (ARDL) approach and their empirical results confirm that financial development has a positive impact on agricultural production in both the long- and short-run.

2.2. Nexus between financial inclusion and agricultural productivity: Theoretical argument

In recent times, financial inclusion has been playing an important role in agricultural productivity (Nathan Associates, 2015). Furthermore, greater access to formal financial services has a positive influence on agricultural productivity (Laha, Kuri, 2014; Nakano, Magezi, 2020; Fowowe, 2020). A theoretical connection between financial inclusion and agricultural productivity is explained in Figure 1.

Figure 1 indicates that financial inclusion can help to boost agricultural productivity through access to an affordable cost of credit and access to attractive deposit and insurance products. The following is how the logic works. Access to affordable and low-cost credit facilitates the purchase of agricultural inputs (such as equipment, fertilizer and quality seeds) and employing labour, which in turn can increase farmers' efficiency and increase agricultural productivity.

3. MATERIALS AND METHODS

3.1. Construction of Financial Inclusion Index (FII)

For the present study, a multidimensional FII is constructed based on the FII previously proposed by Sarma (2015). With the rising interest in financial inclusion among policymakers, a multiplicity of financial inclu-

[1] Nathan is a private multinational economic and analytics consulting company that provides realistic solutions and long run results to government and commercial clients around the world.

Table 1. Survey of existing literature between formal agricultural credit and agricultural production/productivity.

Authors	Study Country	Methodology	Findings
Binswanger *et al.* (1993)	India	Theoretical Analysis	+ve
Navin (1988)	Bangladesh	Theoretical Analysis	+ve
Iqbal *et al.* (2003)	Pakistan	Ordinary Least Square estimates	+ve
Petrick (2004)	Poland	Microeconomic farm household model	+ve
Blancard *et al.* (2006)	France	Credit constraint profit maximization model	+ve
Sindhu *et al.* (2008)	India	Simultaneous (four) equation model	+ve
Guirkinger, Boucher (2008)	Peru	Switching regression model	+ve
Hussein (2009)	Bhutan	Theoretical Analysis	+ve
Das *et al.* (2009)	India	Arellano-Bond Regression	+ve
Pathak (2010)	Bhutan	Theoretical Analysis	+ve
Kumar *et al.* (2010)	India	Tobit model	+ve
Rahman *et al.* (2011)	Bangladesh	Linear and exponential equations, Pearson Correlation equation	+ve
Sial *et al.* (2011)	Pakistan	ADF test, Phillips Perron Unit root test, Granger causality test	+ve
Gyeltshen (2012)	Bhutan	Bivariate PROBIT Model	+ve
Dong *et al.* (2012)	China	Switching regression model	+ve
Ciain (2012)	European countries	Matching estimation	+ve
Laha, Kuri (2013)	India	Financial Inclusion Index	+ve
Alauddin, Biswas (2014)	Bangladesh	Empirical study	+ve
Awunyo-Vitor *et al.* (2014)	Ghana	ANOVA, Heckman's two stages regression model	+ve
Sarker *et al.*(2015)	Bangladesh	Simple linear regression model	+ve
Khandker, Koolwal (2015)	Bangladesh	Augmented household panel data model	+ve
Mishra *et al.* (2016)	India	State-level panel model	+ve
Narayan (2016)	India	Mediation analysis framework	+ve
Chavan, Sivamurugan (2017)	India	Logistic Model	+ve
Iftikhar *et al.* (2017)	Pakistan	Multiple linear regression models	+ve
Onoja (2017)	Developing countries	Fixed effect econometrics approach	+ve
Olaniyi (2017)	Nigeria	Autoregressive Lag Distributed (ARDL) approach	+ve
United States Agency for International Development (2018)	Afghanistan	Theoretical analysis and Ratio analysis	+ve
Chandio *et al.* (2018)	Pakistan	Instrumental variables (two-stage least squares) approach	+ve
Wang *et al.* (2019)	Bhutan	Logit regression model	+ve
Agbodji, Johnson (2019)	Togo	PSM and ESR methods	+ve
Moahid, Maharajan (2020)	Afghanistan	Probit model, and Double-hurdle model	+ve

sion indicators has been developed (Sarma, 2008; Sethy, 2016; Sethy, Goyari, 2018; Sethi, Sethy, 2019; Sethy, Goyari, 2022; Sethy *et al.* 2023). The following steps calculate the multidimensional FII.

Step 1: This study initially calculates a dimension index for each dimension of financial inclusion in order to develop an index. We first define as in equation (i):

$$d_i = w_i * \frac{A_i - m_i}{M_i - m_i} \quad \text{(i)}$$

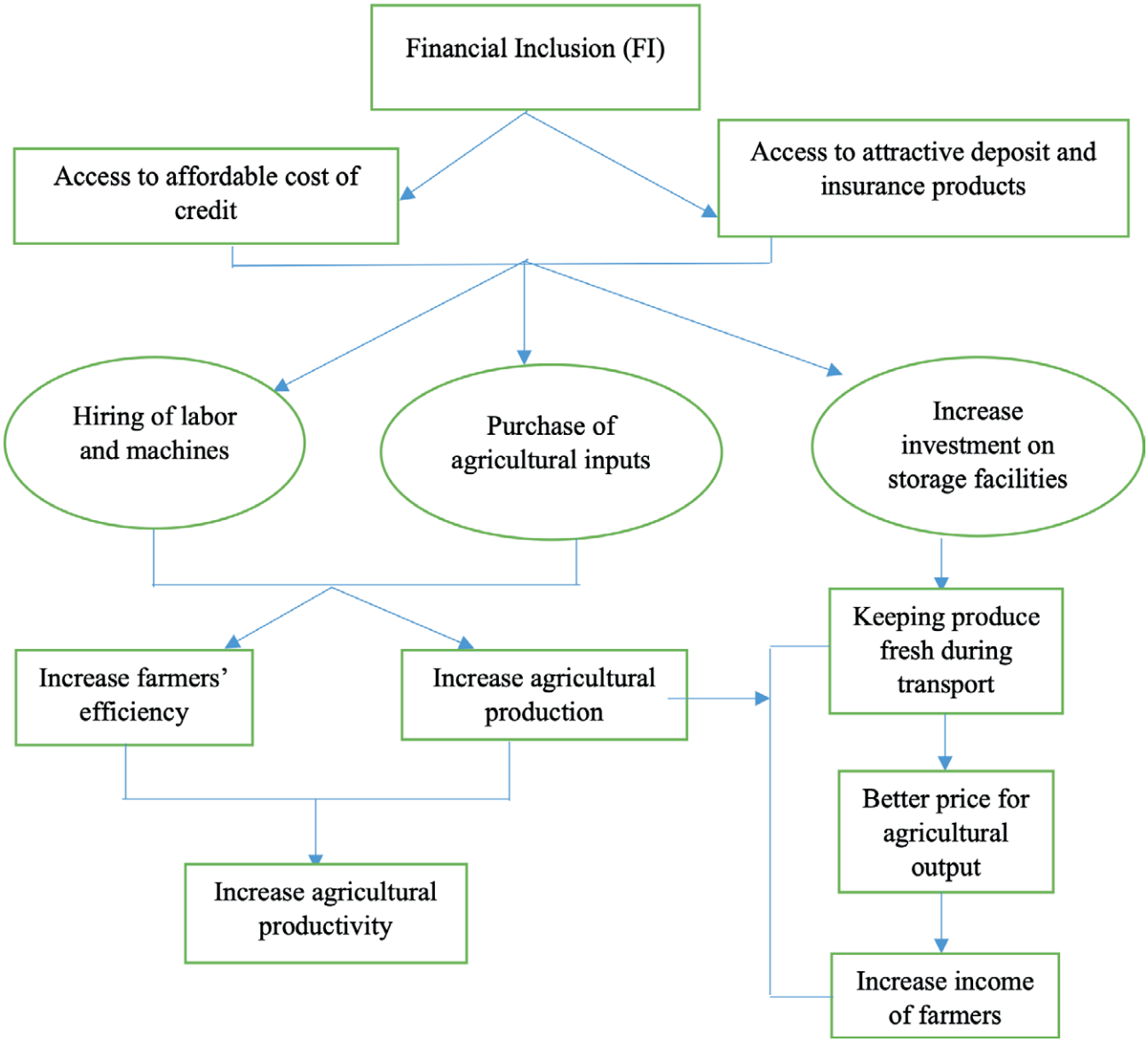
where,
w_i = Weight attached to the dimension i, $0 \leq w_i \leq 1$, A_i = Actual value of dimension i, m_i = Minimum value of dimension i, M_i = Maximum value of dimension i, d_i = Dimensions of financial inclusion i.

Equation (i) confirms that $0 \leq w_i \leq 1$ and here, n dimensions of financial inclusion are represented by a point X = (1, 2, 3…). Point 0 = (0, 0, 0…0) represents the worst situation and Point W = (1, 2, 3 …) represents an ideal situation. Here we take W =1 (equal weighting approach).

Step 2: We calculate X_1 based on d_i and W_i as in equation (ii):

$$X_1 = \frac{\sqrt{d_1^2 + d_2^2 + d_3^2 + \ldots\ldots\ldots + d_n^2}}{\sqrt{w_1^2 + w_2^2 + w_3^2 + \ldots\ldots\ldots + w_n^2}} \quad \text{(ii)}$$

Figure 1. Linkages between financial inclusion and agricultural productivity.



Step 3: In the third step, we calculate X_2 based on d_i and W_i as in equation (iii):

$$X_2 = 1 - \frac{\sqrt{(w_1-d_1)^2+(w_2-d_2)^2+(w_3-d_3)^2+ \ldots\ldots\ldots+(w_n-d_n)^2}}{\sqrt{w_1^2+w_2^2+w_3^2+ \ldots\ldots\ldots+w_n^2}} \quad \text{(iii)}$$

Step 4: We calculate the FII based on X_1 and X_2 as in equation (iv):

$$FII = ½ (X_1 + X_2) \quad \text{(iv)}$$

In equation (ii), for financial inclusion index (FII), X_1 indicates the average of the Euclidian distance between X and 0. In equation (iii), for FII, X_2 indicates inverse Euclidian distance between X and W. Equation (iv)[2] is the simple average of X_1 and X_2 which is the multidimensional Financial Inclusion Index used in the present study.

3.2. Panel cointegration tests

First, to determine whether stationarity exists in the data series, the panel unit root test is used. The

[2] The FII presented in Sarma (2015), Sarma and Pais (2011), Sethy (2016), Goel and Sharma (2017), Sethy and Goyari (2018), Sethy (2023) was based on the distance from the ideal only.

study used the Im, Peseran, Shin (IPS) panel unit root test. The second step of empirical research is to use the panel cointegration test to investigate the long-term relationship between the variables. For panel data research, Pedroni (1999 and 2014) cointegration is the best method for estimating co-integration among variables. The Pedroni (1999) cointegration test is then used to determine whether there is a long-run relationship between all study variables.

Pedroni (2004) considers the following type of regression in equation (v):

$$z_{i,t} = a_i' + \ddot{a}_i t + \widehat{a_{1i}} y_{1i,t} + \widehat{a_{2i}} y_{2i,t} + \ldots\ldots\ldots\ldots + \widehat{a_{Mi}} y_{Mi,t} + e_{it} \quad \text{(v)}$$

for t = 1,2,3……,T; i =1,2,3……N; m =1,2,3…..M.

For the panel data analysis, Pedroni (1997) suggests seven statistics to check the null hypothesis of no cointegration. There are two types of tests in this. First is the panel cointegration test (within dimension) and second, the panel cointegration test (between dimensions).

3.3. FMOLS and DOLS approach

The possibility of heterogeneity cannot be overlooked because this study is based on panel data from seven South Asian countries. With this in mind, we used Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) approaches, which are capable of dealing with heterogeneity and serial correlation in the data (Danish *et al*. 2019). In addition, FMOLS and DOLS methods were employed to solve the endogeneity problem and remove the serial correlation present in Ordinary Least Square (OLS). We examined the long-run effects of financial inclusion on agricultural productivity in South Asian countries employing the FMOLS and DOLS approaches.

The FMOLS method is proposed by Philips, Moon (1999) and the FMOLS cointegrating equation is:

$$\beta_{FMOLS}^{\wedge} = \frac{1}{N}\left[\{\sum_{t=1}^{T}(y_{it} - y_i^-)^2\}^{-1} \{\sum_{t=1}^{T}(y_{it} - y_i^-)\, z_{it}^* - T y_i^{\wedge}\right] \quad \text{(vi)}$$

where $z_{it}^* = y_{it} - y_i^- - \left(\Omega_{21i}^{\wedge} / \Omega_{22i}^{\wedge}\right)\Delta y_{it}$ and

$y_i^{\wedge} = \Gamma_{21i}^{\wedge} + \Omega_{21i}^{\wedge 0} - (\Omega_{21i}^{\wedge} / \Omega_{22i}^{\wedge})(\Gamma_{21i}^{\wedge} + \Omega_{21i}^{\wedge 0})$.

The DOLS method is proposed by Stock and Watson (1993) and the DOLS cointegrating equation is:

$$b_{DOLS} = N^{-1}\sum_{i=0}^{n}(\sum_{t=1}^{T} \forall_{it} \forall'_{it})^{-1} (\sum_{t=1}^{T} \forall_{it}(z_{it} - z_i^-)) \quad \text{(vii)}$$

where $\forall_{it}$ represents 2(K+1)×1 vector of explanatory variables including (y_{it} - y_i^-,..,,,,$\Delta y_{i,j}$).

3.4. Econometric model specification

Generally, the traditional *Cobb-Douglas (CD)* production function consists of two inputs – capital and labour. But, according to Echevarria (1998), a production function can include more factors of production.

The functional form of CD production function is as given below in equation (viii):

$$Y_{i,t} = AK_{i,t}^{\alpha} L_{i,t}^{\beta} e^{\mu_{i,t}} \quad \text{(viii)}$$

where, agricultural productivity is denoted by *Y*, Capital is denoted by *K*, and Labour is denoted by *L*. The parameters α and β are the partial elasticity of Y with respect to capital and labor respectively. Here, *i*……*n*, *t*…..*T*, and the error term is represented by μ.

This study proceeds to investigate *the impact of FI on agricultural productivity*. So when FI is included in the model, equation (viii) becomes (ix):

$$Y_{i,t} = \mathrm{A}K_{i,t}^{\alpha} L_{i,t}^{\beta} FI_{i,t}^{\rho} e^{\mu_{i,t}} \quad \text{(ix)}$$

where, *FI* is represents financial inclusion that is measured by the multidimensional financial inclusion index (FII), the parameter ρ must be in the range between 0 and 1 and it indicates the marginal influence of FI on agricultural productivity. After taking the logarithm, the above equation (ix) becomes equation (x):

$$ln\ Y_{i,t} = \alpha_0 + \alpha(lnK)_{i,t} + \beta(lnL)_{i,t} + \rho(lnFII)_{i,t} + \mu_{i,t} \quad \text{(x)}$$

Besides financial inclusion, agricultural productivity is influenced by a number of other economic variables such as trade openness, lending interest rate and emission.

Then, the above equation (x) can be re-written as in equation (xi):

$$ln(Agripro)_{i,t} = \alpha_0 + \beta_1(lnK)_{i,t} + \beta_2(lnL)_{i,t} + \beta_3(lnFII)_{i,t} + \beta_4(lnTrade)_{i,t} + \beta_5(lnInterest)_{i,t} + \beta_8(lnCO_2)_{i,t} + \alpha_i + \mu_{i,t} \quad \text{(xi)}$$

where, *Agripro* is agricultural productivity defined as agriculture, forestry and fishing, value added per worker (constant 2010 US$), *lnAgripro* = log of agriculture productivity and independent variables are *lnK* = log

of physical capital; *lnL* = log of labour (human capital); ln*FII* = log of multidimensional financial inclusion index; *lnTrade* = log of trade openness; *lnInterest* = log of lending interest rate; $lnCO_2$ = log of carbon emissions; α_i = unseen effects and $\mu_{i,t}$ = error term, t = 1, 2, 3,…….15 years (from 2004 to 2018) and i = 1, 2, 3…7 (Afghanistan, Bangladesh, Bhutan, India, Maldives, Pakistan and Sri Lanka).

Here, financial inclusion (FI) is expected to increase agricultural productivity or is positively associated with it because easy access to affordable formal financial services and micro credit increase agricultural investment. As a result, it increases agricultural productivity and incomes of farmers.

The following regression equation (xii) is used to examine *the conditional effect of FI on agricultural productivity* in South Asian countries.

$$ln(Agripro)_{i,t} = \alpha_0 + \beta_1(lnFII)_{i,t} + \beta_2(lnK)_{i,t} + \beta_3(lnL)_{i,t} + \beta_4(lnFII*lnX)_{i,t} + \alpha_i + \mu_{i,t} \quad \text{(xii)}$$

where, the interaction of a multidimensional FII with other particular control variables (i.e., *lnX*) that can impact the result of FII in terms of increasing agricultural productivity is denoted by (*FII* * *lnX*). The other specifications are the same as the above equation (xi). A brief theoretical explanation on measurement of some independent variables is given below:

Physical capital: Physical capital plays an important role in the agricultural sector. In this study, physical capital is measured by the gross fixed capital formation (% of GDP).

Labour: Human capital is represented by labour force, which is determined by many factors such as education levels of various categories, skills, training, physical health, population size etc. In this study, we measure labour by the secondary school enrolment rate (similar to Barro, Lee, 2010). Others could not be considered due to lack of consistent data for all countries.

Financial inclusion (FI): Inclusive finance is measured by the financial inclusion index (Sarma, 2008; Sethy, 2016; Sethy, Goyari, 2022).

3.5. Variables and data sources

The study is based on 15 years of annual panel data from 2004 to 2018. By excluding Nepal (because of the non-availability of consistent comparable and uniform data of formal financial services and other study variables), the rest of the seven South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Maldives, Pakistan and Sri Lanka) are taken for the analysis. The dataset is collected from the Financial Access Survey (FAS) database of the International Monetary Fund (IMF) and World Development Indicator (WDI). Tables 2 and 3 give a detailed explanation of the variables and sources.

4. EMPIRICAL RESULTS AND DISCUSSIONS

4.1. Descriptive statistics

Table 4 presents descriptive statistics of the study variables used in the regression analysis for the sample of 89 observations over the period 2004-2018 for seven South Asian countries.

Table 4 shows that agricultural productivity has a mean (median) value of 7.17 (7.14) and a standard deviation (SD) of 0.34. It varies from 6.30 (min) to 7.94 (max). Similarly, physical capital (K) has a mean (median) value of 3.27 (3.26) and an SD of 0.41. Labour (L) has a mean (median) value of 4.04 (4.01) and an SD of 0.38. One of the important explanatory variables, *i.e.* financial inclusion, has a mean (median) value of 0.67 (0.72) and SD of 1.03. The coefficients of financial inclusion range from -6.008 (min) to 0.001 (max). Trade openness has a mean (median) value of 3.38 (3.73) and SD of 1.12. The interest rate has a mean (median) value of 2.50 (2.56) and SD of 0.21. Among the variables, agricultural productivity has the highest average (in log form) of 7.17, and a standard deviation of 0.34, and CO_2 emission has the lowest average (in log form) of 0.40 with a standard deviation of 0.75.

4.2. Correlation matrix

Table 5 presents the Pearson correlation matrix, to determine the nature and strength of the correlation among explanatory variables.

Table 5 shows that there is a significant correlation among a few explanatory variables. Two important observations can be found from correlation coefficients in Table 5. First, a positive correlation is present between agricultural productivity with carbon dioxide (0.57), labour (0.29), and financial inclusion (0.46). Particularly, the positive relationship between financial inclusion and agricultural productivity (also observed in other studies like Laha, Kuri 2014; Fowowe 2020; Atakli, Agbenyo, 2020) indicates that access to banking services leads to an increase in agricultural productivity in South Asian countries. Second, other explanatory variables like trade openness, physical capital and interest rate are negatively correlated with agricultural productivity. Such correla-

Table 2. List of variables for constructing the Financial Inclusion Index (FII).

Availability Indicators	Accessibility Indicators	Usage Indicators
Demographic Branch Penetration:	*Geographic ATM Penetration*:	*Credit Penetration*:
(1) Number of bank branches per 1 lakh adults	(5) Number of ATMs per 1000 km^2	(7) Outstanding loans with Commercial Banks
(2) Branches of Commercial Bank		(8) Outstanding loans with Commercial Banks (% of GDP)
Demographic ATM Penetration:	*Geographic Branch Penetration*:	*Deposit Penetration*:
(3) ATMs per 1 lakh Adults	(6) Branches of Commercial Bank per 1000 km^2	(9) Outstanding deposits with Commercial Banks
(4) Number of ATMs		(10) Outstanding deposits with Commercial Banks (% of GDP)

Source: Financial Access Survey (FAS), IMF.

Table 3. Variables, unit and data sources.

Variables	Unit	Source
Agricultural productivity (*Agripro*)	Constant 2010 US$	WDI, World Bank
Capital (*K*)	(% of GDP)	WDI, World Bank
Labour (*L*)	(% gross)	WDI, World Bank
Financial inclusion (*FII*)	Index	Financial Access Survey (FAS), IMF
Trade openness (*Tradeopen*)	Trade percentage of GDP	WDI, World Bank
Lending interest rate (*Interest*)	(%)	WDI, World Bank
Carbon emission (CO_2)	Metric tons per capita	WDI, World Bank

Table 4. Descriptive statistics.

	lnAgripro	lnK	lnL	lnFII	lnTradeopen	lnInterest	ln
Mean	7.175	3.275	4.041	0.671	3.386	2.507	0.404
Median	7.149	3.268	4.011	0.724	3.739	2.56	0.298
SD	0.345	0.417	0.381	1.032	1.127	0.213	0.754
Min	6.302	2.527	2.924	-6.008	0.758	1.939	-2.961
Max	7.941	4.248	4.608	0.001	4.758	2.938	0.722
Observation	89	89	89	89	89	89	89

Source: Authors' estimations based on data compiled from the IMF and WDI.

tions have important policy implications. Interpretations of these results are given in the next section along with estimated regression results.

4.3. Empirical results on the conditional impacts of financial inclusion (FI) on agricultural productivity

It is important to examine the conditional impact between financial inclusion and other micro and macroeconomic variables on agricultural productivity. From Table 6, in specification 1 of the time fixed effect model, estimated coefficient of financial inclusion and agricultural productivity coefficients is positive. Furthermore, estimated results also confirm that there is a positive relationship between FI and agricultural productivity in other specifications (see columns 2, 4, 5, and 6 of Table 6) except column 3. This shows that an inclusive financial system can create more efficient investment in the agricultural sector which can lead to higher productivity. Similarly, the coefficients of carbon emissions indi-

Table 5. Correlation matrix.

	lnAgripro	lnK	lnL	lnFII	lnTradeopen	lnInterest	lnCO_2
lnAgripro	1						
lnK	-0.109	1					
lnL	0.293	0.492	1				
lnFII	0.461	-0.139	0.309	1			
lnTrade	-0.608	0.548	-0.085	-0.159	1		
lnInterest	-0.319	0.136	-0.153	-0.083	0.531	1	
lnCO_2	0.572	0.285	0.448	0.228	-0.26	-0.482	1

Source: Authors' estimations based on data compiled from the IMF and WDI.

Table 6. Conditional effects of financial inclusion on agricultural productivity (fixed effect estimation).

Variables	(1) lnAgripro	(2) lnAgripro	(3) lnAgripro	(4) lnAgripro	(5) lnAgripro	(6) lnAgripro
lnFII	0.150 *** (0.001)	0.889*** (0.002)	- 1.014*** (0.019)	0.147*** (0.002)	1.584*** (0.000)	0.846*** (0.000)
lnK	0.033 (0.755)	- 0.204 (0.134)	- 0.080 (0.464)	0.039 (0.723)	- 0.153 (0.170)	- 0.252*** (0.022)
lnL	0.333 (0.725)	2.640 (0.999)	0.334*** (0.041)	0.036 (0.703)	0.104 (0.274)	0.147* (0.101)
lnCO_2	0.230*** (0.000)	0.235*** (0.000)	0.258*** (0.000)	0.221*** (0.000)	0.267*** (0.000)	0.292*** (0.000)
lnInterest	0.468*** (0.004)	0.449*** (0.004)	0.445*** (0.005)	0.466*** (0.005)	- 0.021 (0.913)	0.049*** (0.000)
lnTradeopen	- 0.179*** (0.000)	- 0.174*** (0.000)	- 0.155*** (0.000)	- 0.180*** (0.000)	- 0.138*** (0.000)	- 0.248*** (0.000)
lnFII*lnK		- 0.216*** (0.008)				
lnFII*lnL			0.295*** (0.007)			
lnFII*lnCO_2				- 0.007 (0.834)		
lnFII*lnInterest					- 0.590*** (0.000)	
lnFII*lnTradeopen						- 0.176*** (0.000)
Constant	6.889*** (0.000)	7.586*** (0.000)	5.760*** (0.000)	6.890*** (0.000)	7.989*** (0.000)	7.362*** (0.000)
Observations	89	89	89	89	89	89
R^2	0.690	0.720	0.722	0.690	0.741	0.774
Number of Id	6	6	6	6	6	6

Note: *** and * indicate significance at 1 and 10% level, respectively.
Source: Authors' estimations based on data compiled from the IMF and WDI.

cate that there is a positive relation between emission, and agricultural productivity. This finding is similar to other studies like NASA (2016), Mujtaba *et al.* (2022) and Chandio *et al.* (2022).

The conditional impact of FI on agricultural productivity in South Asian nations is also presented in Table 6. To assess the independent impact of a particular variable on agricultural productivity, this Table examines control variables and their links with financial inclusion independently. The Table indicates that the interaction term of FI with physical capital, human capital (i.e., *labour*), interest rate and trade openness are significant. However, the interaction term of FI with emissions is not statistically significant for agricultural productivity.

Financial inclusion and physical capital have an adverse effect on agricultural productivity when they are combined, implying that higher physical capital increases the marginal effect of FI in reducing agricultural productivity. This empirical finding is consistent, in the sense that increased fixed capital (i.e., spending on machinery and large equipment purchases, etc.) may create less demand for labour, may decrease real wages and lower the standard of living of many people, particularly in rural areas. This can lead to an inefficient inclusive banking system, which may reduce agricultural investment and then further reduce agricultural productivity. In a study, Zepeda (2001) found that an increase in physical capital had an adverse impact on agricultural production and profits.

Financial inclusion and *human capital* (i.e., proxied by secondary school enrolment) have a positive impact on agricultural productivity when they are combined. This implies that when the number of students enrolled in secondary school rises, the marginal effects of finan-

cial inclusion on growing agricultural productivity increases. This empirical evidence is valid in the sense that a higher education level in poor families increases general workforce skills and farmers become better "managers" by enhancing their decision-making skills, which subsequently increases the financial literacy rate and in turn helps to use digital banking. Such positive relations between financial inclusion and human capital were observed in many studies, also leading to higher agricultural productivity (Asadullah, Rahman, 2009, Nguyen, 1979; Kawagoe *et al*. 1985; Fulginiti, Perrin, 1993; Reimers, Klasen, 2013).

In addition, the interaction term between *FI* and *carbon emission* has a negative impact on agricultural productivity when they are combined. This result can be interpreted like this – an inclusive financial system can improve the accessibility of banking products, which in turn can increase investment and can also increase energy-consuming machines like tractors, power tillers and combine harvesters etc. Finally, it can increase CO_2 emissions that may indirectly reduce agricultural productivity. A similar finding was observed in Kwakwa *et al*. (2022).

Financial inclusion and *interest rate* have a negative impact on agricultural productivity when they are combined. This result can be interpreted in the sense that a higher interest rate charged by the formal financial institutions largely can restrict farmers from seeking credit from these institutions and may create less investment in the agricultural sector. Finally, it may lead to a decrease in agricultural productivity. Some studies (Danladi *et al*. 2021; lliyasu, 2022) had such findings.

The interaction effect between *financial inclusion* and *trade openness* is negatively related to agricultural productivity. This result may be interpreted as sometimes openness to trade has a negative effect on technical efficiency in the agricultural sector (as evidenced in Hart *et al*. 2015) and economic growth (as found in Kim, 2011; Rigobon, Rodrik, 2005; Vamvakids, 2002; Ulasan, 2015; Fenira, 2015). These may create less demand for labour, and will reduce real wages, thus can decrease the standard of living. In this way, negative cycles of opportunities may be generated. This can lead to an inefficient inclusive banking system that reduces agricultural investment and ultimately decreases agricultural productivity. Table 7 reports (results from random effect model) similar results to those in Table 6 (results of fixed effect model estimation).

4.4. Panel unit root results

In general, the panel data model needs to test stationarity of the data before regression estimation (Wang *et al*. 2015). In this section, the order of integration of variables is tested through unit root tests before checking for panel cointegration. In order to ensure the effectiveness and stability of the data, the Im-Pesaran-Shin (IPS) test (Im *et al*. 2003) is employed since it emphasizes parameter heterogeneity in panel models.

Table 7. Conditional effects of financial inclusion on agricultural productivity (random effect estimation).

Variables	(1) lnAgripro	(2) lnAgripro	(3) lnAgripro	(4) lnAgripro	(5) lnAgripro	(6) lnAgripro
lnFII	0.103 *** (0.000)	0.803*** (0.003)	- 0.933*** (0.017)	0.102*** (0.000)	1.142*** (0.002)	0.487*** (0.000)
lnK	0.060 (0.558)	- 0.165 (0.209)	- 0.040 (0.698)	0.062 (0.563)	- 0.079 (0.457)	- 0.100*** (0.312)
lnL	0.056 (0.532)	0.030 (0.725)	0.256* (0.041)	0.057 (0.533)	0.050 (0.577)	0.035 (0.667)
lnCO_2	0.212*** (0.000)	0.216*** (0.000)	0.239*** (0.000)	0.209*** (0.001)	0.238*** (0.000)	0.240*** (0.000)
lnInterest	0.378*** (0.009)	0.371*** (0.008)	0.410*** (0.003)	0.377*** (0.010)	- 0.018 (0.920)	0.372*** (0.003)
lnTradeopen	- 0.186*** (0.000)	- 0.183*** (0.008)	– 0.168*** (0.000)	– 0.186*** (0.000)	– 0.155*** (0.000)	– 0.237*** (0.000)
lnFII*lnK		- 0.207*** (0.015)				
lnFII*lnL			0.258*** (0.008)			
lnFII* lnCO_2				- 0.002 (0.944)		
lnFII*lnInterest					- 0.433*** (0.004)	
lnFII*lnTradeopen						- 0.110*** (0.000)
Constant	7.084*** (0.000)	7.736*** (0.000)	5.997*** (0.000)	7.085*** (0.000)	7.952*** (0.000)	7.432*** (0.000)
Observations	89	89	89	89	89	89
R^2	0.673	0.701	0.703	0.673	0.705	0.717
Number of Id	6	6	6	6	6	6

Note: *** indicates significance at 1% level.
Source: Authors' estimations based on data compiled from the IMF and WDI.

Table 8. IPS panel unit root test.

Variables	lnAgripro	lnK	lnL	lnFII	lnCO_2	lnInterest	lnTradeopen
Level	1.400 (0.919)	0.120 (0.547)	-2.113 (0.017)	- 0.660 (0.254)	2.043 (0.979)	- 1.360 (0.086)	0.612 (0.729)
First differences	- 3.527*** (0.000)	- 2.734*** (0.003)	-2.641*** (0.004)	-2.770*** (0.002)	-1.989*** (0.023)	-3.455*** (0.000)	- 3.118*** (0.000)

Note: *** indicates significance at 1% level.
Source: Authors' estimations based on data compiled from the IMF and WDI.

Table 8 reveals the unit root test. The Im-Pesaran-Shin (IPS) unit root test result indicates that the variables are stationary at first difference but non-stationary at level. In South Asian countries, all the study variables such as lnAgripro, lnK, lnL, lnFII, lnCO_2, lnInter and lnTrade are found to be stationary at their first difference, rejecting the null hypothesis of non-stationary at 1% significance level. This result confirms the use of panel cointegration that requires the same order of integration.

4.5. Cointegration result

The above unit root test confirms that the variables follow the first order of the integration (I(1)) process. This indicates that these two key variables of lnFII and lnAgripro may be cointegrated after controlling the effect of lnK, lnL, lnCO_2, lnInter and lnTrade. To find the cointegration, the Pedroni (1999, 2004) test is employed in a balanced panel because this cointegration test allows heterogeneity among the countries.

Seven test statistics of Pedroni cointegration are reported in Table 9. This result confirms the cointegration between lnFII and lnAgripro across the panel countries. Out of seven, four Pedroni test statistics reject the null hypothesis of non-cointegration at 1% level of significance. It means that financial inclusion and agricultural productivity have a long-run relationship. Furthermore, this implies that if financial inclusion is prioritized now, it would help South Asian countries in the long-run.

Table 9. Pedroni panel cointegration estimation.

	Statistics	P-value
With Dimensions		
Panel *v*-Statistics	-3.037	0.996
Panel ρ Statistics	3.512	0.999
Panel Phillips-Perron *t*	-12.654***	0.000
Panel Augmented Dickey Fuller *t*	-4.187***	0.000
Between Dimensions		
Group ρ Statistics	4.140	1.000
Group Phillips-Perron *t*	-7.512***	0.000
Group Augmented Dickey-Fuller *t*	-4.108***	0.000

Note: *** indicates significance at 1% level.
Source: Authors' estimations based on data compiled from the IMF and WDI.

4.6. Panel FMOLS and DOLS estimations

As the Ordinary Least Square (OLS) estimator is biased and gives inconsistent results in the panel data analysis, the study uses Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) approaches that control the endogeneity and serial correlation problems.

Table 10 shows the FMOLS and DOLS estimation results. The FMOLS results indicate that financial inclusion (i.e., lnFII) and agricultural productivity (i.e., lnAgripro) are cointegrated. The coefficient is positive and statistically significant at 1% level and has the expected sign. This positive sign indicates that 1% increase in access and usage of banking services like savings, microfinance, deposits and loans across the selected nations would increase agricultural productivity by 0.13%. Similarly, the DOLS results confirm that financial inclusion and agricultural productivity have a long-run connection. The long run coefficient is positive, which confirms that a 1% increase in financial inclusion will result in 0.10% increase in agricultural productivity. This result is consistent with findings of some studies like Binswanger *et al*. (1993), Magri (2002), Akudugu *et al*. (2009), Olaniyi (2017), Awunyo-Vitor *et al*. (2014), Fowowe (2020), Atakli, Agbenyo (2020). They found that availability and usage of formal financial services (such as loans, savings and deposits) at an affordable cost leading to an increase in credit that ultimately leads to increased agricultural productivity through efficient investments in inputs like fertilizer, pesticides, quality seeds and irrigation etc. Therefore, financial inclusion can help poor farmers to have more suitable livelihoods.

A strong association between human capital and agricultural productivity is also observed in some studies

Table 10. Panel FMOLS and Panel DOLS estimations.

Dependent Variables:	FMOLS			DOLS		
LnAgripro	Coefficients	t-Statistics	P-Value	Coefficients	t-Statistics	P-Value
lnFII	0.137***	4.270	0.000	0.106***	5.148	0.000
lnK	0.014	0.126	0.899	0.044	0.350	0.720
lnL	0.506***	2.863	0.005	0.343**	2.122	0.037
ln	0.250***	3.279	0.001	0.240***	2.894	0.004
lnInterest	– 0.168*	– 1.668	0.099	– 0.086	-0.828	0.410
lnTradeopen	– 0.086**	– 1.983	0.051	– 0.087*	-1.838	0.069
R^2		0.940			0.932	
Adj. R^2		0.930			0.922	

Notes: ***, **, and * indicate significance at 1%, 5%, and 10 % level, respectively.
Source: Authors' estimations based on data compiled from the IMF and WDI.

(Asadullah, Rahman, 2009; Nguyen, 1979; Kawagoe *et al*. 1985; Fulginiti, Perrin, 1993; Reimers, Klasen, 2013).

The long-run estimated coefficients indicate that a 1% increase in L (i.e., *human capital*) would lead to a 0.50% (FMOLS) and 0.34% (DOLS) increase in agricultural productivity in our panel countries. Similarly, the estimated result has also indicated that there is a positive association between CO_2 emissions and agricultural productivity. The long-run coefficients indicate that a 1% increase in CO_2 emissions would lead to a 0.25% (FMOLS) and 0.24% (DOLS) increase in agricultural productivity. A similar finding was observed in some studies (Mujtaba *et al*., 2022; Chandio *et al*., 2022). But only two study variables (interest rate and trade openness) are found to be negatively cointegrated with agricultural productivity (as seen in Table 10). This indicates that proper policies on interest rates and trade openness have to be formulated and implemented so that agricultural productivity does not decline in the long run.

5. CONCLUSION

Based on annual data, this study has examined the effect of financial inclusion on agricultural productivity for a group of seven South Asian countries from 2004 to 2018. The study has some important findings as follows. *First,* results of the study confirm that the interaction term of financial inclusion with physical capital, interest rates, trade openness and carbon emissions are negatively linked with agricultural productivity. But the interaction term of financial inclusion with human capital is positively linked with agricultural productivity. *Second*, the Pedroni cointegration test result confirms that a long-run relationship exists among study variables. *Third*, FMOLS and DOLS results confirm that financial inclusion has a positive impact on agricultural productivity in the long run. The findings of this study support the evidence from other studies like Laha, Kuri (2014), Fowowe (2020), Atakli, Agbenyo (2020). This result suggests that expanding formal financial services such as savings, loans, deposits, microfinance, etc., can increase agricultural productivity in the long run in South Asian economies.

The findings have important policy implications for the study countries. South Asian countries can increase agricultural productivity by increasing the coverage of financial inclusion services. South Asian governments and policymakers need to resolve the issues surrounding access to banking services. To bridge the gap in financial services in South Asian countries, the government and other stakeholders in South Asia need to have good quality and quantity financial institutions that are inclusive in nature. This will help in meeting the requirements of farmers, especially in rural communities. Furthermore, to increase agricultural productivity, the government needs to invest more in human capital so that skilled labour with better infrastructure facilities can contribute towards agricultural productivity. Proper policies need to be formulated on physical capital creations, interest rates, trade openness and carbon emissions in ways that will increase agricultural productivity.

Like many other studies, the present study also suffers from some limitations, the non-availability of required data for all countries for important study variables being the major one. The study shows results for the aggregate of all seven South Asian countries. Along with aggregate results, it would be interesting to examine individual countries either with the same method or alternative methods using regional data.

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AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analysed during the study are available in the Financial Access Survey (IMF) and World Development Indicator (2019).

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Research article

The Common Agricultural Policy 2023-2027. How member states implement the new delivery model?

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Abstract. All Member States submitted the final version of the CAP Strategic Plan (CSP) 2023-2027 to the European Commission by 31 December 2022. The CSPs approved by the Commission, given the relevant innovations introduced by the New Delivery Model, make specific choices in response to national needs and a programming approach typical of each country. The article aims to provide a synoptic reading of MSs' choices in the CSPs, to identify common strategic paths and national peculiarities. This analysis is realized comparing the Strategic Statements against the financial allocation in each CSP. The contribution exploits both qualitative and quantitative data and information derived from the CSPs 2023-2027. The dataset is based on the Strategic Statements of each country, and the corresponding financial allocation arising from the overviews of the CSP published by the European Commission. The article is based on a two steps analysis: a Text Mining-Clustering technique, the results of which are assessed against the analysis of the financial allocation by type of intervention conducted by the Balassa index and Concentration ratio. The Strategic Statements are sometime inconsistent with the policy mix defined in the budget allocation by type of intervention. Clusters based on Strategic Statements don't always seem to be fully in line with the actual "policy shape" defined in the budget allocation. Some interventions appear to be more discriminating than others in defining the different policy patterns. Regulatory constraints limit the margins of manoeuvre of MSs, although some of them move to voluntarily go beyond minimum commitments, highlighting specific policy choices. These choices are related to the national context in which the CAP operates, and this implies a different use of the available tools to achieve similar goals with different groups of interventions.

Keywords: CAP Strategic Plan, new delivery model, text mining, cluster analysis, strategic statement.
JEL codes: Q18, O21, D7.

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HIGHLIGHTS

- Analysis of the CSPs' Strategic Statements allows the identification of common strategic paths and national peculiarities.

- The Strategic Statements are sometime inconsistent with the policy mix defined in the budget allocation by type of intervention.
- The CAP strategies at MS level are heavily influenced by the EU strategic approach and regulatory constraints.

INTRODUCTION

The new Common Agricultural Policy (CAP) requires each Member State to design a national CAP Strategic Plan (CSP) to deliver operational actions under the two CAP pillars. Each CSP must be built on an evidence-based needs assessment that undergoes rigorous prioritization to plan comprehensive and achievable interventions (Carey, 2019). For the first time, the instruments of the first pillar are integrated with those of the second pillar in one strategic Plan, along the intervention needs indicated in three general objectives subdivided into nine specific objectives and a cross-cutting objective on the knowledge and innovation system. The CSP is intended to offer MSs a relevant manoeuvrability to respond to their specific territorial needs and contexts in their own strategies, still complying with EU-level defined objectives (De Castro *et al.*, 2020). Several authors (Carey, 2019; Matthews, 2021; Cagliero *et al.*, 2021) suggest that this strategic approach is the most crucial element in the new CAP.

The aim of this contribution is twofold: to highlight the efforts made with respect to EU strategic objectives and to assess the coherence and consistency of budget allocation against MSs' Strategic Statements.

The article is organized as follows: section 1 introduces the new CAP structure, while section 2 is dedicated to a literature review, looking at the growing flexibility granted to MSs by CAP reforms. In the third section data and information collected for the analysis are described together with the definition of the methodology. Results of Text Mining-Clustering and clusters analysis against financial plans compositions and focalisation are described in the fourth section. Finally, the policy discussion and conclusions are dealt with in the fifth section.

1. THE NEW COMMON AGRICULTURAL POLICY AT A GLANCE

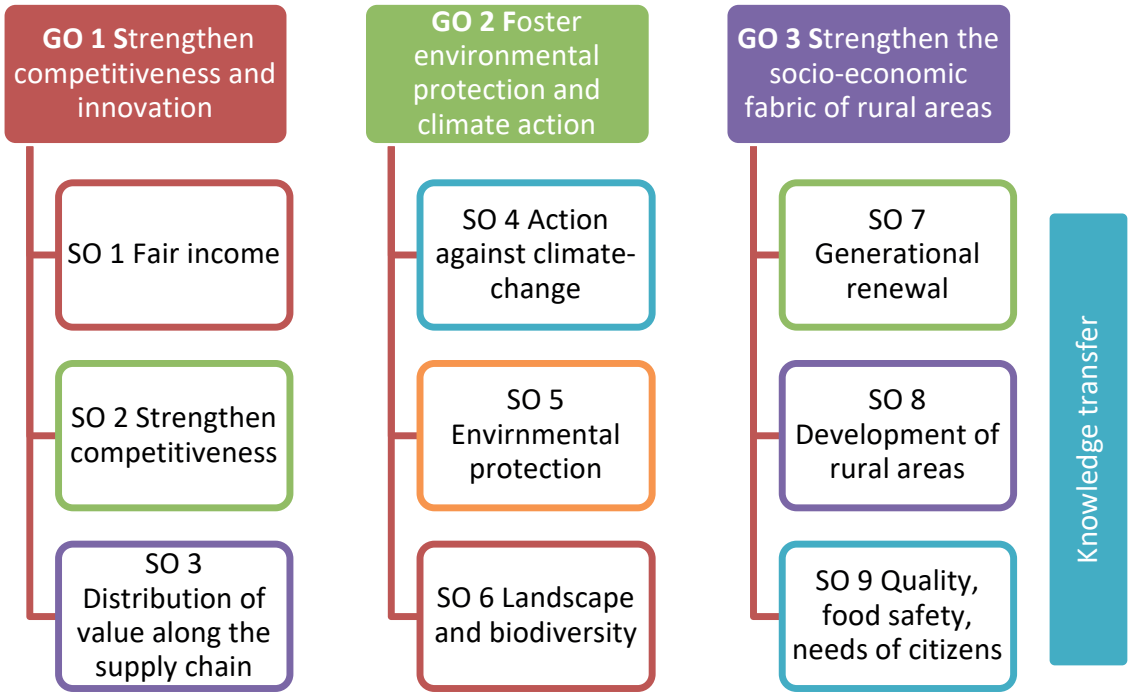
After a long period of negotiations, the CAP reform 2023-2027 was formally approved by the European Parliament in the plenary session of 22-25 November 2021 and then endorsed by the Council on 2nd December. The legislative package is composite and establishes a framework for the reform of the CAP that will operate in a completely different economic and social environment from the one in which it was originally conceived. From the presentation of the proposals in 2018 until their approval, a new European Parliament and European Commission have been appointed; the COVID-19 pandemic strongly impacted the lives of European citizens and consequently influenced the political-economic choices; the UK leaving the EU impacted financial resources available for the EU budget and the CAP; the war in Ukraine has had serious consequences on political priorities, including the availability of food, production inputs and energy. The approved legislative texts confirm the structure of the proposal, inserting innovations aimed at enabling the CAP to face exogenous challenges and contribute to the New Green Deal strategy in support of the transition towards climate neutrality, considering the synergies with the Recovery and Resilience Facility introduced in the Multiannual Financial Framework 2021-2027. Although the final version of the CAP considers the needs and priorities deriving from the new challenges, many authors have observed that it would probably have been appropriate to withdraw the original proposals and present new ones more coherent with EU strategies and the emerging socio-economic framework (for more details see Pupo D'Andrea, 2021; Sotte, 2021).

The 2023-2027 CAP presents an approach that tends to modify the traditional framework for action as it proposes: a more strategic vision of intervention (the New Delivery Model); a new policy governance; an implementation model and an increasing emphasis on societal concerns that try to legitimise the CAP into EU policy framework (Erjavec and Erjavec, 2021).

The context of CAP reform has considered the new environmental, social and economic challenges of European policies, such as the European Green Deal, Farm to Fork, the Biodiversity Strategy and "A long-term vision for the EU's Rural Areas" to define interventions for the revitalisation of Europe's rural territories.

To achieve a better and more coherent strategic approach, the CAP reform 2023-2027 provides for a single programming document – the CAP Strategic Plan (CSP) – gathering all the CAP toolbox of both pillars: direct payments, sectoral interventions, rural development policies. The reform introduces a more constraining framework on MSs, including an extensive analysis to identify specific needs and prioritisations, a sound national "Intervention Logic" and the establishment of targets and milestones for both pillars of the CAP. Hence, each CSP must be built from an evidence-based

Figure 1. The new CAP objectives.



needs assessment that undergoes rigorous prioritisation to plan comprehensive and achievable interventions (Cagliero *et al.*, 2022).

However, the strategic vision is constrained by the ring-fencing spending system that obliges MSs to allocate a minimum percentage of CAP financial resources to specific objectives. The most important ring-fencings concern:

- at least 25% of direct payments and 35% of the rural development policy budget must be allocated to achieve environmental and climate objectives;
- at least 5% of EAFRD resources must be allocated to the LEADER approach for the development of rural territories;
- at least 3% of the equivalent direct payments budget must be reserved for policies for young farmers and generational renewal;
- at least 10% of direct payments must be allocated to Complementary Redistributive Income Support (CRISS).

The new CAP sets out three General Objectives (GOs): to strengthen competitiveness and innovation, to foster environmental protection and climate action, and to strengthen the socio-economic fabric of rural areas. Each GO develops three Specific Objectives (SOs), plus a transversal one aimed at modernising the agricultural sector by promoting innovation and digitization, particularly through the knowledge system (Figure 1).

The CSP represents a novelty in the CAP implementation. The definition of the Plan was characterized by a high level of complexity, due to the challenge of keeping together the different policy instruments that will have to ensure the sustainable development of widely differentiated agricultural systems and rural areas. The CSPs' strategies, furthermore, must contribute to achieving the objectives of the European New Green Deal.

By 31/12/2022 all MSs had the final version of CSP approved by the European Commission. The CSPs, although constructed under a common framework and according to a common guideline, make specific choices in response to national needs and a programming approach typical of each country.

2. LITERATURE REVIEW

Due to the CAP reform process, the physiognomy of the agricultural policy in the EU changed over time in terms of aims, type of interventions and toolbox[1], even though characterized by a marked *path dependency*,

[1] A wide literature exists on this topic. As a very partial list of references: Ackrill *et al.*, 2008; Jensen *et al.*, 2009; Swinnen 2008; Sorrentino *et al.*, 2011; Anania and Pupo D'Andrea, 2015; Erjavec and Lovec, 2017; Matthews, 2018; Pupo D'Andrea, 2019b.

mainly concerning the first pillar (Kay, 2003; Erjavec and Erjavec, 2021). The most recent innovation concerns the programming process, which has also been radically modified, attributing incremental margins of flexibility to MSs (De Castro, 2020; Lovec *et al*, 2020; Garcia Azcárate and Folkeson, 2020). The latter started with the CAP reform 2014-2020, especially under the first pillar. As highlighted in several studies (Swinnen, 2015; Matthews, 2015; Henke *et al.*, 2015; Ecorys, 2017; Henke *et al.*, 2018), it is in relation to direct payments that, with the 2014-2020 CAP reform, MSs have gained an unprecedented level of flexibility from the number and relevance of implementation options, while under rural development the subsidiarity principle has already been a key element in all the programming stages for decades. Under the CAP 2023-2027, flexibility and subsidiarity are combined with a rebalancing of responsibilities between the EU and MSs (Pupo D'Andrea, 2019a).

The growing flexibility granted to MSs and the tendency to provide the CAP with a more holistic approach by strengthening the link between the two pillars, led the scientific debate both to analyse MSs' decisions in each pillar aimed at tailoring the agricultural support to specific national needs and to assess the whole strategy elaborated by MSs.

An in-depth analyses of the tool boxes used by MSs under each pillar of the CAP 2014-2020 is provided by two studies commissioned by the European Parliament: Henke *et al.* (2015), focusing on the *Implementation of the first pillar of the CAP 2014-2020*, stress the high degree of heterogeneity in implementation of the new direct payments, confirming the idea that a "one size fits all" CAP is no longer suitable to the complexity of European agriculture. Dwyer *et al.* (2016), focusing on the *Programmes implementing the 2015-2020 Rural Development Policy*, show a predominance of spending on environmental measures and on physical investments for competitiveness, while less funding is devoted to broader rural development.

A whole assessment of the strategy is performed by Ecorys (2017), whose cluster analysis is the result of the choices that MSs made in the first pillar (in terms of using the flexibility provided or maintaining the *status quo*) and in the second pillar (in terms of budget allocation). The study identifies five clusters focusing on the relative importance each group attaches to each of the general CAP objectives. While Henke *et al.* (2018) run a cluster analysis on MSs choices under direct payments, focusing on *fields of flexibility* in embodying the 2014-2020 reform: i.e. the *transition* toward a uniform per-unit payment to all beneficiaries; the *selection* of beneficiaries; the *redistribution* of support among beneficiaries.

Ecorys (2017) highlights that in most MSs no integrated approach has been taken towards the design and choices under Pillar 1 and Pillar 2. While Dwyer *et al.* (2016) speak about evidence of a more strategic approach than in the previous period even though a considerable continuity exists in priorities and patterns in resource allocation. The presence of a "historic factor" is observed by Ecorys (2017), as in many cases MSs' major concern was to minimise the changes in the support provided to the agricultural sector compared to the previous CAP. While Henke *et al.* (2018) identify a *national path dependency* as a new factor shaping implementation of the CAP. Tarangioli *et al.* (2016) highlight that the menu of tools is not fully exploited, as a fragmentation of financial resources and limited integration among pillars seem to be preferred.

Despite the novelties introduced in the CAP, many scholars are critical of the effectiveness and efficiency of the 2023-2027 CAP to adequately support the European Green Deal and sustainable development (Cuadros-Casanova *et al.*, 2023; Guyomard *et al.*, 2020; Heyl *et al.*, 2020; Pe'er *et al.*, 2020; Salvan *et al.*, 2022), as well as a sustainable food system (Recanati *et al.*, 2019; Schebesta and Candel, 2020; Mowlds, 2020; Tarangioli, 2021). Criticisms also emerge regarding the effectiveness of direct payments in reducing agricultural income inequalities and achieving a fairer distribution of support while providing environmental public goods (Ciliberti *et al.*, 2022; Metta, 2020; Chatellier and Guyomard, 2023; Frascarelli, 2020). The greater flexibility granted to MSs together with the enhanced focus on performance of both pillars represent an opportunity to make the CAP more effective and efficient. At the same time, the different ambitions of MSs and the heterogeneous managing, analytical and strategic capacity of national administrations in the designing of the CSP could lead to different levels of ambition, especially from the environmental and climate point of view, with a risk of distorting competitiveness between MSs, failing to ensure a "level playing field" for all (Carey, 2019; Cagliero *et al.*, 2021; Guyomard *et al.*, 2020; Pupo D'Andrea, 2019b).

3. DATA AND METHODS

3.1. Data

At the base of the CSP there is the Strategic Statement that represents the backbone of the Plan: a national declaration drawing – in a communicative way – the main strategic lines that the CSP intends to pursue over the five-year period based on the evidence collected and tools at disposal. The formal emphasis given to the strategic lines with respect to regulatory constraints, the EU common objectives and the actual financial alloca-

Table 1. A proposal of interventions' aggregates under CAP 2023-27 GOs.

Intervention	Aggregate	Indicative GO
Basic Income Support for Sustainability – BISS (Art. 21)	Income support	GO1
Complementary Redistributive Income Support for Sustainability CRISS (Art. 29)		
Natural or other area-specific constraints ANC (Art. 71)		
Area-specific disadvantages resulting from certain mandatory requirements (Art. 72)		
Risk management tools (Art. 76) (ex. sectoral interventions)	Risk management	GO1
Investments, including investments in irrigation (Art. 73-74)	Investments	GO1
Coupled Income Support CIS (Art. 32)	Coupled support	GO1
Cotton (Art. 36-41)	Sectoral interventions (+ cotton)	GO1
Wine (Art. 57-60)		
Apiculture (Art. 54-56)		
Hop (Art. 61-62)		
Olive oil and table olives (Art. 63-65)		
Other sectors (Art. 66-68)		
Eco-scheme (Art. 31)	Environmental and climate	GO2
Environmental, climate-related and other management commitments AECC (Art. 70)		
Complementary Income Support for Young Farmers CIS-YF (Art. 30)	Young farmers & generational renewal	GO3
Setting up of young farmers and new farmers and rural business start-up (Art. 75)		
Cooperation, included LEADER (Art. 77)	COOP	GO3
Knowledge exchange and dissemination of information (Art. 78)	AKIS	Horiz.

tion defined by the country represent a combination of data and information of great interest for evaluating the recent programming phase.

The contribution exploits both qualitative and quantitative data and information derived from the CSP 2023-2027. Indeed, the dataset is based on the Strategic Statements of each country, and the corresponding financial allocation in each CSP arising from the overviews of the CSP published by European Commission, to have homogeneous data.

The European Commission describes the Strategic Statement as follows: *The overview of the CAP Strategic Plan shall outline what the CAP aims to achieve in the Member State's territory. It shall focus on the main expected results and interventions, including relevant elements of the green architecture, in light of the identified needs, and summarise key choices on financial allocation. It shall demonstrate how these aspects relate to each other. Highlights may be provided as to how the main elements provided in the Commission Recommendations for the CAP Strategic Plan have been addressed* (reg. 2021/2289, Annex I). The Strategic Statement represents the backbone of the Plan, summarizing the main strategic lines that the CSP intends to pursue over the five-year period. The contribution collects the Strategic Statements of the CSP approved by the European Commission and the financial allocation of each CSP annex to Commission implementing Decisions (EC, 2022). This has made it possible to obtain homogeneous information in terms of quantity and quality of data. The financial allocation is related to the whole programming period aggregated by type of intervention and by CAP GOs. It is worth noting that the fruit and vegetable sectoral intervention is not considered in the financial figures as it does not have a pre-allocated envelope.

The qualitative and quantitative data on approved CSP represents a set of information of great interest for evaluating the recent programming period. It allows the coherence of the financial allocation with respect to the strategic objectives at national and European level to be assessed. It allows feedbacks on the effectiveness of the programming methodology to be provided, based on a sound "Intervention logic", developed by the European legislator to orient MSs towards solid and consistent decisions, and characterized by the presence of constraints, i.e. ring-fencing, which limit the degree of freedom at the disposal of national policy makers.

In the analysis, we used a specific aggregation of the types of interventions, considering the main goal of the tool by its nature and implementation. The proposal of these aggregates is presented in Table 1.

3.2. Methods

A Text Mining-Clustering (TMC) task was used as a Text Mining (TM) application to the CAP Strategic

Statements across the EU countries[2]. TM is an automatic process that combines data mining techniques, statistics and computational linguistics to uncover relationships and patterns in unstructured textual data resources (Gupta and Lehal, 2009; Younis, 2015). The TM-C is therefore a cluster analysis conducted on textual data with TM techniques, processed by choosing the software IRaMuTeQ version 0.7 alpha 2 (Ratinaud, 2014).

This textual analysis software embeds the TM-C method named ALCESTE[3] (Reinert, 2001) based on the hierarchical descending classification (HDC) algorithm known as co-occurrence text analysis (Illia *et al.*, 2014). This method individualizes statistically independent word classes found in a whole text (named textual corpus) by maximising Chi-squared distance of matrices intersecting parts of texts and words; each class is composed of words, and thus of textual segments, concatenated to each other to produce a uniform meaning because the vocabulary is similar. Consequently, each class is also dissimilar from one another because the internal vocabulary is also distinct from the one in the other classes. The mechanism starts from the whole textual corpus with descending partitioning into two big classes with the most different use of words, successively the algorithm splits those classes into other parts that are again different, although less than the first ones and so forth until partitions are no longer statistically significant (Illia *et al.*, 2014). The final classes have represented here the extent to which the strategic statements might be in common at European level. Furthermore, the main IRaMuTeQ output of the HDC process consisted of a correspondence factor analysis Cartesian graph with factors generated from the classifications and supplementary variables associated with the strategic statements' textual corpus. These factorial graphs revealed a more exhaustive visualization of how the classes were shaped, and thus how they covaried each other, together with the relative contribution of each supplementary variable[4] to each class and factor.

The results of the first step based on TM-C technique were subsequently assessed against the analysis of the financial allocation by type of intervention conducted by the Balassa index (BI) and Concentration ratio (CR).

In regional economic and trade analysis, BI is a measurement of the degree of specialisation of a territory or sector (Balassa, 1989). The index was initially used in relation to export flows (Liesner, 1958), but the procedure has been refined and is used in many fields as CAP implementation analysis or studies on competitiveness of farms, specific agri-food sectors or territories and regions, as well as in rural development evaluations (Cagliero and Henke, 2005; OECD, 2007; Nomisma, 2008; Pesce, 2008; Trione, 2009; Nuval, 2016). Balassa (1965) proposed using the ratio as an index for comparative advantage. X denotes exports, or a specific item as well as a sector or a policy, for a specific country, a specific commodity, and the world (or any reference group of countries considered), the BI is:

$$BI_{ij} = (X_{ij}/X_i)/(X_{wj}/X_w) = (X_{ij}/X_{wj})/(X_i/X_w) \quad (1)$$

It is noteworthy that:

$$X_i = \Sigma_j X_{ij};\ X_{wj} = \Sigma_i X_{ij};\ X_w = \Sigma_i \Sigma_j X_{ij} \quad (2)$$

A given country is considered to have comparative specialisation (or no specialisation) when BI is greater than 1 (minor). Thus, the comparative neutrality point is when BI is equal to unity, i.e. when the size-wise importance in the country is as big as that in the territorial macroaggregate. Here we use BI, therefore, to offer a proxy for the CSP architecture through an estimation of the budget allocation priorities on the different interventions that can be activated by the CAP: whether a particularly relevant use of one type of intervention (specialisation) can be highlighted or not in relation to the relative weight of the allocated resources and in comparison, with the average EU-wide allocations. The Balassa index has been criticized when used to provide ordinal or cardinal comparability (Sanidas and Shin, 2010). Against these limitations, in our study BI aims to identify comparative specializations in the allocation of financial resources with respect to the neutral point (EU average). Consequently, the index values should not be read to draw up a ranking (ordinal measure), nor to measure the comparative specialization or non-specialization (cardinal measure) of a given MS in the allocation of funds.

The concentration ratio (CR) in economics compares the sales of a specified number of the largest firms in the industry with the industry's total sales (Bikker and Haaf, 2002); this index is also widely used in the analysis of specific agri-food sectors (Pieri, 2013). Here we estimate a concentration ratio by calculating the relative weight of the sum of the 3 main types of intervention in relation to the overall allocation. The aim is to estimate a strategic path of concentration/polarisation of CSPs as opposed to proposing a more complex and articulated policy.

[2] The software worked on the English versions of all the documents examined. The authors dealt with several European languages by means of specific translation software.

[3] Analyse des Lexèmes Cooccurrents dans les Enoncés Simples d'un Texte.

[4] In our study the supplementary variables are the EU countries since the analysed texts were organized by each EU country to evaluate their contribution to the cluster solution.

The methodological pathway identified thus makes it possible to analyse the consistency between the strategic declarations made in the CSPs and the actual prioritisation of interventions, through application of the specialisation and concentration indices. To this path is also added a representation of budget allocation between direct payments, market measures and rural development actions, as well as a description of the attainment of ring fencing.

4. RESULTS

4.1. CAP Strategic Commitments

The entire textual corpus of the 28 EU CAP Strategic Statements (i.e., 28 texts) was composed of 2960 words with 31172 occurrences with a mean of occurrences by text of 1113.29. The mean of words frequency (occurrences/number of words) was 13.40[5] and 1930 active[6] words with a mean of active words frequency of 16.15. The number of hapax (i.e., words that occur just once) was 886 (29.93% of words[7]); Figure 2 presents the text mining-clustering solution that reports a good percentage of classification stability (69% of the text segments correctly classified) of 5 clusters, with 2 (blue and red) more distinct than the other 3. This can be considered an optimal classification. The word clouds in the graph represent the most important words in creating each cluster and the larger they are, the more significant they are in terms of both frequency and co-occurrence, i.e. their ability to connect with others to create common topics. We reported the two-factor solution with a total inertia (i.e., total variance explained[8]) of the 62%. The factors summarize the degree of dispersion of the cluster solution (i.e., the distance from the textual content of each cluster) and they, essentially, permit to visualize how the clusters have related each other: the textual content can be dispersed one from another or concentrated to one another. The factors take also into account the contribution of the supplementary variables as well. As a matter of fact, Figure 3 plots the membership of each MS in the 5 clusters, i.e. which country contributes most to the construction of that cluster; the bigger it is, the more it contributes. Several MSs of the same colour indicate groups with similar strategies, in relation to the topics covered in the cluster to which they belong. The significant segments useful for finding similar topics by cluster is available in the Appendix. These are the classified text segments that contributed most to the construction of the clusters[9].

Cluster 1 (red) is characterized by words highly related to the construction of the EU CAP strategy (EU fitted), such as strategic objectives, Green deal (in particular Farm to Fork strategy) new delivery model. The Strategic Statements of MSs belonging to this cluster appear consistent with the EU major goals and strategic objectives of the CAP, at the same time, giving importance to the organizational and management elements of the new policy framework. We find both regionalised MSs, Spain, Germany, and centralised ones, such as Sweden, Denmark, Estonia, Malta, Austria. These are MSs, in the case of Spain and Germany, with a strongly market-oriented agricultural sector. In the other cases the cluster involves countries with a strongly identity-oriented agriculture and the strategies are oriented to the innovation of specific sectors or farms.

Cluster 2 (grey) is mainly dedicated to supply chain issues to strengthen the competitiveness of the sector. We observe a focus towards the functioning of supply chains and the positioning of agricultural producers. The quality factor is also relevant. This cluster is relatable to the CAP Specific Objectives 2 (Increasing competitiveness) and 3 (Strengthening the position of farmers in value chains). Romania, Croatia, Slovenia, Cyprus and Lithuania belong to this cluster.

Cluster 3 (green) is focused to ensure a fair level of income for agricultural producers and to strengthen the competitiveness of agricultural and agri-food businesses, to close the income gap between the agricultural sector and other sectors, as well as support for young farmers and generational renewal. It faces the challenges of competitiveness and resilience in the light of greater fairness and safety in working conditions. This cluster involves The Netherlands, Latvia, Bulgaria, Greece and Italy, a

[5] Mean values over 5 are an indication of a good lexical richness to conduct a TM (Tuzzi, 2003).

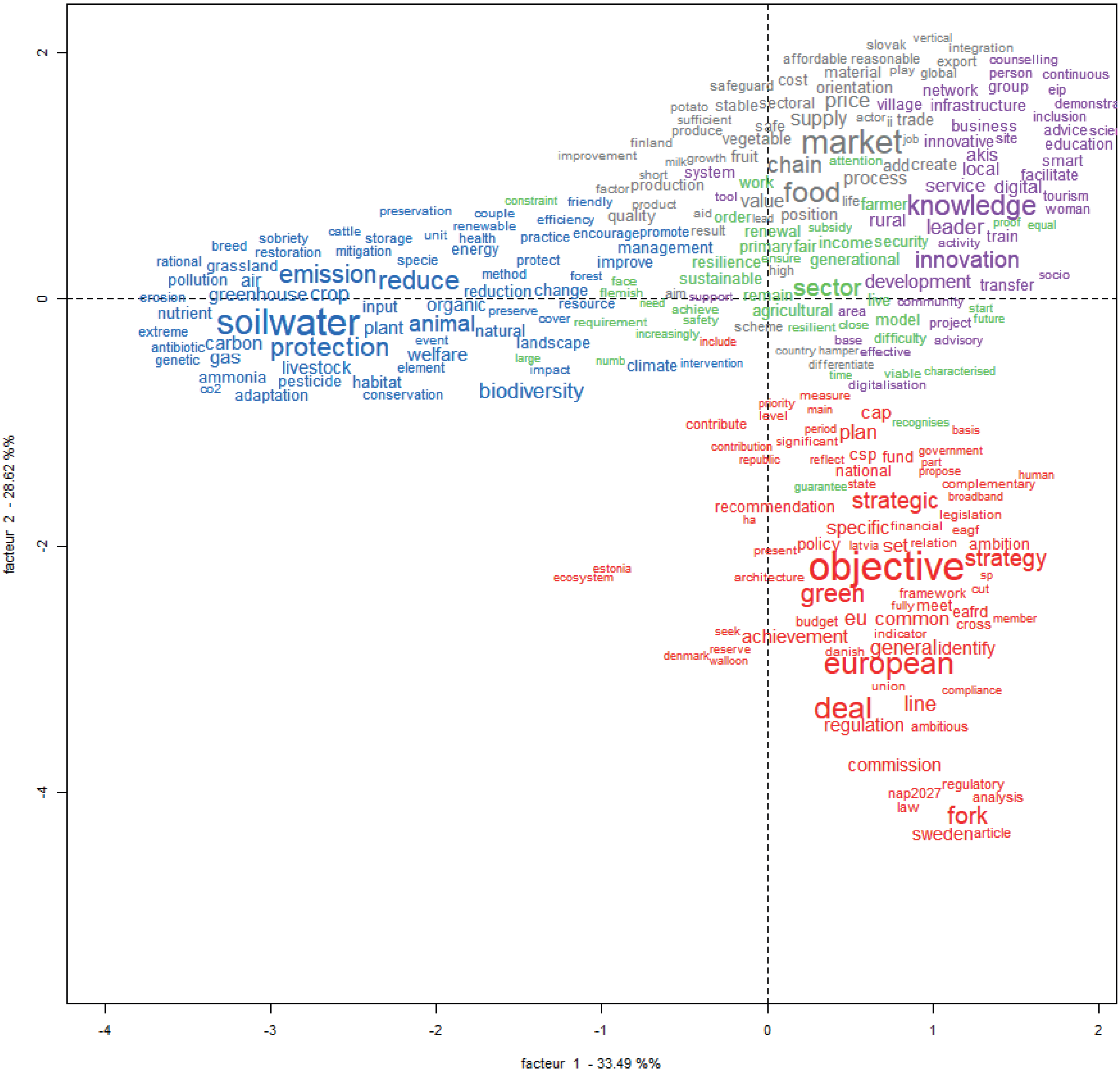
[6] The active words are the words with a proper meaning cleaned by auxiliar verbs, prepositions, articles, adverbs, conjunctions and so forth that are the supplementary forms.

[7] Values under 50% are an indication of good lexical richness to conduct a TM (Tuzzi, 2003).

[8] To our knowledge there is not cut-off criteria to establish recommended levels of explained variance in ALCESTE text analysis, but it is reasonable that a researcher should have at least over 50% of the variance captured by the first two factors to make the solution visible in two dimensions.

[9] Significant segments are classified parts of text that contribute most to the construction of the clusters. These segments are composed of the words, (and thus phrases), that most contributed (because they co-occur within each cluster). These words characterise each cluster and every word is associated to a numerical value score of the Chi-square. By summing these scores, an aggregate Chi-square value is again associated to each segment along with the reference to the MS (i.e. the strategic statement where it came from. The segments will be ordered in descending order of this aggregate Chi-square value, from the highest to the lowest; the higher this value, the more significant the segments are.

Figure 2. Correspondences Factorial Analysis diagram between clusters identified in the TMC.



Source: Authors' estimation from MS CSPs.

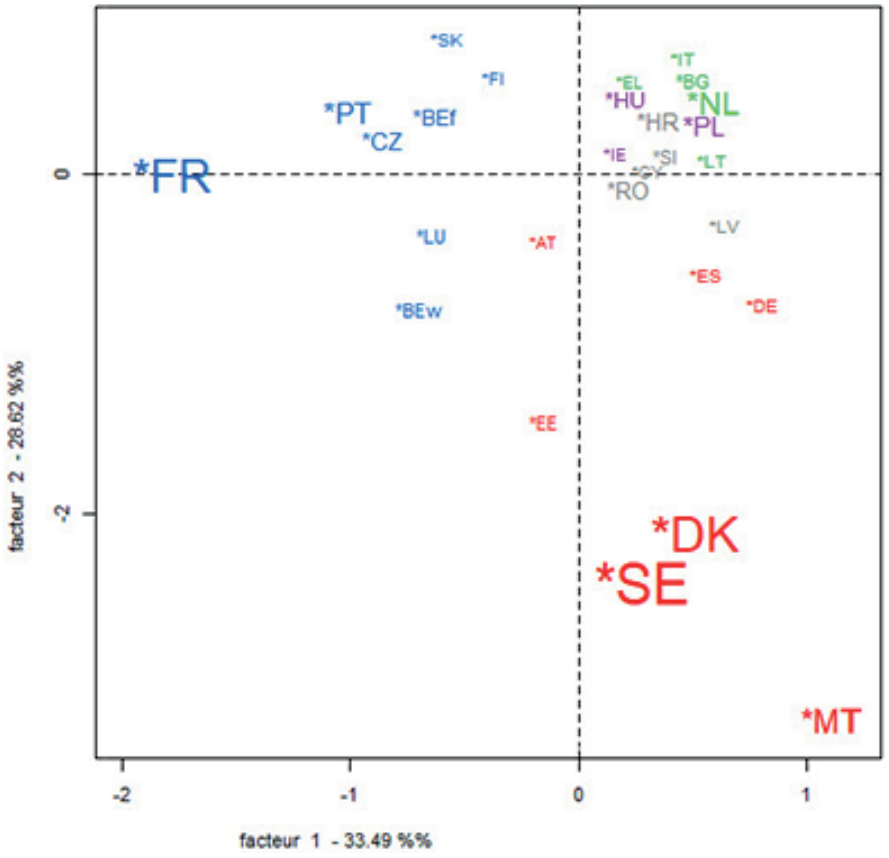
Note: in Red Cluster 1 (EU Fitted); in Grey Cluster 2 (Supply Chain); in Green Cluster 3 (Farm resilience); in Blue Cluster 4 (Env. and climate); in Purple Cluster 5 (Knowledge)

very heterogeneous group of MSs, characterized by a classical approach in line with the asset of CAP.

Cluster 4 (blue) points out the goals to conserve water, soil, landscape and biodiversity, to reduce GHG and ammonia emissions and to improve animal welfare. It is focused on input sobrieties to protect natural resources and on energy efficiency and the development of renewable energy (GO2 and SO9). MSs belonging to this cluster are France, Portugal, Czechia, the two Belgium regions, Slovakia, Finland, Luxembourg.

Cluster 5 (purple) highlights that there is no successful development of agriculture and rural areas without efficient transfer of knowledge and innovation and networks of stakeholders. It points out the relevance of training, diversification, investments (also in digitalization) and support for infrastructure to meet the needs of

Figure 3. Correspondences Factorial Analysis diagram between clusters identified in the TMC and EU-countries.



Source: Authors' estimation from MS CSPs.
Note: in Red Cluster 1 (EU Fitted); in Grey Cluster 2 (Supply Chain); in Green Cluster 3 (Farm resilience); in Blue Cluster 4 (Env. and climate); in Purple Cluster 5 (Knowledge)

rural areas, in the light of local and territorial cooperation**.** Poland, Hungary and Ireland are in this cluster.

In Table 2 we present a summary description of each cluster derived from the TMC procedure; we report the percentages of the segments classified within each cluster, the Member States that belong and propose a label highlighting the main feature of each cluster.

4.2. The composition of financial plans in the estimated clusters

The CSPs are underpinned by Euro 264 billion of EU resources, but the CAP mobilises more than Euro 307 billion of public expenditure, including national resources. Looking at the co-financing shares of rural development, a different picture emerges between MSs. Those highlighting a higher share of national co-financing are Luxembourg (80%), Belgium-Wallonia, Czechia (63% both) and Italy, which is the first co-financer among the major recipients of the CAP (54%). Shares of less than or equal to 20% are highlighted by seven MSs, with Denmark showing the lowest share (11%).

An analysis conducted by the European Commission (2022) on all CSP shows that the CAP EU resources were distributed as follows: 72% to direct payments (DPs), 25% to rural development (RD) and 3% to sectoral interventions. More information on how EU resources are distributed between types of intervention can be found in Figure 4. The MSs allocated more than half of the budget for DPs to BISS and about ¼ of DPs is allocated to Eco-schemes. In the case of RD measures more than 70% of the budget is allocated to 3 types of interventions: AECC, Investments and Areas facing Natural Constraints.

How MSs distribute the financial resources between the different interventions depends on many factors, some exogenous, such as the initial budget allocation (of first and second pillar), and others endogenous, such as intervention's national co-financing, the choices made

Table 2. Cluster identified in the TMC Composition Summary Table.

Cluster	%	Label	MS.
1 – Red	*17.50*	EU Fitted	SE, DK, MT; EE; DE; ES ; AT
2 – Grey	*16.70*	Supply Chain	RO, HR; SI, CY; LV
3 – Green	*16.90*	Farm resilience	NL; LT; BG; EL; IT
4 – Blue	*24.10*	Env. and climate	FR; PT; CZ; BE-F; SK; FI; LU; BE-W
5 – Purple	*24.80*	Knowledge	PL; HU; IE

Source: Authors' estimation from MS CSPs.

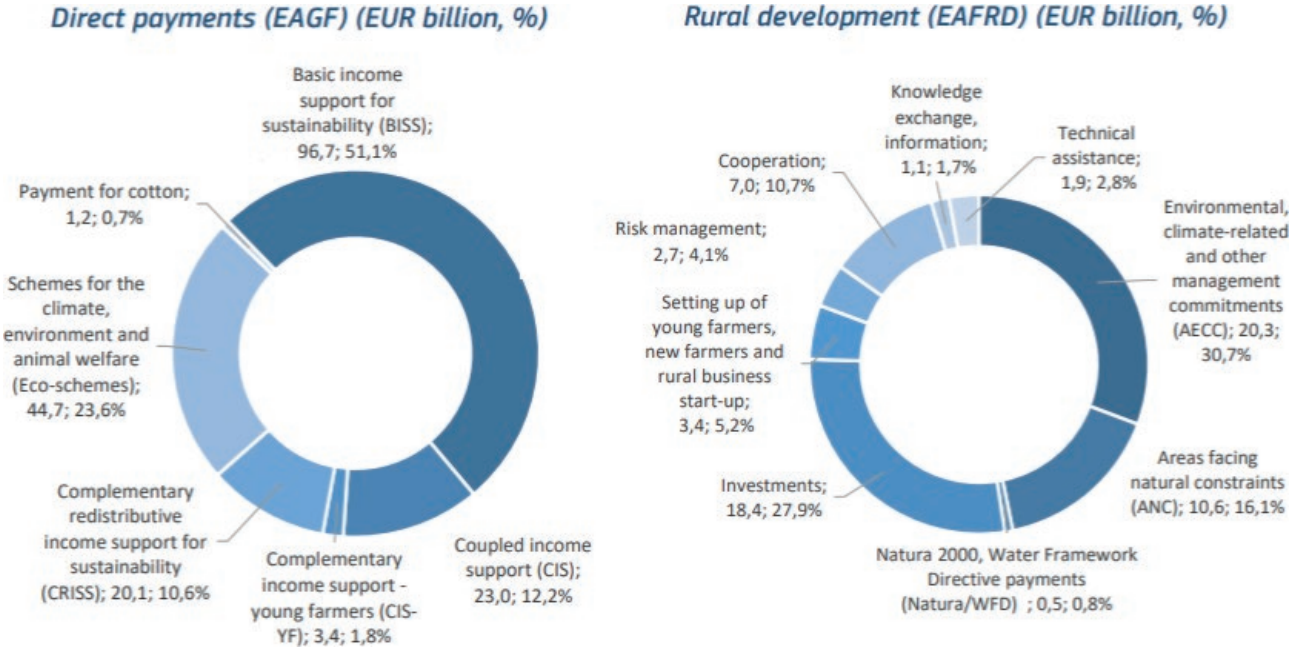
on the flexibility between pillars, the path dependence, the availability of financial resources other than CAP to finance agricultural interventions, etc.. In this analysis, both flexibility and public expenditure are considered; the first because propaedeutic to any other decisions regarding the allocation of budget between different interventions and for this reason included in the EC data utilized. The second because, although only EU funds are analysed in this work, the share of national funds on total public expenditure will serve to better characterize the choices in the clusters. Future progress of the work will have to consider the whole architecture of the CSPs to understand if and to what extent national choices confirm or distort the evidence that emerged from the EU data analysis.

Looking at the distribution of the planned expenditure under the CSP by cluster, a very differentiated pattern in the distribution of CSP resources among the different policy envelopes emerges (Figure 5). In the same figure a set of indicators consisting of CSP elements where ring-fencings applies compared with the EU level as a benchmark is considered[10]. The aim is to highlight commitments that voluntarily go beyond these regulatory constraints or above the average EU level, highlighting a peculiar policy choice.

Cluster 1, EU Fitted, devotes a share of financial resources to DPs higher than the EU average; the opposite happens in RD, where also the national co-financing level is lower. Considering the ring-fencing, a lower level of EU

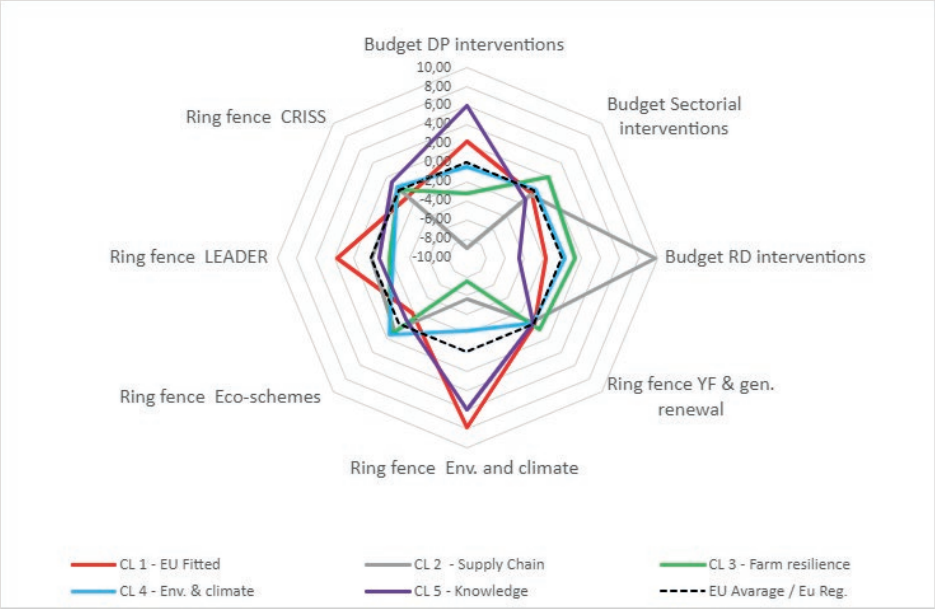
[10] The ring-fencings have been calculated on the basis of the CSP regulation. For young farmers and generational renewal Annex XII defines the reserve for young farmers: CIS-YF (Article 30) and Installation of young farmers (Article 75); Investments by young farmers (Article 73 with a weighting factor of 50%). On average, approximately 2.6% of the total budget at EU level is dedicated to this objective. At least 35% of the total EAFRD contribution has to be reserved for interventions addressing the Specific Objectives related to environment and climate, and animal welfare. Interventions falling under Articles 70, 71, 72 and 73 are eligible, however a weighting factor of 50% is applied to ANC. At EU level, we can estimate nearly 50% of resources under RD are focused on this objective. In the face of at least 5% of the total RD contribution to be reserved to LEADER, 25% of the DP to be reserved to Eco-scheme and 10% to CRISS, the EU averages are, respectively, 7.7%, 23.6% and 10.6%.

Figure 4. Planned distribution of DPs and RD funds in CAP 2023-2027.



Source: EC, 2022.

Figure 5. Distance from the EU average distribution of the planned expenditure under the CAP and ring fences achievement of each cluster identified in the TMC .



Source: Authors' estimation from MS CSPs.

average is shown for CRISS (determined by Malta and Denmark who don't allocate resources to the redistributive payment) and Eco-schemes, while on the RD side a greater focus than EU average is on LEADER and, above all, on environment and climate, and animal welfare.

The Supply Chain group (Cluster 2) is characterized by devoting a higher share than EU average of financial resource to RD, although with low national co-financing (about 20% of total public expenditure), and the lowest share of all clusters to DPs. MSs belonging to this group devote less RD resources to environmental, climate and welfare objectives, although meeting the minimum spending requirement, preferring the Eco-schemes of the DPs.

The group labelled Farm Resilience (Cluster 3) allocates relatively more resources to sectoral interventions, while maintaining a substantial commitment to rural development. This cluster shows a greater focus on young farmers and generational renewal, as well as on Eco-schemes.

Cluster 4, Environment and climate, presents a distribution of resources in line with the EU average. MSs belonging to this group meet the minimum spending requirements but to a lesser extent than the EU average just in the case of environmental objectives of RD, balanced by the major focus on Eco-schemes.

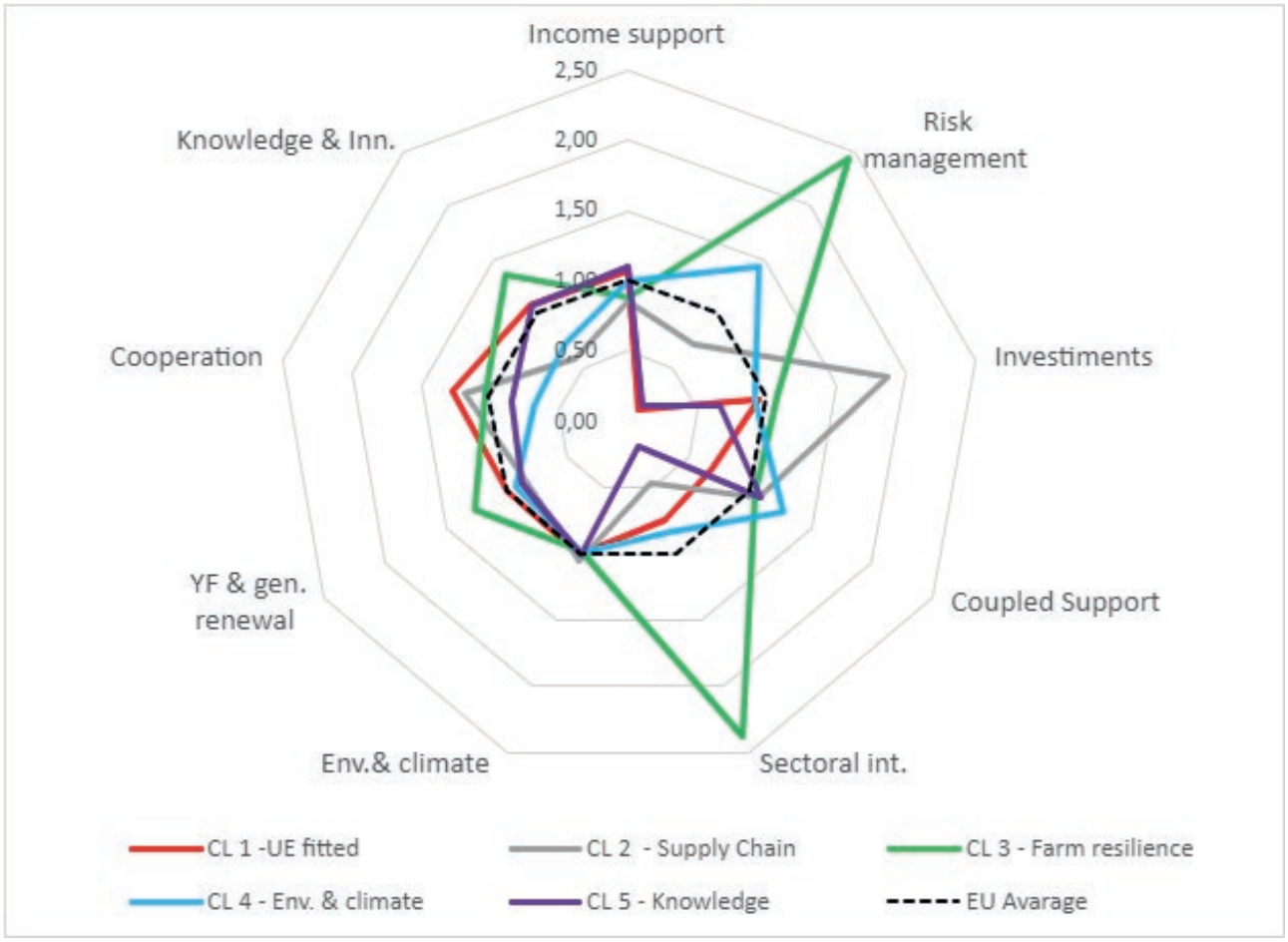
Finally, the Knowledge group (Cluster 5) devotes more resources to DPs than the EU average, and less to RD. This cluster, however, presents the higher share of national co-financing (48%). A higher share than EU average is devoted to Environmental and Climate objectives and to CRISS, to better address the needs of smaller and medium-sized farms.

Definitively, the analysis shows a different positioning between old and new Member States. The first use the instruments of the CAP in an innovative way to respond to more strategic objectives. The new Member States, together with some southern European countries (Italy and Greece) and The Netherlands, emphasise the need to work on the competitiveness of the sector.

4.3. Heroes & Heavies: the policy specialization in the estimated clusters

Under the Balassa index (Figure 6), we can estimate the specialisation pattern in CAP policies for the different clusters. This is a proxy highlighting how the distribution of financial allocations is more (or less) focused compared to the EU average. The BI does not show which cluster has devoted the largest amount of financial resources (in absolute value) to a specific intervention; it identifies which cluster appears more specialised in respect to a specific intervention than the EU average. Within this framework, we can observe different policy shapes between the different clusters. This approach

Fig. 6. Balassa Index for Intervention types by cluster identified in the TMC.



Source: Authors' estimation from MS CSPs.
Note: For the Intervention types see Table 1.

allows us to consider the wide differences in MSs' CAP budgets.

Cluster 1 – EU Fitted, i.e. gathering – according to the TM-C – MSs that declare a strategy aligned with that of the EU, have allocated a share of their budget higher than the EU average to Cooperation (including LEADER), followed by AKIS and Income support; other interventions, such as investments in youth and those aimed at the environment and climate are in line with the average of the 27 MSs, while the limited use of Risk management and Sectoral and Coupled interventions is peculiar. The allocation is fairly concentrated on a few interventions: the first three (Income support; AECC; Investments) account for about 85% of the total budget, in line with the EU average (Figure 4). However, it should be highlighted that this cluster is the only one to show BI values higher than (or really close to) the unit in all the types of intervention affected by EU ring-fencing: COOP – LEADER (1.27), AKIS (1.09), Income support including CRISS (1.05), AECC (1.01) and Young farmers and generational renewal (0.99).

A different pattern emerges for Cluster 2, which reveals a strategy aimed at increasing farmers' bargaining power. These MSs have allocated a share of their financial resources primarily to Investments, Cooperation and CIS, while we estimate a low BI for Sectoral interventions, together with AKIS, Risk management, Income support and for Young farmers and generational renewal. The countries in the cluster seem to assign the development of agri-food supply chains mainly to rural development measures, these are new Member States where the development of agri-food chains, in National CAP Strategy, goes hand in hand with the modernisation and restructuring of production structures. It is worth noting that Sectoral interventions allow very narrow margins for manoeuvre, as they are pre-allocated envelopes for specif-

Table 3. A characterisation of clusters identified in the TMC based on the main discriminating elements (Ring-fencing, BI, CR).

Cluster	Ring-Fencing*	Balassa Index *	Concentration Rate **
CL1 – EU Fitted	LEADER (+)	COOP (+) RISK (-); CIS (-); Sector (-)	*85%* vs. *81%* (EU); INV
CL2 – Supply Chain	-	INV (+); CIS (+) RISK (-); SECTOR (-); AKIS (-)	*81%* vs. *81%* (EU); INV
CL3 – Farm resilience	YF (+); LEADER (-)	RISK (+); YF (+); SECTOR (+); AKIS (+)	*77%* vs. *81%* (EU); CIS
CL4 -Environment & climate	LEADER (-)	RISK (+); CIS (+) COOP (-); AKIS (-)	*85%* vs. *81%* (EU); CIS
CL5 – Knowledge	-	CIS (+) RISK (-); SECTOR (-); INV (-)	*90%* vs. *81%* (EU); CIS

* at least 20% distance from the EU average.
** the third type of intervention is indicated, after BISS and ENV.

ic MSs (with the only exception of Fruit and Vegetables), although CAP 2023-2027 allowed MSs to devote up to 3% of DPs to other sectors under sectoral interventions. Such a possibility has had limited adoption in general and none of the MSs belonging to this cluster adopted it.

MSs declaring a strategic vision based on farm resilience (Cluster 3) show a less polarised policy shape than the others, with an approach based on a greater distribution over different types of intervention. The estimated concentration ratio is the lowest, not reaching 77%. The three most relevant measures in value are Income Support, AECC and CIS. This cluster is characterised by a high BI value for Risk Management, Sectoral Interventions, AKIS and Youth. Also specialised, but more in line with the EU average are Investments, Cooperation and Coupled support.

The focus on environmental and climate issues characterises Cluster 4 in the TM-C analysis. MSs belonging to this cluster show a high specialisation for Risk management and CIS and a lower one for Income support. Relatively low specialisations, but not far from the average of the 27 MSs, are observed for Investments, AECC, and generational renewal and support for Young farmers. Regarding the other interventions, the BI-value is below the EU average (<0.85). The concentration in the first three interventions is 85%, but it should be mentioned that more than 53% of the resources are reserved for direct payments and ANC.

The last cluster identifies a strategy related to knowledge and innovation (Cluster 5). The estimated BI value for interventions focused on AKIS themes is above unity and is in line with those estimated for Income support payments and CIS. The share devoted to AECC is in line with the EU average. In contrast, the other interventions are considered low specialisation, in particular Risk management and Sectoral interventions. The concentration on the first three interventions is the highest (almost 90%) and is mainly attributable to direct payments, both coupled and decoupled.

5. DISCUSSION

According to the expectations of the European Commission, the Strategic Statement presents an overview of the CSP outlining what the CAP will do in the MS territory. It focuses on the main expected achievements and interventions (including the relevant elements of green architecture) considering the identified needs and summarises key choices on financial allocation. Hence, as mentioned, the Strategic Statement represents the backbone of the Plan, summarizing the main strategic lines that the CSP intends to pursue over the five-year period.

Thus, coherence among Strategic Statements and budget allocation ought to be robust. This is expected to be particularly meaningful especially due to the sound methodology built around the principle of "Intervention logic" at the base of each CSP, while a levelling effect might be played by the ring-fencings, which strongly limit the degree of freedom at the disposal of the MSs. However, the cluster analysis based on MSs' Strategic Statements doesn't seem always fully in line with the actual "policy shape". Such a mismatch is more evident in some clusters (i.e. Cluster 4) than in others (i.e. Cluster 2).

At the same time, it emerges that neither the institutional organization of the MS (centralised vs. regionalised) nor the geographical location (north vs. south, east vs. west) seems to discriminate in the choices of the MS.

As in the case when applying optimisation software with the same parameters for all, the solutions cannot

diverge too much. A first piece of information that we can derive is which issues are, or are not, discriminating in the choices made by the MSs and aggregated in the 5 clusters. Not all the information gathered is consistent in determining different patterns and specific shapes of policy (Table 3). As already mentioned, regulatory constraints necessarily lead to a substantially similar application of different policy instruments.

If we look at the analyses done on ring-fencings, we observe that relevant differences result only for the incidence of LEADER on rural development, even if all clusters show a share of budget allocated to LEADER higher than the minimum expenditure required; partially also the indications concerning young farmers and generational renewal show different applications. While the environmental ring-fencings under both RD and the Eco-schemes of DPs, due to their ambitious nature and magnitude lead to very similar applications, as do the choices made concerning redistributive payments.

The analysis conducted via Balassa indices provides a more detailed picture. We can highlight some interventions that concretely have a discriminating function between the different clusters. Risk management, Sectoral interventions, AKIS are the factors that most discriminate one cluster from another; as also, to a lesser extent, can Investment and Cooperation (LEADER and EIP). What might seem paradoxical is that interventions with the highest amount of financial resources, i.e. Income support and AECC under RD, actually describe very similar applications in different clusters, accordingly with the EU average values. This is only an apparent paradox, because this picture confirms that the particularly strict and specific rules determining the application of these interventions (ring-fencings), together with a certain path dependence bias, necessarily lead to very similar choices among MSs and clusters. However, we must consider that BI does not estimate either the absolute value or the simple relative weight of each intervention on the total per cluster, but the relative incidence of the intervention in comparison to the same ratio at EU level. In this light, an intervention that is perhaps not preponderant on the national overall financial framework, becomes instead very indicative if we analyse the level of relative prioritisation, because it indicates a precise policy choice with respect to the EU framework.

The inability to discriminate in policy patterns between MSs of Environmental and Climate interventions in the RD and Income support payments is confirmed in the analysis based on the CR3 estimate. These two types are the most allocated interventions in all clusters, while only the third intervention (Investments or Coupled payments) by allocation seems to lead to differences in policy choices.

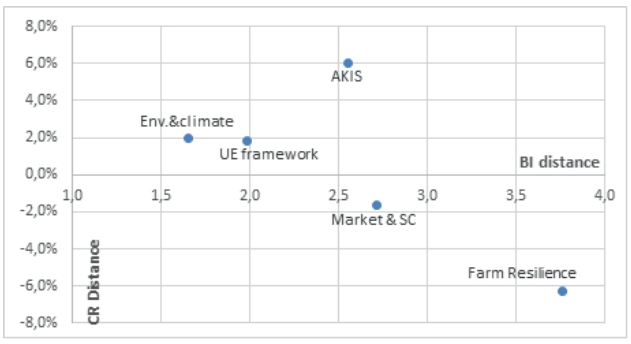
A final aspect is the possibility of defining policy shapes for the different clusters. We can indicate some peculiar characteristics for each cluster from the aggregation of the deviations indicated by the estimation of the different BIs and the declination of the deviation from the EU average of the CR3. In Figure 7, we use a graphical representation of this intersection of the two pieces of information.

The cluster that stands out the most from the others is the one we have labelled "Farm Resilience". The use of different tools characterises the policy shape of this cluster as well as the choice of interventions that only partially act directly on farm incomes, but which contribute to creating conditions for the growth of the sector and with sectoral choices: Risk Management, Sectoral interventions and those still coupled, AKIS and the focus on young people and generational renewal.

The second Cluster by distance from the EU average is based on a strategy focused on the bargaining power of farmers. MSs focus their resources especially on Investments, which are also the third intervention by financial allocation, and on Coupled support, whilst the level of specialisation is particularly low for Risk management and AKIS and Sectoral interventions. This picture, however, does not appear entirely consistent with the stated strategy; we would have expected a stronger focus on Sectoral support (also considering the possibility, not exploited, to apply the sectoral intervention to other sectors) and AKIS and more generally on network policies, as well as on strengthening farm structures.

The Knowledge Cluster indicates strong performance in fulfilling environmental ring-fencing and a consistent specialisation towards Coupled support. In contrast, we observe low specialisation in the case of Risk management, Investments and Sectoral interventions. This cluster is characterised by the highest con-

Figure 7. Cluster identified in the TMC summary by the main analyses conducted.



centration (90%) of the first three policies, where again a significant role is given to Coupled support.

Clusters 1 and 4 converge on the EU vision of a greener CAP and show a specialised focus on climate-environmental interventions. However, the patterns of the two clusters diverge on the other GO of a smart, competitive, resilient and diversified agricultural sector and to strengthen the socio-economic fabric of rural areas (Art. 6 of the CSP regulation). Cluster 1, which shows a marked coherence towards the Union's strategy, can be considered oriented towards the themes of general objective 3, i.e. the development of rural areas. In fact, in the policy shape of this cluster, we observe a specialisation for LEADER and Cooperation processes more generally, against a low BI-index for interventions linked to productive sectors and Risk management. On the contrary, Cluster 4, with a more environmental and climatic character, is little oriented towards these themes and towards interventions such as AKIS and Cooperation, while Risk management and CIS show a high BI level.

6. CONCLUSIONS

The analysis of the financial allocation by type of intervention, and their coherence and consistency with MSs' Strategic Statements, evidently represents a *proxy* for the strategic approach developed by each MS, considering that the achievement of results and strategic objectives can be realized by means of different interventions and a multitude of combinations of interventions under the CAP toolbox. This analysis has been conducted taking into account the EU financial resources, not considering the national co-financing for interventions under the Second pillar, which, in some cases, could reverse some of the conclusions regarding specific priorities. However, information about the share of EAFRD on public expenditure has been considered showing that the EU average is around 60%, with some of them who have chosen a higher national co-financing (just under 50%) and others (Cluster 2) significantly lower (20%). The second element to be considered is the possibility of achieving the strategic objectives through financial resources other than those made available by the CAP (for example the Recovery and Resilience Facility). Despite these limitations, the analysis provides interesting evidence, useful for an *ex ante* evaluation of the programming phase at EU level.

This work aims to be a first contribution to stimulate the debate around the strategic choices of MSs and the coherence of interventions adopted. Future progress will consider the contents of the MSs' CSPs and their target indicators, as soon as they are all available, and the structural and socio-economic characteristics of the MSs.

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APPENDIX

Table A.1. Distribution of the planned expenditure under the CAP by cluster identified in the TMC (%).

		CL 1 -UE fitted	CL 2 – Supply Chain	CL 3 – Farm resilience	CL 4 – Env. and climate	CL 5 – Knowledge	EU Avarage
% budget	DP	*75,0%*	*63,8%*	*69,5%*	*72,4%*	*78,8%*	*72,8%*
	Sector	*1,3%*	*1,1%*	*3,8%*	*1,9%*	*0,4%*	*1,8%*
	RD	*23,6%*	*35,1%*	*26,7%*	*25,7%*	*20,8%*	*25,4%*
	RD EAFRD/Pub.expend.	*61,8%*	*79,6%*	*53,8%*	*60,7%*	*52,3%*	*59,9%*
Ring fences	YF & gen. renewal	*2,6%*	*2,2%*	*3,3%*	*2,4%*	*2,3%*	*2,6%*
	Env. & climate	*55,6%*	*42,2%*	*40,3%*	*45,5%*	*53,8%*	*47,8%*
	Eco-schemes	*21,8%*	*24,5%*	*25,0%*	*25,1%*	*22,8%*	*23,6%*
	LEADER	*11,4%*	*7,7%*	*5,9%*	*5,5%*	*7,0%*	*7,7%*
	CRISS	*9,5%*	*10,9%*	*10,8%*	*11,1%*	*11,8%*	*10,6%*

Source: Authors' estimation from MS CSPs.

Table A.2. Balassa Index and Concentration Ratio by cluster identified in the TMC.

		CL 1 -UE fitted	CL 2 – Supply Chain	CL 3 – Farm resilience	CL 4 – Env. and climate	CL 5 – Knowledge	EU Avarage
Balassa Index	Income support	1,08	0,85	0,88	1,00	1,10	-
	Risk management	0,12	0,73	2,45	1,43	0,16	-
	Investiments	0,94	1,87	1,08	0,92	0,65	-
	Coupled Support	0,68	1,07	1,04	1,27	1,08	-
	Sectoral int.	0,74	0,46	2,38	0,84	0,18	-
	Env. and climate	1,01	1,05	0,97	0,99	1,01	-
	YF and gen. renewal	0,99	0,85	1,27	0,92	0,87	-
	Cooperation	1,27	1,19	1,04	0,68	0,84	-
	Knowledge and Inn.	1,09	0,59	1,36	0,71	1,07	-
Concentration Ratio 3		0,85	0,81	0,77	0,85	0,89	0,83

Source: Authors' estimation from MS CSPs.

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Review article

Le nuove frontiere nella didattica dell'impresa agraria: elementi per un dibattito[1]

New frontiers in the teaching of the agricultural enterprise: elements for a debate

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Abstract. The ecological transition assigns a strategic role to farms in achieving the sustainable transformation of agricultural systems. Therefore, teaching of agricultural economics must make these demands of civil society its own and rethink topics, decision-making tools, and teaching methods fostering the transition to sustainable agriculture. The main aim of this article is discussing the relevant teaching topics and the useful decision support tools useful for concrete progress in agricultural economics in the cycles of university studies. Five topics are recognized as priorities for the rethinking of courses on agricultural economics: agricultural systems, equitable distribution of value, quality and value of agri-food products, territorial regeneration, protection and regeneration of natural resources. The paper focuses also on the nature and role of decision support tools in university teaching. Finally, some considerations are extended to the opportunities offered by formal teaching in the context of informal training such as university-enterprise cooperation and in the context of the internationalization of degree courses supported by the Erasmus+ program. Further analysis is needed to evaluate how to rethink both single training courses, and global study programs in agricultural economics.

Keywords: agricultural and natural resource economics, environmental and ecological economics, rural regeneration, agricultural value chains, farm decision tools, economic teaching, internationalization of academic degrees.
JEL codes: A23, Q12, Q57, M21.

[1] Il testo è frutto del lavoro comune degli autori, tuttavia i paragrafi 1 e 3.5 sono da attribuire a Biancamaria Torquati, 2 e 4 a Maria Teresa Gorgitano, 3.1 a Benedetto Rocchi, 3.2 a Danilo Gambelli, 3.3 a Silvio Franco, 3.4 ad Angelo Belliggiano, 5 ad Alessio Cavicchi, 6 a Paola Gatto. Tutti gli autori hanno contribuito alla stesura delle conclusioni.

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HIGHLIGHTS:

- Third-level education finalized to an agricultural academic degree has a key role in the process of the ecological transition of the agricultural system.
- In agricultural economics classes, farm analysis must regain a central role in agricultural academic degrees.
- The teaching of agricultural economics must rethink topics, decision-making tools, and teaching methods.
- Formal teaching in the context of informal teaching is a new opportunity for university training.

1. INTRODUZIONE

L'impresa agraria è stata a lungo il tema centrale delle analisi degli economisti agrari e della formazione universitaria. La ricca letteratura specialistica e i numerosi manuali pubblicati fino al primo quinquennio degli anni 2000 ne sono la testimonianza tangibile. Negli anni più recenti, invece, le indagini sul comportamento del consumatore hanno raccolto il maggiore interesse degli economisti agrari italiani. La priorità della transizione ecologica riporta l'attenzione sul ruolo principale delle imprese nel processo di cambiamento del settore e inevitabilmente su quello della formazione universitaria. In particolare, il ruolo fondamentale dell'alta formazione quale catalizzatore del processo della transizione ecologica dell'agricoltura è trattato da numerosi autori (Cortese, 2003; Lans *et al*., 2014; Ahmed *et al*., 2017; Ng e Litzenberg, 2019; Valderrama-Hernández, 2019; Alcántara-Rubio *et al*., 2022; Muma *et al.,* 2022). Ruolo che richiede un cambiamento dell'attuale indirizzo formativo orientato all'acquisizione di competenze specialistiche sempre più parcellizzate, mentre la transizione ecologica richiede un ripensamento dei temi, l'armonizzazione delle competenze e una chiara finalizzazione capace di incoraggiare una nuova imprenditorialità in agricoltura (Ahmed *et al*., 2017; Kirschke, 2019). Richieste che potrebbero trovare una loro concreta attuazione attraverso il cosiddetto modello AKIS (Agricultural Knowledge and Innovation System) che si propone di affiancare un processo di innovazione fondato sulla valorizzazione delle conoscenze esistenti localmente, riconnettendo il saper fare, il sapere tecnico e scientifico in un'ottica di compartecipazione contestuale e multiattore (European Union, 2019).

Concordando sull'osservazione che oggi l'impresa agraria si trova a operare in un ambiente più articolato definito dalla transizione ecologica e che la formazione universitaria debba coglierne la sfida, ci siamo interrogati sulle nuove esigenze nella didattica dell'impresa agraria[2]. Le riflessioni hanno interessato in primo luogo i temi e gli strumenti di aiuto alle decisioni negli insegnamenti universitari. Altri due argomenti di grande interesse hanno affiancato questo iniziale nucleo di riflessioni. Un primo pone l'attenzione sui metodi didattici, il secondo sull'esperienza dell'internazionalizzazione dei corsi di laurea incoraggiata dal programma Erasmus. Elemento comune a tutte le riflessioni è l'attenzione all'impresa agraria nei diversi insegnamenti del settore scientifico disciplinare di Economia ed Estimo rurale con focus sugli ambiti disciplinari di Economia aziendale, Economia industriale e Economia politica. Riflessioni riguardanti l'Estimo rurale e la Politica agraria sono state volutamente omesse convinti che queste discipline, diverse per quadro teorico di riferimento ed evoluzione del loro dibattito, siano di rilevanza tale da richiedere riflessioni ampie e specifiche indispensabili per un più ampio confronto sulla didattica dell'impresa agraria. L'articolazione del lavoro prevede che una volta inquadrati i temi e gli strumenti negli ambiti disciplinari di riferimento (paragrafo 2), ciascun tema sia presentato tracciando l'evoluzione del dibattito teorico più recente, le connessioni e le sinergie con gli altri temi identificati (paragrafo 3), e completati da riflessione sugli strumenti e metodi di analisi nella formazione universitaria (paragrafo 4). Gli ultimi due paragrafi sono dedicati alle innovazioni nella metodologia didattica e all'internazionalizzazione dei corsi universitari (paragrafi 5 e 6). Infine, sono raccolte alcune prime valutazioni utili per per avviare una riflessione aperta a nuovi e successivi approfondimenti.

2. APPROCCIO TEORICO-METODOLOGICO

I temi prioritari individuati sono sintetizzati come: i sistemi agrari, la distribuzione equa del valore, la qualità e il valore dei prodotti agroalimentari, la rigenerazione territoriale, la salvaguardia e la rigenerazione delle risorse naturali. Alcuni di questi temi, o solo talune loro parti, potrebbero costituire il *syllabus* di un unico corso o di più corsi universitari di un ciclo di studio triennale, magistrale o di un master.

Ciascun tema prioritario è stato ricondotto all'ambito disciplinare caratteristico del settore scientifico disci-

[2] Un'iniziale presentazione delle riflessioni riportate nell'articolo è avvenuta nel corso delle sessioni organizzate di due convegni annuali della Sidea dal titolo: *Le nuove frontiere della didattica nell'economia dell'impresa agraria*: *contenuti e strumenti* del LVII convegno di Bologna e *Saperi accademici in transizione* del LVIII convegno di Palermo.

plinare (Economia ed Estimo rurale) al fine di metterlo in relazione al dibattito specifico di ciascun ambito, assicurare la coerenza tra temi e strumenti di aiuto alle decisioni più pertinenti e immaginarne la trasposizione in un percorso di formazione. Com'è noto, nel settore scientifico disciplinare dell'Economia ed Estimo rurale coesistono discipline diverse (Economia, Politica ed Estimo) accumunate dall'interesse per la produzione, trasformazione, distribuzione e consumo dei prodotti del settore primario e delle agro-biotecnologie. Ciascuna delle tre discipline è articolata in ambiti disciplinari distinti per oggetto, finalità d'analisi e indirizzi di ricerca e, inoltre, ciascun ambito disciplinare è ulteriormente articolato in *corpus* tematici.

Al fine di ripensare la didattica dell'impresa agraria nei diversi insegnamenti del settore scientifico disciplinare di Economia ed Estimo rurale sono rilevanti almeno tre ambiti della disciplina economica: l'Economia politica, l'Economia aziendale e l'Economia industriale. Sebbene l'impresa abbia un ruolo centrale in ciascuno di essi, la sua rappresentazione, i suoi obiettivi, le finalità e l'analisi del suo comportamento sono profondamenti diversi. Per l'Economia politica, l'impresa è una struttura produttiva che contribuisce alla produzione e alla distribuzione della ricchezza nel sistema economico studiato a diversa scala spaziale (sovranazionale, nazionale, regionale, comprensoriale); *corpus* tematici specifici sono lo sviluppo delle aree rurali, la pianificazione delle risorse naturali e territoriali, l'analisi del settore nel sistema economico. Per l'Economia aziendale, invece, l'impresa è un istituto (insieme di struttura e regole di funzionamento) che opera in un particolare ambiente competitivo. L'impresa è rappresentata come un sistema aperto al suo ambiente economico, sociale, istituzionale e naturale. La priorità dell'analisi consiste nel verificare le condizioni affinché l'impresa sia vitale ovvero in grado di assicurare alla propria attività continuità, autonomia da terzi, un reddito adeguato all'imprenditore. Molti i *corpus* tematici di questo ambito disciplinare tra i quali: l'organizzazione aziendale e delle attività produttive, l'economia dell'azienda (valutazione dei risultati parziali e globali, delle scelte strategiche, delle politiche aziendali), l'economia e la gestione dell'impresa (definizione delle strategia e delle decisioni di assetto dell'impresa, marketing, gestione degli investimenti e dei finanziamenti). Nell'Economia industriale, infine, l'attenzione è all'impresa quale organizzazione alternativa al mercato la cui struttura trae origine dalle interazioni con i soggetti coinvolti nell'attività produttiva. I fattori che rendono il mercato imperfetto, l'incertezza, la specificità dei capitali (fisici e umani) coinvolti nell'attività produttiva e la frequenza con cui l'impresa deve ricorre al mercato per averne la disponibilità motivano l'esistenza dell'impresa e delle altre forme organizzate dell'attività economica intermedie tra il mercato e il sistema delle imprese. Innovazione, investimenti, pubblicità, differenziazione dei prodotti, potere di mercato e contratti costituiscono le leve principali delle politiche d'impresa che concorrono a modellare la struttura del sistema in cui opera. Molteplici i *corpus* tematici tra i quali l'analisi delle catene del valore, il potere di mercato, le reti d'imprese, l'integrazione verticale.

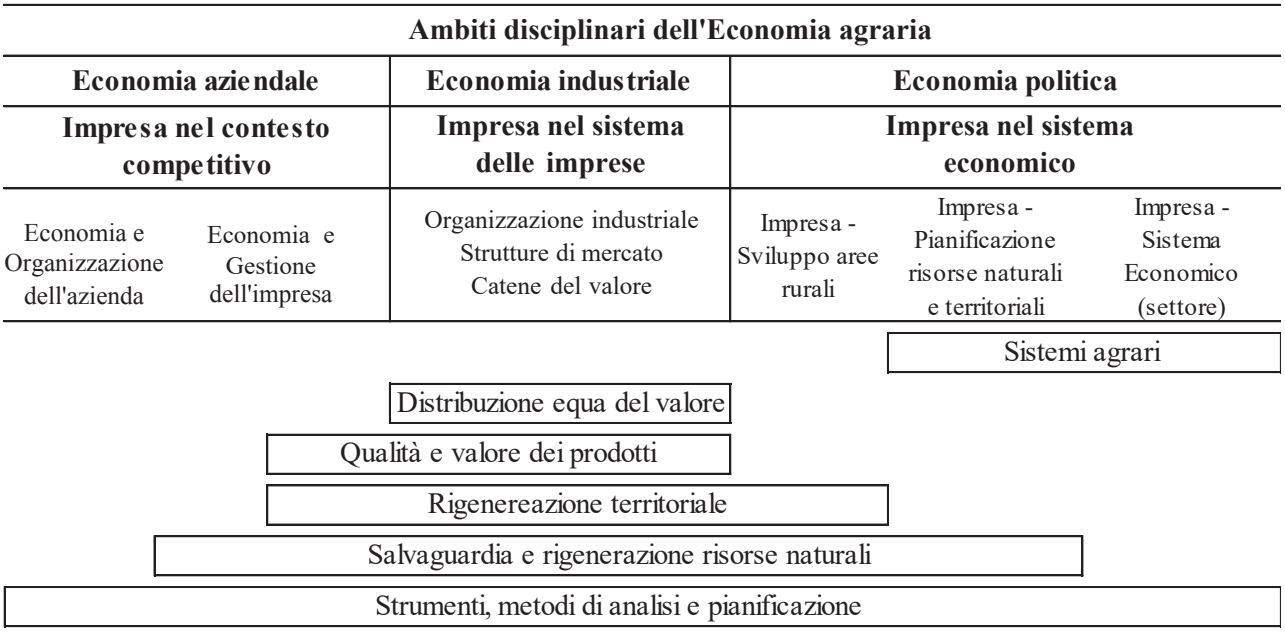
La Figura 1 sintetizza la classificazione sia dei temi prioritari individuati, sia degli strumenti di aiuto alle decisioni rispetto agli ambiti disciplinari dell'Economia agraria e dei suoi principali *corpus* tematici.

3. I TEMI DELLA DIDATTICA

3.1. I sistemi agrari: nuove opportunità didattiche per un vecchio concetto di analisi

Il concetto di sistema agrario proposto da Bandini nel suo Manuale di Economia Agraria (1959) può essere utile per organizzare l'insegnamento di temi come economia della produzione, rapporti tra agricoltura e ambiente rurale, produzione agricola e valore della terra, reticoli istituzionali e struttura degli incentivi. Bandini osserva che nel tempo tendono a osservarsi delle regolarità dell'organizzazione del processo in unità tecniche, nonostante l'estrema variabilità delle condizioni fisiche e ambientali nelle quali si svolge la produzione agricola. Determinati modelli organizzativo-aziendali diventano prevalenti, o si presentano con più intensità, in determinate aree modellando a loro volta il territorio rurale e le sue traiettorie evolutive. Per Bandini, «(…) la struttura agraria di tutto il mondo non è un indecifrabile e incomprensibile caso, ma un complesso che ha una sua logica» (Bandini, 1959: 731). Egli schematizza la nascita di determinati assetti produttivo-territoriali sulla base della logica delle scelte economiche, intendendo tuttavia queste ultime come determinate da un ampio spettro di fenomeni ed incentivi: non solo le caratteristiche dell'ambiente fisico e le dotazioni di fattori a livello aziendale, ma anche la natura del processo produttivo, gli assetti sociali e le dinamiche culturali. Per comprendere i sistemi agrari devono necessariamente essere considerati anche quei fattori esterni all'azienda che definiscono l'ambito delle scelte possibili e le potenzialità di sviluppo; quindi, non solo variazioni dei prezzi, ma anche progresso tecnico, limitazione delle risorse e fenomeni di rendita e quasi-rendita (con un ruolo centrale della terra), dinamica strutturale macroeconomica, qualità delle informazioni sui prezzi e sui mercati e quadro

Figura 1. Ambiti disciplinari dell'Economia agraria, *corpus* tematici e classificazione dei temi prioritari e degli strumenti.



istituzionale all'interno del quale vengono effettuate le scelte. Secondo Bandini solo un quadro completo di tutti questi aspetti può ricondurre le scelte produttive che si possono osservare nella realtà all'interno della logica economica.

Poiché l'analisi per sistemi agrari è fondamentalmente centrata sull'idea cardine di produzione (Quadrio Curzio e Scazzieri, 1983) ben si adatta a inquadrare lo studio dell'economia in percorsi di studio settoriali, come quelli agrari o di pianificazione territoriale. Per studenti che spesso non hanno nel loro background lo studio dell'economia, questa rimane una chiave di lettura fondamentale anche nella loro futura attività di consulenti, oltre che nelle professioni legate alla progettazione e all'implementazione delle politiche settoriali (impiego nella pubblica amministrazione, progettazione territoriale). La visione sistemica estende con naturalezza lo studio dell'economia della produzione oltre i confini aziendali, in un'ottica consapevolmente territoriale, dove ogni attività di produzione s'inserisce in una dinamica strutturale del contesto nel quale si colloca, a partire dal luogo dove essa opera.

L'intrinseca interdisciplinarità del concetto di sistema agrario, inoltre, fa interagire le categorie del ragionamento economico con lo studio di altre discipline (scienze naturali, tecnologiche, aspetti socio-istituzionali). Questa interdisciplinarità impedisce che la stilizzazione economica diventi un economicismo autoreferenziale che sarebbe inutile nella formazione di consulenti.

La prospettiva didattica proposta da Bandini può svolgere un ruolo centrale nello studio delle traiettorie di sviluppo dei territori rurali e delle politiche collegate. Comprendere la struttura degli incentivi che guidano le scelte di agricoltori in specifici territori costituisce una condizione necessaria per progettare e orientare l'implementazione di politiche volte a riconciliare obiettivi privati e finalità pubbliche.

Un ulteriore tema illuminato dal recupero di questa prospettiva è il rapporto tra agricoltura e ambiente, la multifunzionalità, troppo spesso intesa come pura e semplice diversificazione delle attività aziendali. La stessa natura dell'ambiente fisico suggerisce tecniche sostenibili, quando le scelte produttive sono studiate in una prospettiva di lungo periodo che consente di comprendere come e perché si sono configurati nel tempo determinati sistemi produttivi. A sua volta lo svilupparsi delle tecniche di produzione e delle soluzioni organizzative contribuisce a formare gli aspetti socio-istituzionali contestuali che regolano le attività di produzione (contratti, struttura della proprietà e modalità di accesso alla terra). Le più recenti definizioni di quello che viene chiamato approccio agroecologico alla produzione, includono anche gli aspetti sociali nella transizione verso un settore agricolo più sostenibile (Anderson e Maughan, 2021). Fornire agli studenti una categoria concettuale che proietta la logica economica delle scelte produttive all'interno di un quadro concreto di opportunità, è fondamentale per superare una didattica centrata sul puro e semplice sviluppo di competenze specifiche.

3.2. Distribuzione equa del valore

La sfida didattica relativa alla trattazione della equa distribuzione del valore nell'ambito economico-agrario riguarda sia gli aspetti più tradizionalmente legati alla analisi delle strutture delle filiere, e alle catene del valore e dei prezzi, sia l'evoluzione del concetto stesso di valore in un'ottica di sostenibilità intesa nella accezione di equilibrio tra redditività, aspetti ambientali ed equità sociale.

L'analisi del valore dei prodotti agroalimentari ha spesso fatto riferimento a un tradizionale schema generalmente incentrato sulla ricerca di creazione di valore attraverso l'efficientamento dei processi e la riduzione dei costi (Taylor, 2005; Lewis *et al.,* 2014). Purtroppo, al di là di una trattazione spesso teorica degli aspetti legati alla distribuzione di valore nelle filiere agricole, risulta tuttora poco diffusa una analisi empirica della tematica (Mahajan *et al.,* 2017), che potrebbe invece risultare di particolare rilievo nei percorsi didattici delle tematiche economico agrarie.

Le filiere agroalimentari, già caratterizzate da intrinseca complessità dovuta alla connessione con aspetti legati alla biosfera (Archer *et al.,* 2009), sono divenute nel tempo più articolate anche in conseguenza della necessità di includere standard di sicurezza e qualità progressivamente più stringenti (Goldsmith *et al*., 2002). La crescente importanza degli aspetti legati alla commercializzazione, branding, schemi di qualità richiederebbe una adeguata trasparenza di mercato per valutare l'efficienza nella allocazione delle risorse e verificare i meccanismi di trasmissione del prezzo lungo le filiere agroalimentare (Lewis *et al.,* 2014). Queste condizioni non risultano sempre verificate, e tra gli effetti maggiormente rilevanti nel contesto agroalimentare si individuano spesso quelli riferiti alla concentrazione di potere di mercato nel settore distributivo, e parzialmente in quello industriale, a scapito del settore primario (Cucagna e Goldsmith, 2018; Rezitis e Tsionas, 2019). Tale processo può assumere connotati svantaggiosi per la salvaguardia della quota di valore riconoscibile al settore primario qualora si verifichino fenomeni distorsivi nelle fasi di commercializzazione, come ad esempio prassi commerciali sleali, procedure di aste al doppio ribasso e vendite sottocosto. Il tema è assunto a rilevanza tale da vedere un intervento normativo comunitario che ha portato alla promulgazione della Direttiva 2019/633 sulle pratiche commerciali sleali nelle filiere agroalimentari (European Parliament and the Council, 2019). Se si considerano anche le implicazioni per il settore agroalimentare legate alle normative sui *food quality schemes* (Arfini e Bellassen, 2019) e alla regolamentazione delle filiere tramite blockchain (Scuderi *et al.,* 2019; Al-Amin *et al.,* 2021), sembra interessante considerare una integrazione tra tematiche proprie delle discipline economico-agrarie e quelle giuridiche che potrebbe portare alla individuazione di percorsi didattici innovativi e alla formazione di nuove figure professionali specializzate in tali ambiti.

Il tema della distribuzione del valore nel contesto dei mercati agroalimentari si riferisce anche agli aspetti legati al funzionamento del mercato stesso, e agli effetti che le oscillazioni di prezzo dei prodotti agricoli possono indurre sul mantenimento di una adeguata redditività dell'impresa agricola (Assefa *et al.,* 2015; Filippi e Chapdaniel, 2021). Diventa quindi rilevante fornire strumenti didattici che permettano un'analisi dei meccanismi di formazione dei prezzi, di gestione del rischio, degli aspetti speculativi di breve termine, della interazione di prezzo dei prodotti agricoli con quelli di altre commodities (Assefa *et al.,* 2015; Rezitis e Tsionas, 2019; Jose e Shanmugam, 2020).

Infine, sembra opportuno considerare che un'equa distribuzione del valore in ambito agricolo presupponga da un lato la necessità di approfondire nella didattica i temi legati alla tutela del valore prodotto elaborando idonee strategie aziendali, e dall'altro quella di giungere a un'adeguata quantificazione del valore economico generato.

Per quanto riguarda il primo tema si richiama qui l'attenzione sugli aspetti della diversificazione, dell'innovazione della gestione e dell'adozione degli strumenti per la tutela del valore prodotto. La diversificazione deve essere intesa con riferimento a più aspetti; in una prima accezione come differenziazione del prodotto orientata al miglioramento qualitativo che, anche grazie ai consolidati strumenti di certificazione, permette di salvaguardare le opportunità di mercato per l'impresa; in una seconda come diversificazione produttiva o colturale, e infine, come diversificazione dei redditi aziendali ed extra aziendali per contribuire a salvaguardare la redditività complessiva (Darnhofer, 2010; Jetté-Nantel *et al*., 2011). Le innovazioni della gestione, infine, favorendo una maggiore attitudine alla flessibilità organizzativa (Carlisle, 2014) e un processo di apprendimento continuo (Tendall *et al*., 2015) sono elementi fondamentali per la protezione del valore prodotto che attraverso le reti sociali accrescono la capacità di resilienza in agricoltura (Wreford, Ignaciuk e Gruère, 2017). Infine, con riferimento alla tutela del valore prodotto in ambito agricolo, possono essere presentati gli strumenti tipici per la copertura del rischio, come le assicurazioni, i fondi mutualistici e gli strumenti di stabilizzazione del reddito, ma anche le opportunità offerte dalla contrattualizzazione di filiera e di distretto e gli strumenti finanziari per la copertura dei rischi in agricoltura (Zuppiroli, 2019).

Per quanto riguarda il tema della definizione e misurazione del valore, questo rientra tra gli ambiti didattici forse più stimolanti e per molti versi attuali in ambito economico agrario e conduce alla analisi della capacità dei mercati di fornire una misura adeguata del valore dei prodotti agroalimentari. Il tema è ampio, e rientra nel dibattito sul superamento del "fondamentalismo del mercato" come condizione per una economia più equilibrata (Stiglitz, 2009). Da questo punto di vista il meccanismo della formazione del prezzo in un contesto di asimmetrie informative, accentramenti di potere di mercato, congiunture di breve periodo, può essere messo in discussione. Il perseguimento dell'equità diventa così il presupposto di una analisi della distribuzione del valore lungo le filiere che tenga conto di un approccio di una *sustainable value chain* (Bhaskaran *et al.,* 2006; Gorgitano *et al*., 2012; Gorgitano e Sodano, 2019a; Contini *et al*., 2020; Filippi e Chapdaniel, 2021; Toussaint *et al.,* 2021; Torquati *et al*., 2021; Viganò *et al.,* 2022). Un moderno approccio alla didattica economico agraria potrebbe quindi porre le basi per una analisi del valore che riesca a valutare adeguatamente l'importanza dei servizi ecosistemici generati nei food system, riconoscendo esplicitamente le ricadute degli aspetti ambientali, sociali, culturali sul prezzo dei prodotti agroalimentari (TEEB, 2010; Sukhdev, 2018). Ciò porrebbe la prospettiva dell'approccio didattico sul tema centrale della creazione, e distribuzione, sostenibile ed equa del valore nel contesto economico agrario.

3.3. Qualità e valore dei prodotti agroalimentari

Nell'ottica del marketing, il prodotto rappresenta il complesso della soddisfazione fisica, psicologica e sociale che l'acquirente ricava da acquisto, possesso e consumo. Questa definizione evidenzia come il prodotto agroalimentare sia qualcosa che va oltre la capacità di rispondere a un bisogno primario (soddisfazione fisica che l'acquirente ricava dal consumo); a questa, infatti, si aggiunge il beneficio psicologico e sociale che deriva da acquisto e possesso (Kotler e Keller, 2012). Ne consegue che nel processo di scelta di un cibo, una bevanda, un pasto al ristorante, un panino in un *food truck*, intervengano valutazioni che attengono ad un insieme molto ampio di caratteristiche del prodotto.

Per i prodotti agroalimentari si tende spesso ad associare la qualità alla modalità di svolgimento del processo produttivo, alle caratteristiche organolettiche e alle proprietà nutrizionali. Questi aspetti, che attengono alle caratteristiche oggettive e riscontrabili (*experience*) che possono essere oggetto di controllo e anche di certificazione, fanno capo alla sola dimensione della qualità erogata. Il concetto di qualità dei prodotti agroalimentari invece si riferisce anche a caratteristiche immateriali – quali l'area di provenienza, la reputazione dell'impresa, aspetti etici legati alle materie prime o al processo di produzione, o, semplicemente, la moda del momento – che sono legate a una dimensione soggettiva e non verificabile (*credence*) e fanno capo alla qualità attesa del prodotto (Srinivasan e Till, 2002).

Non è facile definire quale siano i pesi della qualità erogata e di quella attesa nel determinare la percezione della qualità di un prodotto agroalimentare, poiché dipendono dal tipo di prodotto, dalla funzione che deve svolgere e, soprattutto, dalle caratteristiche del consumatore. Quello che è innegabile è che il cibo ha ormai assunto uno status in cui l'importanza della componente legata al suo acquisto/possesso supera spesso quella associata all'atto del consumo (Del Giudice *et al*., 2018). Ciò che è profondamente cambiato nel settore agroalimentare è, per dirla con il linguaggio del marketing, il *product involvement*; infatti, i prodotti non hanno più una esclusiva connotazione di flussi di input del processo di consumo, ma sono diventati degli agenti in grado di modificare gli stock valoriale-identitario (siamo quello che mangiamo) e sociale-relazionale (siamo considerati per quello che mangiamo).

Il modello di qualità che ne deriva evidenzia come la qualità (percepita) sulla base della quale vengono operate le scelte di acquisto – dai consumatori, ma anche dagli altri attori della filiera – dipenda da fattori che vanno ben oltre le caratteristiche materiali del prodotto (Steenkamp, 1989; Grunert, 2005). Acquisire questa consapevolezza consente alle imprese del settore agroalimentare di proporre i propri prodotti caratterizzandoli con una predeterminata qualità. Però, mentre il livello di qualità erogata può essere pianificato e, compatibilmente con i vincoli tecnico-economici, raggiunto, la situazione è diversa per la qualità attesa. Questa dimensione, infatti, è influenzata da aspetti soggettivi e sociali di cui l'impresa non ha il pieno controllo. Ciò non significa che il produttore non può puntare a raggiungere un determinato livello di qualità attesa; deve essere però consapevole che non tutti i consumatori reagiranno alle strategie come egli ha previsto. Per questa ragione è necessario che l'impresa individui preventivamente il proprio segmento target e che tale operazione avvenga tenendo conto di variabili che guardano agli stili di vita, ai valori e alle aspettative dei consumatori, i quali sono, sempre e comunque, i destinatari finali del prodotto.

In estrema sintesi, quindi, l'imprenditore dovrebbe conoscere (fase analitica) e, per quanto possibile, scegliere (fase strategica) il mercato cui rivolgersi e quindi organizzare (fase strategica) e proporre (fase operativa) la propria offerta tenendo conto, da un lato, delle carat-

teristiche strutturali dell'impresa, e, dall'altro, degli aspetti sociali, economici e culturali che definiscono il proprio mercato di riferimento (Kotler e Keller, 2012).

Queste considerazioni evidenziano come le conoscenze tecnico-economiche siano una condizione non (più) sufficiente per poter gestire un'impresa agraria o per poter fornire una consulenza professionalmente significativa agli imprenditori del settore. Da una tale consapevolezza discende la necessità non solo di ampliare l'ambito delle conoscenze gestionali ma soprattutto di riconsiderare alcuni aspetti teorici legati allo studio dell'impresa agraria. A questo riguardo, le implicazioni sulla didattica sono rilevanti, a partire dalla necessità di prendere le distanze da un paradigma, quale quello neoclassico, che, al di là dei suoi ormai evidenti limiti epistemologici, non è più in grado di offrire metodi e strumenti in grado di descrivere la realtà.

La scelta dei prodotti e la costruzione della loro qualità deve essere basata su un approccio *market oriented*. Ciò richiede che il mercato non sia più un'entità indefinita in cui vige l'irrealistica ipotesi della concorrenza perfetta quanto piuttosto il luogo della destinazione dell'offerta scelto sulla base del target di riferimento e dei potenziali competitors.

Il prodotto, come detto, andando oltre la dimensione materiale, assume la sua identità non soltanto in relazione alle modalità con cui è condotto il processo produttivo ma anche attraverso il racconto che ne viene fatto ai consumatori e alla modalità con cui li raggiunge. Ciò implica che la componente legata alle leve della comunicazione e distribuzione deve essere esplicitata nel bilancio dell'impresa, attraverso le relative componenti patrimoniali (immobilizzazioni immateriali) ed economiche (costi fissi e costi variabili).

Le caratteristiche che connotano il prodotto nell'immaginario del consumatore si trasformano in parametro di scelta di acquisto attraverso il prezzo, il quale agisce quindi come un convertitore della qualità in valore. Per un'impresa che si relaziona con uno specifico mercato di riferimento il prezzo diviene una variabile di scelta del marketing mix e, di conseguenza, anche l'ipotesi che l'imprenditore agricolo sia un *price taker* deve essere riconsiderata, nella consapevolezza che ciò determina una profonda revisione metodologica, in particolare per quanto riguarda gli strumenti di analisi preventiva dei risultati dell'impresa agraria.

Quelle citate sono solo alcune delle ricadute dell'evoluzione del comparto agroalimentare e, più in generale, della società sulla gestione dell'impresa agraria. È necessario che la didattica le faccia proprie inquadrandole in un contesto teorico che aiuti gli studenti a interpretare la realtà e in strumenti utili a fini gestionali.

3.4. Rigenerazione territoriale

L'importanza economica, ecologica e culturale che negli ultimi anni è stata attribuita al recupero dei valori e delle tradizioni delle società contadine (Van der Ploeg, 2012), così come il crescente interesse turistico per i contesti rurali (Flanigan *et al.*, 2014; Torquati *et al.*, 2017; Streifeneder e Dax, 2020), hanno offerto alle aree più fragili del Paese nuove opportunità per sperimentare sentieri alternativi di sviluppo locale centrati sulle produzioni agro-alimentari (Rastoin, 2010).

Le pratiche sottese ai nuovi modelli di sviluppo rurale, oltre ad essere ecologicamente sostenibili, risultano anche altamente rigenerative per le piccole comunità montane o interne (Dax, 2020), la cui sopravvivenza continua ad essere minacciata da gravi fenomeni di spopolamento e dal conseguente invecchiamento della popolazione (De Rubertis, 2019).

Gli incoraggianti segnali di ripresa registrati dai territori che sono riusciti a conservare accettabili equilibri agroecologici, attraverso la cura delle risorse endogene naturali e culturali (materiali e immateriali), possono costituire quindi un modello di riferimento e al contempo una sfida professionale dei futuri laureati in scienze agrarie, che, evidentemente, dovranno disporre anche di nuove conoscenze e competenze, oltre a quelle tradizionalmente proposte dai corsi di economia dell'impresa agraria.

Un primo ambito di approfondimento dovrebbe riguardare i processi di organizzazione (e funzionamento) della governance territoriale (Esparcia e Abbasi, 2020). La nuova articolazione delle politiche di sviluppo rurale impone infatti il coinvolgimento di un maggior numero di attori rispetto al passato (De Rubertis *et al.,* 2012), chiamando direttamente in causa anche le aziende agricole, cui è richiesta l'adozione e l'applicazione di nuovi approcci e strumenti di progettazione per l'accesso alle risorse finanziarie messe a disposizione dall'Unione Europea nell'ambito dei grandi quadri di policy (Stoustrup, 2022). Tale accesso è subordinato alla qualità della progettazione, valutata secondo procedure (più o meno) severe di selezione, con particolare riferimento alla coerenza della stessa con i programmi di sviluppo regionali/transregionali.

Un secondo ambito di approfondimento è riconducibile alle scelte di marketing delle imprese agrarie. La diversificazione produttiva costituisce infatti la traiettoria elettiva delle retoriche e delle pratiche dello sviluppo rurale (Hernández-Mogollón *et al.*, 2011; Lange *et al.,* 2013; Tonner e Wilson, 2015; De Rosa *et al.*, 2019) imponendo alle aziende un approccio necessariamente diverso alle questioni della scelta dei canali distributivi

e delle modalità di commercializzazione delle produzioni (Marsden *et al.*, 2000; Renting *et al.,* 2003; Bazzani e Canavari, 2013; Ventura *et al.*, 2016), che influenzano inesorabilmente anche le decisioni riguardanti le stesse attività di differenziazione di prodotto e di processo.

Un terzo ambito di analisi, strettamente legato ai primi due, è quello della valorizzazione del patrimonio culturale sotteso alle pratiche agricole e al turismo rurale (Belliggiano *et al.,* 2021). L'implicita centralità dell'agricoltura nella convenzione di Faro, in quanto naturale custode del patrimonio immateriale dei contesti rurali (Ray, 2001), offre infatti alla stessa nuove opportunità per contribuire alla rigenerazione delle aree interne o marginali (Paffarini *et al.*, 2021; Bindi *et al.*, 2022), sollecitando le imprese verso nuovi obiettivi produttivi e nuove forme organizzative (Belliggiano *et al.*, 2020), mobilitate in una più diretta partecipazione ai processi di programmazione dello sviluppo del territorio (Labianca *et al.*, 2020).

Tale condizione non interferisce con la primigenia natura produttivista dell'agricoltura, ma sollecita le aziende ad introdurre e ad integrare l'offerta primaria con altri beni o servizi (Arru *et al.*, 2019), al fine di internalizzare in fase di commercializzazione le esternalità ambientali e sociali generate dalle normali pratiche agricole.

Da tali considerazioni emergerebbe una domanda formativa diversa, da sviluppare in forma integrata agli argomenti più tradizionali dei corsi di economia dell'impresa agraria (quali il bilancio consuntivo di esercizio e il bilancio preventivo globale), tra questi: a) conoscenze e competenze che consentono al laureato in agraria di supportare le imprese agricole nei processi di organizzazione e di partecipazione alla governance territoriale cui le stesse appartengono (GAL, SNAI, GO-PEI, Biodistretti, Contratti di fiume, ecc.) (Navarro *et. al.*, 2016; Basile e Cavallo, 2020; Molina *et al.*, 2021; Giarè e Vagnozzi, 2021; Dias *et al.,* 2021; Rovai e Andrioli, 2016); b) conoscenze e competenze per supportare il riposizionamento delle micro e delle piccole imprese agroalimentari sul mercato, considerato il successo dei farmers' market o dei GAS (Brunori *et al.*, 2011; Viganò *et al.*, 2012), così come di tutte le altre tipologie di filiera corta riconducibili alle crescenti opportunità commerciali offerte dalle ICT (Ievoli *et al.,* 2019); c) conoscenze e competenze per riprogettare l'organizzazione e la gestione di un'impresa agricola impegnata in attività turistiche (Lupi *et al.,* 2017); d) conoscenze e competenze per stimolare e accompagnare i processi di stakeholder engagement e/o di *capacity building* (Cavicchi *et al.*, 2013; Tomasi *et al.,* 2021; Bindi, 2022).

3.5. Salvaguardia e rigenerazione delle risorse naturali

Il tema della salvaguardia e rigenerazione delle risorse naturali è stato trattato in stretto collegamento con il tema della transizione ecologica intendendola come il passaggio o la trasformazione da un sistema produttivo non sostenibile dal punto di vista dell'impiego delle risorse, a un modello che invece ha il proprio punto di forza nella sostenibilità ambientale, sociale ed economica.

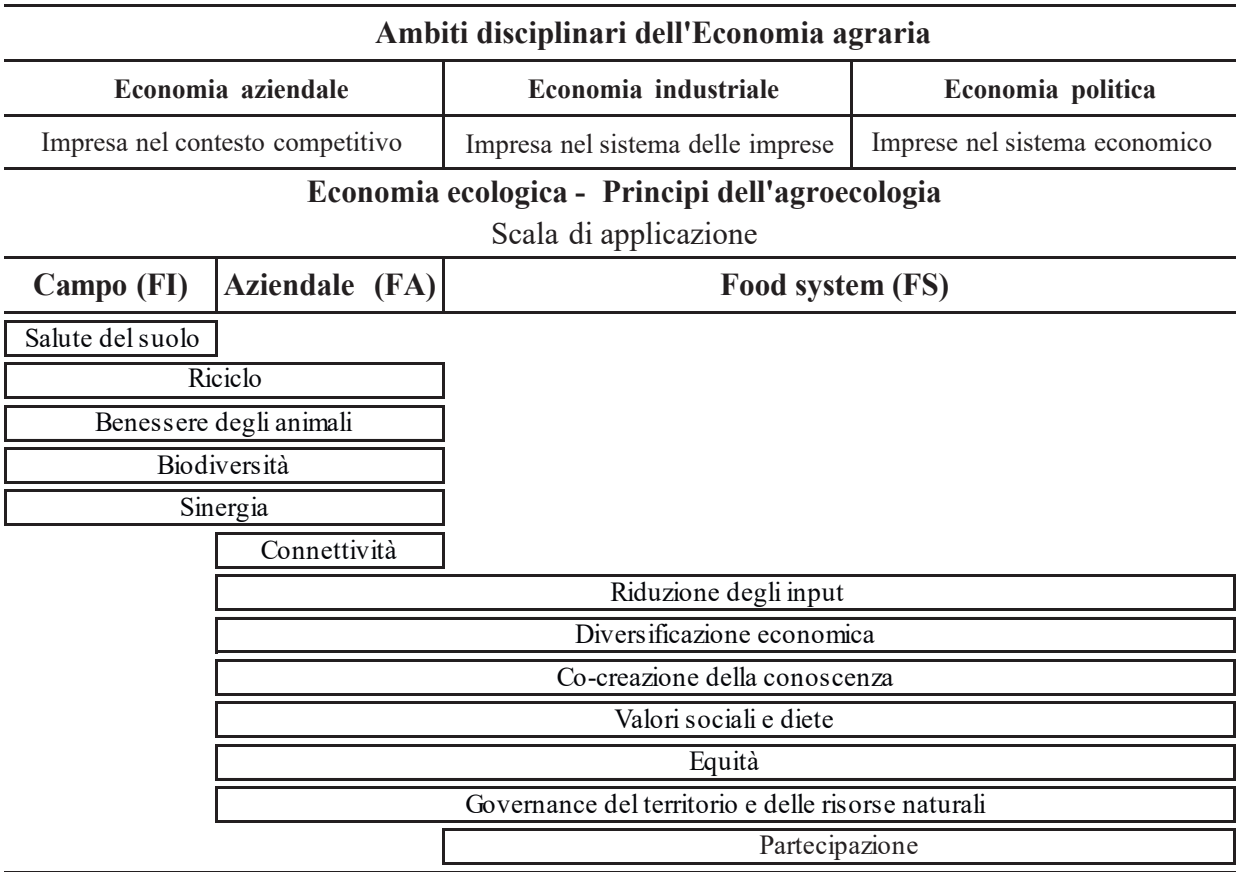
L'approccio suggerito è quello di legare l'agroecologia allo studio, e quindi alla didattica, dell'impresa agraria per gestire agroecosistemi sostenibili dal punto di vista economico, sociale e ambientale a scala aziendale. Ciò comporterebbe un cambio di paradigma importante perché il riferimento diventa l'Economia ecologica, definita scienza della sostenibilità, che utilizza un approccio transdisciplinare basato sull'assunzione che il sistema economico è incorporato in un sistema sociale, che a sua volta è incorporato in un sistema ecologico (Cosme *et al.*, 2017). Ciò significa riconoscere la necessità di rendere l'economia più consapevole della sua dipendenza dal sistema ecologico (biosfera) (Costanza, 1989). Secondo l'economia ecologica molti dei problemi ambientali sono causati dal livello delle attività economiche che vanno oltre i limiti dell'ecosistema (Daly e Farley, 2011) e non dal fallimento del mercato (ad esempio le esternalità negative) come sostiene l'economia neoclassica.

La scienza che applica i principi ecologici alla progettazione, sviluppo e gestione dei sistemi agricoli sostenibili è l'agroecologia mentre l'economia agroecologica valuta, dal punto di vista economico, le conseguenze ecologiche dei metodi di produzione agricola (Wojtkowski, 2010).

L'agroecologia, oggi, conta 13 principi (attinenti alla scala di field e/o farm e/o food system) che in parte sono associati alla gestione agricola ed ecologica dei sistemi agroalimentari, e in parte sono associati ad alcuni principi socioeconomici, culturali e politici di più ampio respiro (Wezel *et al.*, 2020). Pertanto, introdurre i principi dell'agroecologia all'interno della didattica dell'impresa agraria vuol dire intercettare tutti e tre gli ambiti disciplinari presi in considerazione in questo studio (Figura 2).

Uno dei problemi sul tappeto è come fare per misurare il livello di transizione ecologica a livello aziendale e, di conseguenza, indirizzare le scelte nella giusta direzione. La FAO ha costruito un tool per misurare le performance agroecologiche a livello aziendale. Si tratta di una specie di rating di sostenibilità (chiamato rating ESG, Environmental, Social and Governance) costruito in tre fasi: 1) individuazione di 10 elementi connessi alla

Figura 2. Ambiti disciplinari dell'Economia agraria e principi dell'agroecologia



agroecologia; 2) caratterizzazione di tali elementi in base alla transizione agro-ecologica; 3) misurazione attraverso una scala da 0 a 4 (FAO, 2019). Alcuni ricercatori (Wezel *et al*., 2020) hanno poi associato i tredici principi dell'agroecologia ai dieci indicatori proposti della FAO, suggerendo un interessante strumento di lavoro.

Per gli economisti agrari, che si occupano di transizione ecologica, è importante comprendere il legame/connessione tra i principi dell'agroecologia, l'economia ecologica e le discipline economico agrarie. Un primo gruppo di cinque principi dell'agroecologia (riciclo, salute del suolo, benessere animale, biodiversità, sinergia) interessa l'impresa agraria esclusivamente nel suo contesto competitivo (economia aziendale). Un secondo gruppo costituito dai principi della diversificazione e dell'equità interessa l'impresa nel contesto competitivo e in quello di filiera produttiva. I principi della riduzione degli input, della connettività, della creazione della conoscenza, dei valori sociali e diete, della governance del territorio e delle risorse interessa l'impresa in più contesti di indagine (contesto competitivo, pianificazione territoriale e gestione ambientale, sviluppo rurale e filiere). Infine, il principio della partecipazione interessa l'impresa quale attore di un comprensorio e delle filiere produttive.

L'applicazione e lo studio a scala aziendale della transizione ecologica implica l'uso di strumenti e metodologie che permettano di analizzare, rendicontare, gestire e migliorare la sostenibilità aziendale. Alcuni strumenti fanno già parte della cassetta degli attrezzi dell'economista agrario (ad esempio, valutazione del rischio, life cycle assessment, carbon footprint, water footprint, business model canvas), altri devono essere introdotti e contestualizzati alla realtà dell'impresa agraria (ad esempio, bilancio di sostenibilità, bilancio sociale, rating ESG, ecological footprint, sLCA, sustainability business model canvas).

Per concludere, si ribadisce che il profondo legame tra la sfida della sostenibilità e l'aumento della complessità delle strategie e delle funzioni che le imprese agricole sono chiamate a svolgere è un dato di fatto (Malorgio e Marangon, 2021) così come sembra indiscutibile il contributo dell'istruzione superiore alla transizione verso la sostenibilità (Maini *et al.,* 2021).

4. GLI STRUMENTI: METODI DI ANALISI, PIANIFICAZIONE E PROGRAMMAZIONE

Gli strumenti sono tradizionalmente parte degli insegnamenti legati all'impresa agraria. Costituiti da un ampio insieme di metodi e procedure, gli strumenti compongono la cassetta degli attrezzi che gli economisti agrari utilizzano per affiancare l'imprenditore e il policy-maker in fase di scelta. La natura dei problemi e l'ambito disciplinare delle analisi, così come gli obiettivi, le priorità e le metodologie operative adottate spiegano la loro ampia diversità. Sebbene l'impresa abbia sempre il ruolo centrale nelle analisi, le dimensioni analitiche, la rappresentazione e le regole di comportamento dell'impresa differiscono profondamente tra gli ambiti disciplinari. I continui cambiamenti interni al sistema economico, sociale e istituzionale pongono problemi nuovi modificando le priorità e gli obiettivi da raggiungere. Nel corso degli anni, il settore agricolo è stato chiamato a contribuire a obiettivi molto diversi: aumentare la produzione nazionale; produrre alimenti abbondanti e a costi minimi (favorire lo sviluppo economico del paese); riequilibrare i mercati agricoli (accrescere l'efficienza economica nazionale); potenziare i servizi agro-ecosistemici e la multifunzionalità (attuare lo sviluppo sostenibile), e oggi, consolidare i sistemi alimentari sostenibili (realizzare la transizione agro-ecologica). Ciascun obiettivo ha sollecitato lo sviluppo di metodi e strumenti operativi che hanno fatto propri i nuovi concetti elaborati dalla disciplina economica quali non-rivalità e bene pubblico (Samuelson, 1954), esternalità negativa (Coase, 1960), sostenibilità dello sviluppo e resilienza, a cui hanno contribuito l'economia ambientale e l'economia ecologica (Georgescu-Roegen, 1976; Martínez-Alier, 1987; Costanza, 1992).

Nel tempo, ai più tradizionali strumenti del bilancio di esercizio e ai giudizi di convenienza economica si sono affiancati i bilanci preventivi, gli strumenti di analisi comparata dell'efficienza aziendale e i metodi ottimizzanti coerenti con gli obiettivi più produttivistici (De Benedictis e Cosentino, 1979). Successivamente, si sono aggiungi gli strumenti per l'analisi dell'organizzazione della produzione in ambito aziendale (Romagnoli, 1996), per l'analisi strategica dell'impresa e dei modelli di business (Gorgitano e Torquati, 2003; Osterwalder e Pigneur, 2010), per l'organizzazione delle catene produttive e per i mercati agricoli non concorrenziali (Ahumada e Villalobos, 2009; Gorgitano e Sodano, 2019b). Più di recente sono stati sviluppati strumenti per l'analisi dei servizi eco-sistemici (Sukhdev *et al.*, 2014) quali i simulatori di esternalità (Donatelli *et al.*, 2009), modelli bio-economici (Stokle e Donatelli, 1997; Attonaty *et al.*, 2005; Flichman, 2011; Holzworth, 2015), strumenti di analisi della sostenibilità dell'impresa (Howes, 2002; Hani *et al.*, 2003) e delle supply-chain (Scialabba *et al.*, 2014), della multifunzionalità e delle esternalità negative dovute ai gas clima alteranti (Howes, 2002; Hani *et al.*, 2003; Gerrard, 2012; Curran, 2012; Sukhdev *et al.*, 2014; Broeze, 2021). Infine, più recenti sono gli strumenti di gestione partecipata all'uso delle risorse naturali e della produzione lungo la filiera produttiva (D'Aquino, 2016) e gli strumenti a supporto della transizione ecologica (FAO, 2019). Nel tempo è condivisa la rappresentazione dell'impresa come sistema aperto verso l'esterno il cui comportamento è sempre più articolato in dimensioni e fenomeni diversi, i cui effetti oltrepassano i confini fisici dell'impresa e dell'attività agricola (Sodano e Gorgitano, 2022). Rispondendo a obiettivi diversi, gli strumenti più recenti non hanno sostituito ma affiancato quelli tradizionali, che conservano la loro validità nei limiti dei problemi di scelta per i quali sono stati sviluppati. Costituiscono la cassetta degli attrezzi strumenti sempre più diversi per natura delle scelte (lungo o breve periodo), approccio (globale o parziale), procedura adottata (ottimizzante vs non-ottimizzante), obiettivi (mono vs multi-obiettivo), criteri di scelta (mono vs multicriterio) ed effetti considerati (economici, ambientali, sociali).

Una didattica innovata nei temi richiama inevitabilmente la necessità di rinnovare anche gli strumenti di aiuto alle decisioni. Due vie consentono tale risultato: la selezione degli strumenti più coerenti ai nuovi temi e la ridefinizione del ruolo degli strumenti nella formazione. Nella didattica dell'impresa agraria, gli strumenti costituiscono il ponte tra la teoria e i casi reali, indispensabile per una disciplina applicata. Tuttavia, il loro ruolo funzionale nella didattica e la finalità della formazione possono differire profondamente secondo la relazione di precedenza (verso) che lega teoria e caso reale. Se tradizionalmente la relazione va dalla teoria al caso reale, il fulcro dell'analisi è la teoria, lo strumento è al suo servizio per assicurarne un'applicazione pratica. La semplificazione della complessità del particolare caso reale è inevitabile. La formazione rafforza il pensiero convergente e la proposta di soluzioni ottenute applicando uno stesso set di regole, conoscenze e strategie. Al contrario, se la relazione va dal caso reale alla teoria, il fulcro dell'analisi è il caso di studio con la sua unicità e complessità, l'analisi può avvantaggiarsi del contributo analitico di più teorie. Gli strumenti e le teorie sono ora al servizio del caso reale rafforzando una maggiore consapevolezza critica sia nelle fasi di analisi (pluralità di teorie) che di valutazione dei risultati attesi (limiti operativi degli strumenti). In tal modo, l'attività formativa incoraggia il pensiero divergente, l'abilità di analisi e la proposta di

soluzioni più articolate e coerenti con il caso di studio.

Affinché gli strumenti di aiuto alle decisioni possano diventare effettivo ponte fra il sapere teorico-metodologico offerto negli insegnamenti e la pratica operativa, è necessario riconsiderare la loro posizione nei cicli di formazione. I laboratori tematici quali attività formative autonome appaiono la soluzione didattica più promettente. Già adottati da alcuni corsi di studio universitari, possono essere previsti in tutti i cicli di studio per raggiungere differenti obiettivi formativi.

Nelle lauree di primo livello possono essere fondamentali per avvicinare gli studenti allo studio dell'Economia agraria, nelle lauree magistrali e nei master i laboratori tematici devono assicurare l'acquisizione di competenze elevate orientate alla ricerca operativa e alla consulenza professionale, combinando conoscenze specifiche sui singoli strumenti di analisi con quelle di base (economia politica e analisi delle politiche), affiancate da competenze di corredo sia tecnico-operative (analisi dei dati, redazione di un piano) che teorico-operative (metodi di negoziazione multi-attore e di valutazione partecipata). Per quanto ben progettato, nessun laboratorio tematico può presentare un insieme così diverso di competenze. Pertanto, è indispensabile uno stretto coordinamento tra gli insegnamenti economici nei diversi livelli di studio. I percorsi di formazione devono essere ripensati come delle filiere di conoscenza nelle quali i laboratori tematici costituiscano occasione di analisi delle imprese e del loro contesto competitivo per sviluppare usi pertinenti, consapevoli e critici degli strumenti presenti nella cassetta degli attrezzi degli economisti agrari.

5. METODOLOGIE DIDATTICHE INNOVATIVE E COLLABORAZIONE UNIVERSITÀ-IMPRESA

Negli ultimi anni le Politiche per l'innovazione e per lo sviluppo regionale hanno dato maggiore rilievo al ruolo delle università quale motore di sviluppo economico e sociale favorendone l'attività di ricerca e d'innovazione con i fondi della Politica di coesione e dei programmi Urbact, Erasmus+ e Horizon. Non meno importanti due iniziative patrocinate dalla Commissione europea l'University-Business Forum e l'European Week of Regions and Cities, che hanno avuto il merito di far conoscere su ampia scala i modelli della tripla elica (Etzkowitz, 2008) e della quadrupla elica (Ranga e Etzkowitz, 2013) secondo i quali l'innovazione è il risultato di un processo d'interazione tra l'università, i decisori politici, gli operatori economici e le comunità locali. Termini quali modelli multi-attore, stakeholder engagement, gruppi operativi, living labs, lighthouses hanno rapidamente caratterizzato i più recenti bandi di finanziamento e sono entrati nel vocabolario dei ricercatori chiamati a favorire i processi partecipativi, a promuovere i contratti di rete o delle altre forme di aggregazione territoriale e le iniziative finalizzate alla co-creazione di valore (Cavicchi *et al*., 2021). Tale approccio riconosce all'università il ruolo di attore-chiave all'interno dei sistemi territoriali ed è accompagnato dall'elaborazione di una pluralità di procedure e strumenti capaci di favorire l'attivo coinvolgimento delle diverse tipologie di stakeholders attorno all'idea di sviluppo comune (Tomasi *et al*., 2021). In agricoltura, l'iniziativa europea di Partenariato Europeo per l'Innovazione produttività e sostenibilità dell'agricoltura (PEI-AGRI) e i Gruppi Operativi previsti dalla Misura 16 dei Programmi di Sviluppo Regionali ne sono solo gli esempi più noti.

L'interazione tra università e impresa diventa quindi sempre più frequente ed è istituzionalizzata in quella che si chiama Terza Missione. Tuttavia, al momento tali attività sono vissute dai docenti molto spesso come impegno straordinario, che va oltre i compiti istituzionali della didattica e della ricerca. Inoltre, nonostante questo tipo di attività possa rappresentare uno strumento didattico importante per l'acquisizione di competenze-chiave e trasversali, gli studenti non sono sempre coinvolti direttamente in questi percorsi di sviluppo. L'attività di formazione in contesti informali di apprendimento nei quali attuare percorsi di apprendimento formale costituisce un ulteriore ambito di apprendimento, che espone gli studenti al dialogo con i saperi, valori ed istanze di diverse comunità e diversi stili imprenditoriali. Questo tipo di processo è stato facilitato negli ultimi anni da programmi di finanziamento come l'Erasmus+, in particolare attraverso le *Knowledge Alliances* e le *Strategic Partnerships* finalizzate a incentivare il dialogo tra soggetti, la mobilità internazionale, lo sviluppo di metodologie didattiche innovative, favorendo gli approcci pedagogici costruttivisti.

Questi approcci richiedono un ripensamento del modo di operare sia dei docenti che degli studenti. Per il docente, agire in contesti di apprendimento informali implica una revisione del proprio insegnamento e del modo di fare ricerca senza contrapporre l'azione di insegnare a quella di ricercare, ma provando a individuare la loro sintesi in un'attività comune a entrambe: l'apprendimento. L'apprendimento scientifico associato ai percorsi di ricerca può essere potenzialmente insegnato agli studenti. Il contesto può essere interpretato come prodotto di ricerca, ma soprattutto come processo di ricerca. Allo stesso modo, l'insegnamento può essere interpretato come un'esplorazione del mondo, piuttosto che una trasmissione diretta di informazioni dal mondo. Da questa

esplorazione possono aver origine nuove domande di ricerca che, se affrontate con rigore scientifico insieme ai propri studenti, possono avere il duplice valore di un approccio originale da pubblicare su riviste accademiche e di una risposta a problemi indicati dagli stakeholders di riferimento.

Per lo studente apprendere direttamente sul territorio diventa l'occasione per interagire in maniera positiva con "l'età della super complessità" (Barnett, 2000) caratterizzata da sfide sempre più globali e interconnesse. Inoltre, la possibilità di apprendere in un contesto reale favorisce il suo processo di costruzione della conoscenza epistemologica e del pensiero critico che, fondamentali nel percorso di professionalizzazione, costituiscono una potente leva motivazionale per favorire il suo successo negli studi (Paviotti e Cavicchi, 2019).

Operativamente l'organizzazione di tali percorsi formativi richiede che il docente si impegni in attività preliminare di stakeholder engagement. Appare chiaro che la didattica in contesti di apprendimento informale aggiunge un'ulteriore complessità alle attività del docente, gli richiede ulteriori conoscenze e ulteriori abilità quali la comprensione e la mediazione del contesto, il supporto all'interpretazione critica del dato raccolto, la capacità di coinvolgere attivamente gli attori che operano in un territorio perché abbiano un ruolo attivo nel processo di formazione (Aleffi *et al.*, 2020).

In sintesi, sotto la pressione esercitata dalle *policies* e dalle grandi sfide globali, la comunità scientifica e docente vive una fase di grande cambiamento che la spinge a riconsiderare il proprio compito superando la tradizionale separazione tra didattica, ricerca e terza missione. Il ricercatore-docente è chiamato a ripensare al proprio ruolo in maniera olistica, ponendosi al centro di un percorso complesso che tenga insieme ricerca, didattica e le attività d'internazionalizzazione, facilitazione e co-creazione di conoscenza nell'ambiente economico e sociale di riferimento.

6. DIDATTICA E INTERNAZIONALIZZAZIONE DEI CORSI DI STUDIO: OPPORTUNITÀ E CRITICITÀ

Nelle riflessioni sui temi e sui metodi didattici relativi all'impresa agraria non poteva infine mancare un accenno al tema dell'internazionalizzazione. Negli ultimi anni, l'onda lunga del calo demografico e la conseguente contrazione delle immatricolazioni universitarie degli studenti italiani hanno posto gli atenei di fronte al serio rischio chiusura di corsi e sedi (Almalaurea, 2020). Una delle strategie adottate in risposta a questo problema è stata la proposta di corsi di laurea erogati in lingua veicolare e destinati a studenti provenienti da paesi esteri. Ad oggi, gli atenei italiani, sostenuti anche dalla premialità nell'assegnazione dei funzionamenti ministeriali, hanno attivato 595 corsi internazionali, pari a circa il 10% dell'intera offerta formativa nazionale, 132 dei quali sono stati attivati in tre dei grandi atenei italiani (Bologna, Padova e Roma La Sapienza). Sono 23 i corsi di laurea internazionale a indirizzo agrario-alimentare/enologico-forestale, tra i quali una laurea triennale e 22 corsi di laurea magistrale, che erogano complessivamente 2.820 crediti di cui 328, pari al 12%, attribuiti al settore scientifico disciplinare di Economia ed Estimo rurale (fonte Universitaly, 2023).

I corsi di studio in lingua veicolare hanno permesso di attrarre un maggior numero di studenti internazionali, consentendo di rispondere alle domande di un mercato del lavoro sempre più globale di cogliere migliori opportunità di lavoro. Oltre alle maggiori risorse finanziarie nazionali, i corsi di laurea internazionali possono accedere più facilmente a partenariati e ad alleanze strategiche e ricevere finanziamenti comunitari e internazionali. Le regole per la loro progettazione didattica e per il reclutamento dei docenti sono più flessibili rispetto a quelle dei corsi di studio ordinari.

A fronte di questi vantaggi, l'istituzione di un corso internazionale pone gli atenei davanti a una sfida complessa in termini organizzativi e finanziari, poiché richiede una speciale attenzione alla costruzione della reputazione internazionale e del ranking, al miglioramento delle strutture e dei servizi agli studenti per portarli a livelli comparabili a quelli dei principali competitors internazionali, alla formazione del personale tecnico-amministrativo, agli investimenti nella promozione dell'offerta formativa adeguando linguaggi e strumenti di comunicazione. Inoltre, se il corso internazionale prevede un doppio titolo, particolari difficoltà si incontrano nella fase di armonizzazione delle procedure di accreditamento e nelle regole di progettazione della struttura del corso di studi (Kloehn, 2020) perché la legislazione italiana rende particolarmente difficoltosa l'attuazione di percorsi di titolo congiunto e conseguentemente il rilascio di una European Degree Label.

I corsi internazionali costituiscono una sfida anche di natura strettamente didattica perché i punti di forza e di debolezza delle metodologie di didattica innovativa vengono a essere amplificati dal contesto internazionale. Tipicamente, il docente si confronta con una platea di studenti da un lato disomogenei per background formativo, dall'altro costituiti da individui molto motivati ed esigenti che spesso hanno familiarità con metodi didattici fondati sul maggiore coinvolgimento degli studenti, sul peer-to-peer learning, sui giochi di ruolo, sulla rifles-

sione critica. Inevitabile il maggiore impegno richiesto ai docenti nel progettare l'insegnamento e nel ripensarne i contenuti, così come nel ridefinire il proprio ruolo nella classe, nel rafforzare/adeguare le proprie competenze linguistiche. Tutto questo a fronte di un'esperienza molto interessante, che offre al docente e allo studente l'opportunità di modificare i metodi d'insegnamento, offrendo l'opportunità di sperimentare nuovi contenuti e l'interdisciplinarietà (Secco *et al*., 2020).

Come esempio dello spazio che la didattica del settore scientifico-disciplinare Economia ed Estimo rurale può assumere nel contesto di un corso di laurea internazionale, raccogliendo molte delle suggestioni di contenuto, approccio e metodologie didattiche discusse nei precedenti paragrafi, viene riportato il caso di uno specifico curriculum del corso internazionale di Laurea Magistrale in *Forest Science* offerto dall'Università di Padova fin dal 2014. Durante il corso è realizzato un percorso di specializzazione in *Social and Environmental Responsibility in Forestry* (55 crediti complessivi), i cui contenuti fanno riferimento all'ambito dei servizi ecosistemici, in particolare alla loro valutazione, agli strumenti di valorizzazione (pagamenti servizi ecosistemici, certificazioni volontarie, responsabilità sociale di impresa, sviluppo dei mercati connessi), al raccordo con le politiche internazionali, alla governance dei sistemi a diversa scala e alle capacità di promuovere e gestire la partecipazione dei portatori di interesse e i conflitti. Questa offerta, che risponde in pieno alla crescente domanda di formazione a livello internazionale di *green jobs* per la gestione, conservazione e valorizzazione delle risorse naturali e forestali (UNECE FAO, 2018), ha consentito al corso di *Forest Science* di assumere un ruolo di riferimento nel contesto della formazione universitaria europea delle scienze forestali, concretizzata con la partecipazione a ben 4 iniziative di doppio titolo, di cui 3 finanziate tramite bandi competitivi *Erasmus Mundus* mentre la quarta coinvolge le principali università canadesi impegnate nell'insegnamento delle Scienze Forestali.

7. CONSIDERAZIONI PER UN ULTERIORE DIBATTITO

Il tema della transizione ecologica ha richiamato l'attenzione degli economisti agrari sul ruolo decisivo che le imprese sono chiamate ad avere nell'attuale processo di cambiamento del settore agricolo. Il nuovo indirizzo di gestione dei sistemi agricoli, denominato agroecologia, pone come prioritaria la creazione di un legame stretto tra equilibrio dell'ecosistema e benessere dei singoli, così come indicato dall'economia ecologica. Secondo questa prospettiva di analisi l'agricoltura è un sottosistema (aperto), parte del sistema economico, a sua volta parte del sistema sociale (aperto) incluso nell'ecosistema naturale che è, invece, un sistema finito e chiuso. Pertanto, quanto avviene in un particolare agro-sistema, attraverso la mediazione operata dal sistema economico e da quello sociale, ha ripercussione sull'ecosistema naturale e al contempo ne è influenzato. L'integrazione tra produttività, stabilità, sostenibilità ed equità caratterizza l'applicazione dei principi dell'agroecologia alla produzione sostenibile dei prodotti sia alimentari che non food.

In questo nuovo contesto, il ruolo dell'istruzione universitaria quale volano del processo di transizione ecologica del settore agricolo è cruciale per incoraggiare una nuova imprenditorialità, favorire un processo di creazione delle innovazioni diffuso e multi-attore, incoraggiare il rinnovamento della consulenza in agricoltura. La transizione ecologica sollecita la riflessione su più aspetti della didattica universitaria: i temi, la natura e il ruolo degli strumenti di aiuto alle decisioni, i metodi e le nuove soluzioni organizzative della didattica.

Limitando l'attenzione all'impresa agraria negli insegnamenti che fanno riferimento a più ambiti disciplinari (Economia aziendale, Economia industriale ed Economia politica) del settore scientifico disciplinare dell'Economia ed Estimo rurale, sono stati identificati cinque temi prioritari, che sono una iniziale, ma articolata risposta alla domanda di nuovi contenuti della didattica. I cinque temi (sistemi agrari; distribuzione equa del valore; qualità e valore dei prodotti agroalimentari; rigenerazione territoriale; salvaguardia e rigenerazione delle risorse naturali) diversi per oggetto e per dimensione analitica adottata, condividono la chiave interpretativa sistemica restituendo una lettura multiforme dell'impresa agraria e del suo ruolo nel processo di transizione ecologica.

Il rinnovamento degli strumenti di analisi delle decisioni è parte della proposta dei nuovi contenuti della didattica non solo perché coerenti con i nuovi temi, ma anche per un diverso loro ruolo nel processo di formazione. I laboratori tematici, quali attività autonome di insegnamento, possono favorire l'acquisizione di abilità di analisi di sistemi complessi e multidimensionali come sono quelli agricoli. La finalità ultima della formazione è favorire lo sviluppo di un pensiero divergente che, valutando criticamente il contributo analitico offerto anche da più teorie economiche, possa guidare nell'analisi al fine di proporre soluzioni di intervento che siano originali, inusuali ed efficaci in relazione al contesto studiato.

Il rinnovamento della didattica richiede che gli studenti sappiano dialogare con i saperi, valori e istanze diverse tra le comunità o tra gli imprenditori. A tal fine, è utile una formazione in contesti informali di appren-

dimento extra-universitari nei quali attuare percorsi di apprendimento formale. Fondamentale il ruolo dell'organizzazione di corsi di studio internazionali che, grazie alle regole di progettazione più flessibili, possono costituire l'esperienza per validare su piccola scala sia i nuovi insegnamenti sia i percorsi di formazione per rinnovare i percorsi di studio universitari.

Pensando alla trasposizione di queste indicazioni nei cicli di studi universitari, le soluzioni da adottare dovranno essere necessariamente molto diverse in considerazione del particolare insegnamento universitario (Scienze agrarie, Scienze veterinarie, Economia o altri insegnamenti), dell'indirizzo dei corsi di studi, del livello del ciclo di formazione (laurea triennale, magistrale, master professionalizzanti o di secondo livello) e delle circostanze specifiche di ciascun corso di laurea (quali ad esempio, la finalità della formazione e degli sbocchi professionali, le categorie identificate come potenziali studenti, il peso accordato ai settori scientifici disciplinari). Nonostante questi elementi di variabilità, alcune indicazioni guida possano essere formulate.

In primo luogo, lo studio dell'impresa nei diversi insegnamenti di Economia agraria deve ritrovare un ruolo centrale nella formazione. Tale risultato non deve avvenire per sostituzione degli insegnamenti, come forse è successo negli anni più recenti, bensì ampliando i temi e gli ambiti disciplinari dell'offerta didattica del nostro settore scientifico disciplinare. È indubbio, poi, che la didattica dell'impresa nei vari corsi di Economia agraria debba innovarsi profondamente nei temi, negli strumenti e nei modi della didattica. L'agroecologia richiede un approccio che integri prospettive multiple sia nell'analisi dei problemi che in quella degli effetti delle scelte compiute. Lo spazio limitato accordato allo studio dell'impresa negli insegnamenti di Economia agraria ha costretto a privilegiare i temi più istituzionali e funzionali all'abilitazione professionale. Molti dei temi che in passato erano oggetto delle analisi dell'impresa agraria, come quello delle innovazioni o dell'organizzazione dei piani produttivi, sono stati fatti propri da altre discipline non economiche, proponendone unicamente una loro lettura tecnica, ne sono un esempio l'agricoltura di precisione e la digitalizzazione. Coerente con lo spirito dell'agroecologia e della transizione economica, una lettura che combini l'analisi tecnica, sociale con una valutazione economica, tipica della tradizione degli studi dell'impresa agraria è attuale e fondamentale. Allo stesso modo è necessario coltivare una visione unitaria dell'impresa conservando la diversità di analisi offerte da diversi *corpus* disciplinari dell'Economia agraria, della Politica agraria e dell'Estimo rurale in cui si articola il settore disciplinare dell'Economia ed Estimo rurale.

Con riferimento ai temi della didattica, i cinque temi prioritari costituiscono un insieme di argomenti che possono essere ricombinati in diversi modi e a differenti fini. In alcuni casi i cinque temi prioritari (o solo alcune loro parti) possono essere argomenti del programma di un singolo insegnamento; in altri, possono costituire gli argomenti di specifici insegnamenti inclusi in un gruppo di corsi obbligatori oppure di insegnamenti di profilo, ancora, costituire alternativi percorsi dei cicli di formazione (laurea triennale, magistrale, master di primo o secondo livello).

Un altro elemento centrale è costituito da una equilibrata combinazione tra la didattica formale e la didattica laboratoriale perseguendo fini diversi in relazione ai cicli di studio. Nelle lauree di primo livello, la didattica laboratoriale può essere utile per avvicinare gli studenti alla prospettiva globale e multidimensionale dell'attività di un'impresa agraria, mentre nei cicli successivi di formazione deve consentire l'acquisizione di una capacità di analisi globale e di competenze specialistiche orientate alla ricerca operativa e alla consulenza professionale.

In tutti i casi, infine, è indispensabile uno stretto coordinamento tra gli insegnamenti economici nei diversi livelli di studio ancora più forte e indispensabile che in passato, condividendo una lettura sistemica dei fenomeni. Gli insegnamenti dell'impresa nell'ambito del settore disciplinare dell'Economia ed Estimo rurale devono essere pensati come componenti di una filiera della conoscenza il cui prodotto finale è costituito dalle competenze dei laureati utili per favorire la transizione ecologica dell'agricoltura.

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Short communication

CAP 2023-2027: effects of direct payments internal convergence in Italy

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Abstract. The 2023-2027 CAP reform strongly emphasises Specific Objective 1, targeted to support viable farm income and resilience of the agricultural sector. The new CAP aims to achieve a fairer distribution of income support, in particular for small and medium-sized farms. This does not affect all Member States in the same way, depending on the choices made in previous programming periods. Italy has maintained the allocation of income support based on payment entitlements. Despite the internal convergence process that started in 2015, there are still important differences among farms in the level of unit support. This paper aims to analyse the effects of internal convergence of the Basic income support for sustainability (BISS), according to the Italian decisions established in the CAP Strategic Plan 2023-2027. It exploits administrative micro-data containing the value of each of the 10.5 million payment entitlements stored in Italy in the Entitlement Register of the Integrated Administrative and Control System (IACS). The analyses are based on the development of an original simulation tool replicating the actual implementation methods adopted by Italy for the 2023-2027 period. The results highlight that the internal convergence determines a significant modification to the financial allocation at both farm and territorial levels. Indeed, the internal convergence transfers support from very small and large farms towards small- and medium-sized ones. At the territorial level, the areas with a specialized agricultural sector experience a reduction of support to the benefit of more marginal and rural areas.

Keywords: direct payment, CAP, farm incomes, internal convergence.
JEL codes: Q18, Q12.

HIGHLIGHTS:

- Recommendations by the European Commission asked Italy to advance in the internal convergence process of direct payments to improve the fairness of support and its effectiveness.
- The internal convergence of the Basic income support for sustainability will determine a significant modification in the financial allocation at both farm and territorial levels.

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1. INTRODUCTION

After six decades and numerous reforms, the EU agricultural policy has radically changed its appearance, becoming an increasing community and less common policy, more in keeping with the changed socio-economic context of reference and better equipped to face the numerous challenges of the agricultural sector and rural areas (Buckwell, Tangermann, 1999; De Filippis, Salvatici, 2002; Swinnen, 2008; Sorrentino *et al*., 2011; Erjavec, Lovec, 2017). The role of Member States (MSs) has also changed, becoming crucial not only for the application of the Common Agricultural Policy (CAP) on their territory but also in achieving its objectives. Among the many innovations of the 2023-2027 CAP reform, the most important one, on which the principle of the new delivery model is based, is the fact that the objectives of the CAP are made more explicit: three General objectives detailed into more concrete priorities by nine Specific objectives.

In particular, Specific Objective 1 (SO1) aims «to support viable farm income and resilience of the agricultural sector across the Union in order to enhance long-term food security and agricultural diversity as well as to ensure the economic sustainability of agricultural production in the Union», translating into concrete priorities the (economic) General objective of fostering «a smart, competitive, resilient and diversified agricultural sector ensuring long-term food security». Each MS must contribute to the achievement of SOs based on an assessment of national needs, according to the logic of intervention of the new delivery model. As regards SO1, Commission recommendations to Italy, before the presentation of the CAP Strategic Plan (CSP), highlight the significant differences in the distribution of support, due to the presence of direct payments, (still) based on historical individual references (European Commission, 2020). To strengthen the competitive position and resilience of the agricultural sector, the recommendations ask Italy to advance the internal convergence process of direct payments to improve the fairness of support and its effectiveness, also using other available tools, such as the complementary redistributive income support for sustainability and the reduction of payments. Based on the Observations letter, received on the first draft of the CSP presented in December 2021 (European Commission, 2022a), Italy submitted a revised version of the CSP in November 2022, receiving formal approval on December 2nd (European Commission, 2022b).

The preliminary analyses underlying the Italian CSP (context, SWOT and needs analyses) highlighted the persistence of a gap between agricultural income and the average wage in the rest of the economy, especially for farms of medium-small size. The average agricultural income in terms of Farm Net Value Added per labour unit is approximately 77% of the average wage in the rest of the economy. To significantly reduce this difference, Italy decided to use the Basic income support for sustainability (BISS) and the Complementary redistributive income support for sustainability (CRISS) in a synergic way.

This paper aims to provide an overview of the redistributive effects of BISS internal convergence of CAP 2023-2027 in Italy, looking at the impact on farm size, unit value and territorial level. The national choices concerning BISS can be summarized as follows:

- BISS continues to be granted based on payment entitlements[1];
- Internal convergence is applied continuing to consider Italy as a single region (as for the 2014-2020 CAP reform);
- 48% of the national envelope for direct payments is allocated to BISS, reinforcing the internal convergence process through a progressive equalization of the unit amount of support;
- Internal convergence ensures that all payment entitlements below the national average value reach a value equal to at least 85% of the national average value by 2026, proceeding in four equal steps;
- The maximum loss of those who experience a reduction in the value of payment entitlements (those with a unit value higher than the national average) cannot exceed 30% (stop loss);
- The maximum level for the value of each individual payment entitlement is set at 2,000 euros starting from 2023; this value is subject to convergence, therefore by 2026 it reaches around 1,400 euros;[2]
- The stop loss is calculated not considering the reduction determined by application of the maximum level of value for payment entitlements.

It is worth noting that internal convergence is a process that started in the 2014-2020 CAP reform, at a pace differentiated by MSs according to national choices on the speed of convergence, point of arrival (uniform payment per hectare or historical individual references),

[1] Any payment entitlement is activated, by the farmer, upon declaration of the corresponding eligible hectare. Thus, in general, one hectare corresponds to one payment entitlement. However, one payment entitlement can be activated also declaring an area smaller than one hectare; in that case, the unit value of the payment entitlement is proportional to the area declared.

[2] The maximum level of individual payment entitlements differs from capping, applied by Italy in the 2014-2020 programming period but not confirmed in CAP 2023-2027, as the maximum level is applied on each payment entitlement regardless of the total amount of the Basic Income support received by each farmer.

Table 1. An overview of the EU MSs' choices on basic income schemes (BPS and BISS).

	CAP 2014-2020 Basic payment scheme (BPS)			CAP 2023-2027 Basic income support for sustainability (BISS)		
	Partial convergence	Flat rate	SAPS	Partial convergence	Flat rate	SAPS
Belgium	x			x		
Ireland	x			x		
Greece	x (regional)				x (regional) 2026	
Spain	x (regional)			x (regional)		
Italy	x			x		
Portugal	x				x 2026	
France	x	x (Corsica)		x	x (Corsica)	
Netherlands		X			x	
Austria		X			x	
Croatia	x				x 2026	
Slovenia	x				x	
Malta		X			x	
Luxemburg	x				x 2027	
Germany		x			x	
Denmark		x			x	
Finland		x			x	
Sweden		x			x	
Bulgaria			x			x
Czech Rep.			x			x
Estonia			x			x
Cyprus			x			x
Latvia			x			x
Lithuania			x			x
Hungary			x			x
Poland			x			x
Romania			x			x
Slovakia			x			x

Source: own elaboration based on European Commission (2021) and CAP Strategic Plan webpage (link: https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en#publishednationalstrategicplans).

maintenance or not of payment entitlements and inclusion in Basic Payment Scheme (BPS) of additional land uses not eligible before 2015 (i.e. vineyards, fruit and vegetables) (Henke *et al.*, 2015 and 2018).

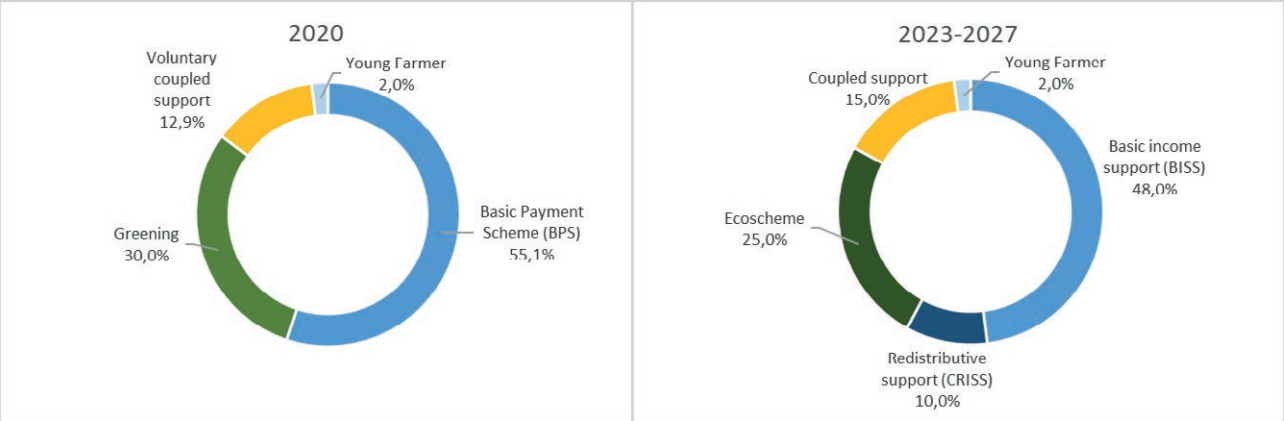
An overview of national choices regarding basic income schemes in the last two periods is provided in Table 1.

Italy chose to maintain payment entitlements and proceed towards a more uniform payment per hectare, without reaching a flat-rate payment. Moreover, Italy decided to not apply for the optional redistributive payment in 2014-2020, which became mandatory for the period 2023-2027. Although from national choices the existence of a "national path dependency" emerges (Henke *et al.*, 2018), the implementation of internal convergence considering Italy as a single region has an important redistributive effect, as highlighted by the European Court of Auditors (European Court of Auditors, 2018)[3].

This paper focuses on the effects of internal convergence in Italy to highlight the redistribution of direct payments based on payment entitlements, to ensure greater equity by reducing the differences among farmers.

[3] «We found that not only the choice of the BPS model but also the criteria for the regional allocation of available budgetary ceilings could have a significant effect on the level of redistribution and farmers could retain particularly high support levels resulting from past production» (European Court of Auditors, 2018, pag. 46, par. 68).

Figure 1. The financial allocation of the national envelope for direct payments in 2020 and 2023-2027.



2. DATA AND METHODS: THE EXPLOITATION OF ADMINISTRATIVE DATA FOR DIRECT PAYMENTS SCENARIOS

On the effects of the internal convergence on farms, a key role is played by the financial allocation of the national envelope for direct payments, which in the 2023-2027 period is quite different from that in 2020. This is due to changes both in new CAP legislation (i.e., the abolition of mandatory "green payment", the introduction of voluntary eco-schemes, the redistributive payment which becomes mandatory starting from 2023) and in national choices following the greater flexibility due to the *new delivery model*. All these changes led to a strong reduction in BISS in Italy. Indeed, while in the previous period the BPS received around 55% of the national envelope and another 30% was compulsorily allocated to greening (payment granted to farmers as a percentage of the total value of entitlements held by each of them), starting from 2023 the share allocated to BISS is 48% (Figure 1).

The definition of the Italian CSP required the development of simulations and analyses to provide timely assessment, during the programming phase, of the effects of different potential scenarios.

Specific tools and models able to simulate and evaluate the impact of such reforms on individual farms need to be developed (Louhichi *et al.*, 2015). This is particularly fitting for internal convergence, which is characterised by another element of complexity: payment entitlements should be determined all together, simultaneously, implying the use of data concerning all farms.

To this aim, an original *EU-wide Simulation tool* (ST) was developed, in accordance with reg. (EU) 2021/2115, within the project New IACS Vision in Action – NIVA (Horizon 2020, Grant agreement n. 842009). The ST can generate simulations relating to 3 procedures:

- Payment entitlements and internal convergence – MS grants the BISS based on entitlements.
- Uniform amount of support per hectare – MS grants the BISS based on eligible hectares.
- Redistributive Payment – related to the CRISS based on eligible hectares.

Therefore, the ST can support policy-makers during the programming phase and in the implementation one, providing an assessment of different scenarios, tailored to MS's decisions; furthermore, it is useful for Paying Agencies in the implementation of the CSP.

In the following sub-sections, a description of data and methods is provided.

2.1. Data: IACS entitlement register

The simulations are based on administrative micro-data stored in Italy in the Entitlement Register, which is one of the main elements of the Integrated Administrative and Control System (IACS). The use of IACS data is needed for the proper implementation of the convergence process (Solazzo, Pierangeli, 2016), as the value of a single payment entitlement affects the value of all the others. The dataset contains information on the eligible area corresponding to each payment entitlement, the monetary value of each payment entitlement (claim year 2020[4]) and the farm identification code, namely the holder of one or more payment entitlements.

The dataset exploited in the simulations contains

[4] 2020 is the latest data available at the moment. It represents a sound proxy for the claim 2022 (indicated in the regulation) because in the period 2020-2022 Italy didn't apply the internal convergence.

10.5 million entitlements (corresponding to 10.04 million hectares) held by about 800,000 farmers in Italy. In general, each entitlement corresponds to an eligible hectare. However, entitlements accompanied by less than one eligible hectare also exist; in this case, the value of the entitlement is proportionally reduced.

Moving from the initial value, the ST quantifies the yearly value of each payment entitlement during the period 2023-2026 based on the MS's decisions in the CSP (see section 2.2).

2.2. Methodology: an EU-wide simulation tool[5]

The ST collects in a single platform the procedures for quantification of CAP Direct Payments based on MS's decisions, according to reg. (EU) 2021/2115 on CSP.

The rules provided by the Regulation on internal convergence are less exhaustive than those provided for the previous convergence of BPS under reg. (EU) 1307/2013 for the period 2015-2019. Therefore, some assumptions (at the bottom of the national choices described in Section 1) were fixed in the development of algorithms and procedures. The assumptions included in the procedures developed in the ST are:

1. the application of a maximum level for the value of individual payment entitlements takes place *ex ante* with respect to the internal convergence process;
2. the contribution to the convergence is guaranteed, first of all, by the financial resources arising from application of the maximum level to the value of payment entitlements (see (1)) and, subsequently, by the reduction of the value of payment entitlements above the average unit value;
3. the reduction of the value of the payment entitlements above the average unit value occurs in proportion to the distance of the entitlement from the average value, taking into consideration only the excess part.

The ST allows simulations on the financial effects of the transition from the BPS to the BISS, quantifying the value of each payment entitlement. To do this, the ST is structured into four phases of the convergence mechanism: i) definition of the value of payment entitlements before convergence; ii) application of the maximum value for each individual payment entitlement and quantification of the related freed-up financial resources; iii) the "minimum guaranteed level"; and iv) the "maximum loss", with a maximum decrease of at least -30% of the initial unit value. Each phase is made up of several steps.

Under the first phase ("Definition of the value of payment entitlements before convergence") the ST determines – according to article 24(1) of reg. (EU) 2021/2115 – the unit value of payment entitlements before convergence by adjusting the value of payment entitlements proportionally to the modification of the national envelope, considering also the payment for greening.

Starting from these new values, the internal convergence process foresees the second phase ("application of the maximum level for the value of each individual payment entitlement and quantification of the related freed up financial resources"), which concerns payment entitlements of higher value than the maximum level. Indeed, according to article 24(3) of the Regulation, MSs finance increases in the value of the payment entitlements under the average unit amount, using the financial resources resulting from application of the maximum level. The maximum level of individual payment entitlement fixed in the Italian CSP is equal to 2,000 euro/ha as from 2023. This value is also affected by the convergence process afterwards.

Under the third stage ("minimum guaranteed level"), the ST aims at ensuring that no payment entitlement shall have a unit value lower than 85% of the average unit amount at national level in 2026. The ST aims at closing part of the gap between the national average in 2026 and the initial unit value of each entitlement in 2023, estimating the financial needs experienced by those farmers who, having an initial value lower than the national average, have the unit value increased by at least 85% of the average unit amount at national level, at the latest by the claim year 2026.

Finally, under the fourth phase ("maximum loss"), the ST applies the maximum loss fixed at -30% of the initial value of each payment entitlement before convergence, for those farmers who finance the internal convergence. This stage is based on a *routine*. So, after the contribution to the third phase (the maximum level is excluded by the quantification of maximum loss), farmers experiencing a decrease higher than -30% of their initial unit value are checked. When this condition is positive, a "stop loss" is applied. The *routine* runs as long as the condition is positive, reallocating at every round a smaller share of contributions exceeding the "stop loss".

3. THE INTERNAL CONVERGENCE EFFECTS DEFINED IN THE ITALIAN CAP PLAN 2023-2027

The process of internal convergence provides for significant changes in the distribution of financial resources among different farm sizes, payment levels and territo-

[5] New IACS Vision in Action (NIVA), funded by the Horizon program (Grant Agreement No: 842009). https://www.niva4cap.eu/project/

Table 2. The internal convergence effects by payment entitlement unit value.

By payment entitlement unit value (rif. 2023 pre-convergence)	BPS+Green (2020) (euro/ha)	2023 pre-convergence* (euro/ha)	2026 (euro/ha)	Envelope effect 2020 vs 2023 (%)	Convergence effect 2023 vs 2026 (%)
0-130	201.4	106.7	142.1	*-47*	*33*
130-167	288.6	152.9	154.2	*-47*	*1*
167-250	354.8	188.0	177.1	*-47*	*-6*
250-500	598.5	317.1	240.1	*-47*	*-24*
500-1,000	1,233.0	653.2	456.8	*-47*	*-30*
1,000-2,500	2,403.4	1,262.0	882.3	*-47*	*-30*
2,500-5,000	6,116.1	2,000.0	1,400.0	*-67*	*-30*
> 5,000	16,330.1	2,000.0	1,400.0	*-88*	*-30*
National average	315.6	167.2	167.2	*-47*	*0*

Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020)
* In the 2023 pre-convergence the maximum level for the value of individual payment entitlements is applied before the internal convergence process in the claim year 2023. *See phase 2 section. 2.2.*

rial contexts. It is worth recalling that the unit value of payment entitlements, on which the internal convergence (2023 pre-convergence) applies, is determined by the value of payment entitlements for the claim year 2022 plus the related payment for agricultural practices beneficial for the climate and environment (greening) proportionally adjusted to the national envelope for BISS 2023-2027.

The analysis focuses only on the convergence effect, identified by comparing the initial year (2023 pre-convergence) and the final year (claim year 2026) of the 2023-2027 CAP reform. This comparison can be considered an intra-programming period effect. The analysis also shows an envelope effect from the comparison between the last year of the previous CAP reform (claim year 2020) and the beginning of the 2023-2027 reform before the application of convergence (2023 pre-convergence), This effect derives from the reduction of the national ceiling for direct payments, by the lower percentage of direct payments allocated to income support (BISS) and by application of the maximum level of payment entitlement. In this case, we can consider it an inter-programming period effect.

3.1. Effects by payment entitlement unit value

With the proportional adjustment between 2020 and 2023, a shift of payment entitlements towards classes with lower unit value is observed (envelope effect; Table 2). Focusing on the convergence effect, two factors affect the process applied at national level: the convergence towards the national average unit amount (equal to 167 euro/ha) and the stop loss (-30%), which safeguards the entitlements with values starting from 500 euro/ha. The unit value of payment entitlements increases in the classes with a unit value lower than the national average, in particular in the group below 130 €/ha. The contribution to this increase is granted by the other classes having a unit value higher than the national average and the reduction is steeper as the unit value increases.

The overall effect of the reform on the total value of payment entitlements is shown in Figure 2, confirming the shift of payment entitlements towards classes with lower unit value.

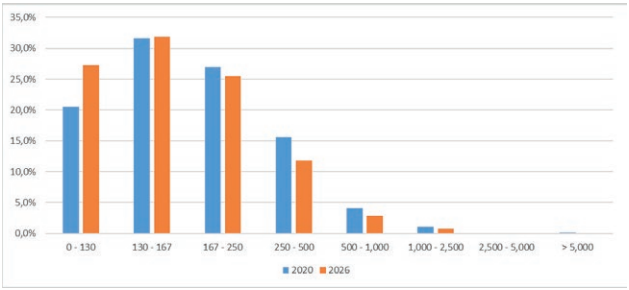
3.2. Farm size effects[6]

The analysis by farm size highlights that the internal convergence involves a net shift of resources in favour of farms belonging to size classes between 3 and 50 hectares with a decreasing benefit (Table 3). While the main contributors to the convergence are farms included in the classes up to 2 hectares and above 50 hectares.

The most significant contribution to the convergence is ensured by the class up to 1 hectare. This result on small farms – quite surprising in the EU context –, is because this class includes farms holding high-value entitlements deriving from the former special entitlements for livestock, entitlements deriving from sec-

[6] The utilisation of administrative data from AGEA allows providing analysis of all farms (about 800 thousand). However, the dataset doesn't allow analysis by farm economic size.

Figure 2. The percentage of distribution of the total value of payment entitlements by class of unit value in 2020 and 2026.



Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).

tors historically highly subsidized and, residually, from speculative activities. Therefore, the CAP reform 2023-2026 strongly affects these realities, (almost) completely neutralizing the entitlement historical reference period and reducing the variability between a minimum of 142 euros/ha and a maximum of 1,400 euros/ha by 2026.

Looking at the overall effect of the reform on the distribution of the total value of payment entitlements by farm size, a slight increase emerges in the share held by farms included in the classes between 3 and 50 hectares (Figure 3).

3.3. Territorial effects: rural areas

The territorial identification of rural areas was used, for the first time, in the Rural Development programming period 2007-2013. The methodology is still applied in the period 2023-2027. The Italian territory is classified into: Urban poles (A); Rural areas with intensive and specialized agriculture (B); Intermediate rural areas (C); and Less developed rural areas (D).

Table 4 shows the modification of the unit values of payment entitlements among territorial classifications defined above: the internal convergence negatively affects the areas characterized by intensive and specialized agriculture (B), historically benefitting from a high level of support, with a reduction of about -7.7% (2023 pre-convergence vs 2026), in favour of a more marginal territorial context localized in inner and mountain areas identified by Intermediate (C) and Less developed rural areas (D), which experiences an increase in the unit value of +2.1% and +6.9% respectively.

The financial allocation is modified accordingly, as shown in Figure 4.

3.4. Combined effects by territorial context and farm size

The effects described in the previous two subsections are, generally, confirmed also in this analysis aiming

Table 3. The internal convergence effects by farm size.

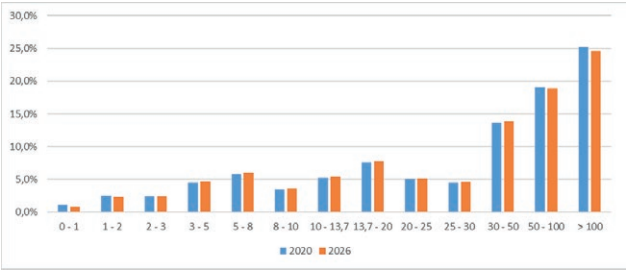
Farm size (ha)	BPS+Green (2020) (euro/ha)	2023 pre-convergence * (euro/ha)	2026 (euro/ha)	Envelope effect 2020 vs 2023 (%)	Convergence effect 2023 vs 2026 (%)
0-1	518.6	270.5	221.2	*-48*	*-18*
1-2	365.0	192.6	179.5	*-47*	*-7*
2-3	318.3	168.3	168.5	*-47*	*0*
3-5	299.9	158.4	164.4	*-47*	*4*
5-8	295.0	155.8	163.0	*-47*	*5*
8-10	297.5	157.2	163.3	*-47*	*4*
10-13.7**	299.6	158.4	163.7	*-47*	*3*
13.7-20	302.8	160.0	164.1	*-47*	*2*
20-25	306.3	162.2	164.8	*-47*	*2*
25-30	306.5	162.3	164.7	*-47*	*1*
30-50	309.0	163.6	165.2	*-47*	*1*
50-100	320.4	169.6	168.1	*-47*	*-1*
> 100	328.3	173.9	170.0	*-47*	*-2*
National average	315.6	167.2	167.2	*-47*	*0*

Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).

* In the 2023 pre-convergence the maximum level for the value of individual payment entitlements is applied before the internal convergence process in the claim year 2023. *See phase 2 section 2.2.*

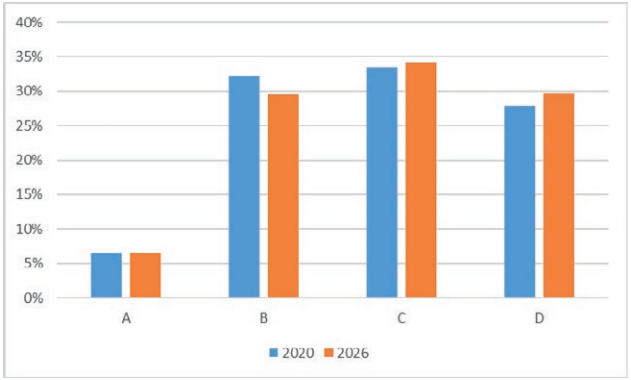
** 13.70 ha is the average farm size at national level observed in IACS – entitlement Register.

Figure 3. The percentage distribution of the total value of payment entitlements by class of farm size (ha) in 2020 and 2026.



Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).

Figure 4. The percentage of distribution of the total value of payment entitlements by rural areas in 2020 and 2026.



Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).

to combine the effect by territorial and farm size, with some peculiarities (Table 5). Indeed, the reduction of the financial contribution for farms up to 1 hectare and, at a lower level, up to 2 hectares is verified in all rural contexts. This means that, on average, these farms contribute to the convergence regardless of their territorial location. However, the situation is different for farms larger than 50 hectares. Their contribution to the convergence is observed only in areas with intensive and specialized agriculture (B) and in urban poles (A), while a positive effect of the convergence is estimated in the other rural areas (C and D).

4. CONCLUDING REMARKS

The debate that accompanied the reform of the direct payments system, starting with the 2003 reform, has raised the question of the justification and fairness of direct payments. With the CAP 2014-2020, the Commission launched a process of internal convergence that aimed to make the unitary payment more uniform, giving MSs the possibility of reaching a flat-rate payment. The CAP 2023-2027 confirmed the need to proceed with a redistribution of support among farms, especially in favour of small and medium-sized ones, advancing the process of internal convergence and making the redistributive payment mandatory. Also in this case, Italy has confirmed its willingness to keep a part, albeit residual, of the payments based on historical references, to avoid destabilizing changes in the value of payment entitlements for farms. However, the choice to apply the convergence considering Italy as a single region determines, as in the past reform, redistribution of support between territories, as the higher value unit payments are geographically concentrated by virtue of the historical production systems (Pupo D'Andrea, 2014). This evidence was also highlighted by the European Court of Auditors (2018), according to which «Italy […] decided to define only one region with a 2019 target value per hectare of around 217 euro. The redistribution of support from

Table 4. The internal convergence effects by rural areas, euro/ha.

	BPS+Green (2020) (euro/ha)	2023 pre-convergence * (euro/ha)	2026 (euro/ha)	Envelope effect (%)	Convergence effect (%)
A	317.7	167.9	167.4	*-47*	*0*
B	376.0	198.6	183.3	*-47*	*-8*
C	302.3	160.1	163.5	*-47*	*2*
D	278.2	147.3	157.5	*-47*	*7*
National average	315.6	167.2	167.2	*-47*	*0*

Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).
* In the 2023 pre-convergence the maximum level for the value of individual payment entitlements is applied before the internal convergence process in the claim year 2023. *See phase 2 section 2.2.*

Table 5. The internal convergence effects by rural areas and farm size, euro/ha (2023, 2026).

Farm size (ha)	A			B			C			D		
	2023 pre-conv*	2026	var.%	2023 pre-conv*	2026	var.%	2023 pre-conv*	2026	var.%	2023 pre-conv*	2026	var.%
0 – 1	261.9	215.9	*-17.6*	272.5	223.3	*-18.0*	256.3	212.6	*-17.0*	301.4	238.8	*-20.8*
1 – 2	185.1	175.5	*-5.2*	199.8	183.7	*-8.0*	186.1	175.6	*-5.6*	199.9	183.9	*-8.0*
2 – 3	161.6	165.0	*2.1*	184.0	176.4	*-4.1*	162.0	165.1	*1.9*	165.5	167.4	*1.2*
3 – 5	154.6	162.7	*5.2*	174.6	173.0	*-0.9*	153.3	161.6	*5.4*	152.8	161.4	*5.6*
5 – 8	151.9	161.3	*6.2*	172.5	171.9	*-0.3*	151.2	160.6	*6.2*	148.6	158.9	*7.0*
8 – 13,7	156.7	163.4	*4.3*	177.2	173.9	*-1.8*	152.2	160.7	*5.5*	148.5	158.2	*6.5*
13,7 – 30	160.8	164.2	*2.1*	185.9	177.2	*-4.7*	155.2	161.5	*4.0*	147.1	157.0	*6.7*
30 – 50	165.7	166.1	*0.3*	196.1	181.4	*-7.5*	158.7	162.7	*2.5*	143.4	155.1	*8.2*
50 – 100	171.8	168.6	*-1.9*	212.3	189.7	*-10.7*	162.5	164.0	*0.9*	142.9	155.3	*8.7*
> 100	173.0	169.6	*-2.0*	215.6	190.9	*-11.4*	163.8	164.2	*0.2*	144.4	155.9	*8.0*
National average	167.9	167.4	*-0.3*	198.6	183.3	*-7.7*	160.1	163.5	*2.1*	147.3	157.5	*6.9*

Source: own elaboration using "EU-wide Simulation tool" developed by the "New IACS Vision in Action – NIVA" project (Horizon 2020, Grant agreement n. 842009) on AGEA data (2020).

* In the 2023 pre-convergence the maximum level for the value of individual payment entitlements is applied before the effect of internal convergence in the claim year 2023. *See phase 2 section 2.2.*

2015 to 2019 between farmers and regions will represent 10.7% of the total annual BPS ceiling» (par. 68 Box 6).

The reduced financial envelope for direct payments of the period 2023-2027 compared to 2014-2020 and the strong reduction in the percentage of direct payments devoted to BISS result in a lower value of all payment entitlements. Focusing on the 2023-2027 distribution, the internal convergence leads to a rebalancing in the allocation of financial resources to the advantage of small- and medium-sized farms (between 3 and 50 hectares) and of marginal rural areas (C and D) and a shift of entitlements towards classes close to the average unit amount. However, depending on farm characteristics, type of production and agri-environmental practices, farmers could balance the losses in income support (BISS) using other components of direct payments (i.e. Coupled support, eco-schemes, complementary redistributive support, young farmer support).

The achievement of a flat-rate payment in Italy is postponed to an (eventually) forthcoming reform when the convergence process probably will come to an end. However, even if we were to arrive at an EU flat-rate payment per hectare, this would not shield it from criticisms regarding its fairness, equity and targeting, putting the CAP under pressure for a reduction of financial resources allocated to the system of direct payments. To safeguard the CAP budget in the next future, direct payments should demonstrate the EU value added and their contribution to the achievement of the EU objectives fixed in the main common strategies: Green Deal, Farm to Fork, Biodiversity 2030, Forest Strategy for 2030.

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Short communication

A library of climate adaptation measures in agriculture and their economic assessment

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Abstract. The objective of this study is to present the CAMBIA library, created by ARPAE, which collects more than 100 measures of adaptation of the agricultural sector to climate change, together with their evaluation, developed by CREA PB, in terms of costs and benefits to encourage their adoption by Italian farmers. The study was conducted as part of the LIFE ADA project, which aims to improve the resilience of the agricultural sector by providing farmers with knowledge and tools to adapt to climate change. Users' adaptive capacity will be enhanced by the ADA web tool, which will include the CAMBIA library and cost-benefit assessment of measures, and will be used to define adaptation plans at both farm and supply chain levels. This is an innovative tool that offers the possibility to consult and compare a set of climate change adaptation measures, together with the cost/benefit assessment related to their adoption so as to help farmers make an informed choice of the measures best suited to their farm reality. In addition, such a tool could encourage the engagement of policymakers and practitioners in their promotion, further fostering farmers' engagement in adopting climate change adaptation and resilience measures based on their possible cost-effectiveness.

Keywords: climate change, adaptation, climatic risk, costs/benefits, sustainability.
JEL codes: Q54.

HIGHLIGHTS:

- Concerns about the increase in adverse climate events prompted the European policies to suggest a critical recommendation for mitigation in agriculture.
- The climate adaptation measures contribute to increasing the resilience of the agricultural sector.
- Ability to consult and compare in a database a range of climate change adaptation measures, along with cost-benefit assessments related to their adoption, so as to help farmers choose the most appropriate measures.

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1. INTRODUCTION

The impacts of climate change on economic sectors, as well as the sustainability of agri-food production as a whole, continue to be a heated issue of public debate (EEA Report No 04/2019) at global and local level. According to a Eurobarometer survey conducted in 2021, after health, economy and food security, climate is considered, in Italy, to be the fourth main emergency. The current challenge is to demonstrate that adaptation is a valuable strategy, consisting of taking appropriate measures to prevent or minimize impacts. The requirement for adaptation involves the agricultural sector in particular, which is one of the sectors most vulnerable to climate change (Reidsma *et al.*, 2010; Mushtaq *et al.*, 2013; Pontrandolfi *et al.*, 2016; Abbass *et al.*, 2022) because of its high dependence on meteo-climatic conditions. In the next decades, the expected modifications to the climate, in terms of average values, as well as the intensification of hard-to-predict extreme weather events will put pressure on the agricultural sector, impacting farmers' incomes and farms' survival (Schmitt *et al.*, 2022). The productivity of some crops is expected to increase, while yields of other crops will decrease.

Several studies have demonstrated that wheat output is negatively affected by the rising temperatures (Garcìa *et al.*, 2015; Ortiz *et al.*, 2021) and wheat productivity trends are negatively influenced by extreme temperatures (Lobell, Feld, 2007). Agriculture both contributes to and is affected by climate change (Parker *et al.*, 2019) and is affected both positively and negatively depending on geographical regions. As a result, climate change determines risks and opportunities to agricultural production in the European agroclimatic regions (Iglesias *et al.*, 2012) and site-specific (El Chami, Daccache, 2015); for this reason, adaptation measures can show heterogeneous results depending on regions and agro-ecosystems.

These considerations highlight the need for the agricultural sector to implement immediate adaptation actions. According to Matthews (2020), at institutional level, the fight against climate change will continue to be one of the strategic objectives of the CAP even in the post 2020 framework (reg. EU 2021/1119). Although climate adaptation measures are considered necessary to increase the resilience of the agricultural sector and to limit its vulnerability, the literature contains few studies evaluating the costs and benefits of their adoption. Iizumi *et al.* (2020) for example, estimate the adaptation cost and residual damage to climate change for global crops. Wreford and Renwick (2012) estimate global adaptation to climate change costs in the agricultural sector, while a few studies assess the cost of climate change adaptation options for the agricultural sector in the Near East and North Africa region (El Chami *et al.*, 2022). In addition, some authors analyse the factors that determine willingness to adopt adaptation measures, including socioeconomic conditions – such as age, education level, household size, household income, farm size, and farming experience (Bryan *et al.*, 2009; Masud *et al.*, 2017 [a], 2017 [b]; Frame *et al.*, 2018; Kabir *et al.*, 2020; Kabir, Alam (2021) and agronomic ones (Ulukan *et al.*, 2008; Dednath *et al.*, 2021) that influence their adoption.

Adaptation measures are therefore case-specific and cannot be generalized, as costs and benefits depend on the specific cropping systems. In this context, EU-funded projects that focus on adaptation in agriculture both with specific research activities on actions to be taken at farm and supply chain level and with cost and benefit assessment to reduce economic and environmental damages due to climate risk, can be strategic in providing valuable support to environmental economists and policies.

Under this perspective, we contribute to this topic by presenting part of the results of the Life ADA project (ADaptation in Agriculture). More in detail, the overall objective of this study is to present the CAMBIA library (Catalog of Actions and Measures collected in the Adaptation Library), which collects more than 100 measures of adaptation of the agricultural sector to climate change, together with their evaluation in terms of costs and benefits in order to encourage their adoption by Italian farmers. This is an innovative tool that offers the possibility to consult and compare a set of climate change adaptation measures, together with an evaluation of the costs/benefits related to their adoption so as to help farmers make an informed choice of the measures best suited to their farm reality. In addition, such a tool could encourage the engagement of policymakers and practitioners in their promotion, further fostering farmers' engagement in adopting climate change adaptation and resilience measures based on their possible cost-effectiveness.

This manuscript is organized in four sections: the first section discusses the relationship between adaptation and climate change, while the second one shows data and research methodology; the research results and discussions are presented in the third section and, finally, the main conclusions and future research design are reported in the last section.

1.1. The Life ADA project

The Life ADA project – Adaptation in Agriculture (https://www.lifeada.eu/it/), is co-financed by the European Commission through the Life Program and aims at

fostering the capacity of the agricultural sector to define adaptation plans to climate change, in order to enhance the management of risks and prevention of damages.

The project is addressed to individual farmers and aggregated forms of producers (POs and cooperatives) for three food chains (wine, fruit & vegetables and dairy) with the following aims:

- to transfer knowledge about future climate change projections, risk management and adaptation measures to improve the ability of farmers to deal with current and future climate risks;
- to develop proper tools to support decision-making processes in defining efficient adaptation plans, including the CAMBIA library that allows the user to consult the main existing adaptation actions and choose the most effective ones for each specific context;
- to promote an innovative approach by insurance to strengthen the ability to reduce (current and future) climate risk in order to maintain farmers' long-term insurability.

One of the technical objectives of ADA is the development of a web tool aimed at supporting farmers and POs in the adoption of adaptation plans. One of the information sources that feeds the ADA tool is the CAMBIA library, focus of the present study.

2. METHOD AND MATERIALS

2.1. Description of the CAMBIA library

Knowledge of the state-of-the-art concerning the adaptation measures in agriculture is the baseline to accomplish "ad hoc" adaptation plans tailored to actual farm needs and, ultimately, to enhance the resilience of the agricultural sector; therefore, the development of the CAMBIA library has been foreseen in the Life ADA project.

The rationale behind the design of CAMBIA is the development of a tool addressed to farmers where the main existing adaptation measures are described. This specific task implies that a combination between a scientific approach and the practical needs of the users is needed, by means of the inclusion of decision filters useful in order to assess the degree of application, the benefits and limits of a specific adaptation measure for a specific farm.

The CAMBIA library is a database (in spreadsheet format) designed according to the entity-relationship scheme shown in Figure 1: the rectangles represent the entities shown in Table 1, defined by the attributes within the rectangles, whereas the ovals represent the relationships between the entities.

The core of the database is the Action entity, whose attributes, helpful to assess and evaluate the adaptation

Figure 1. Entity relationship scheme.

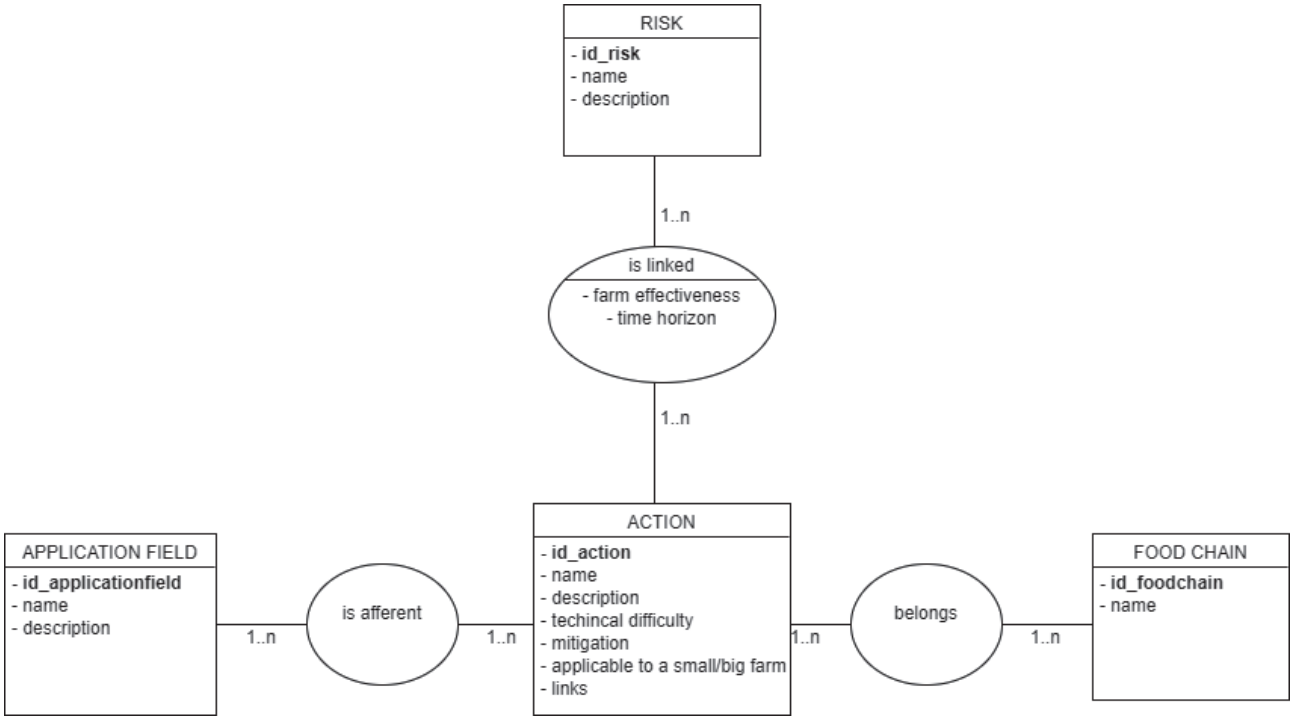

Table 1. Entities description.

Entity name	Description	Type | Possible values
Action	Name of the adaptation measure	-
Risk	The climate risk that the adaptation measure is tackling	Filter | drought, wind, hail, water surplus, floods, damages by extreme maximum temperatures, damages by extreme minimum temperatures, intense precipitation, loss of suitability of the territory, saltwater intrusion, erosion, phytosanitary damages
Food chain	The food chain to which the adaptation measure can be applied	Filter | Dairy (Parmigiano Reggiano), wine production, fruit and vegetables
Application field	The agronomic topic concerning the adaptation measure	Filter | soil, water, agronomic management, crop systems, animal welfare, oenology

Table 2. Attributes of the entity Action.

Attribute name	Description	Possible values
Description	Detailed information, explanation about the implementation, advantages and limits, suggestions, specific references to the food chains	-
Mitigation	Evaluation of the potential beneficial effects on climate change mitigation	Yes/No
Technical difficulty	Degree of technical difficulty in the implementation	1 (Low), 2 (Medium), 3 (High)
Effectiveness for the farm	Degree of effectiveness of the measure in relation to the risks	1 (Low), 2 (Medium), 3 (High)
Applicable to a small/big farm	Evaluation of the suitability of the measure in relation to the size of the farm	Yes/No
Time horizon	Time required for the measure to become effective from an economic, agronomic and environmental point of view in relation to the risks	1 (Short term: 1 year or crop cycle), 2 (Medium term: from 3 to 5 years), 3 (Long term: from 7-10 years or more than 10 years)
Links to further information	Link to in-depth researches, interviews and case studies about the empirical application of the measure	-

measures are listed and described in Table 2. Each action could be applied to one or more food chain, application field, farm effectiveness and time horizon: in other words, one action can tackle *n* climate risks, with *n* time horizon and *n* degree of effectiveness.

CAMBIA has been designed following two main steps: first, a review of similar tools in the literature or in outcomes from EU projects was carried out, then the library was defined and populated, according to the specific aims of the ADA project. The review of similar projects highlighted that two tools have been developed within two Life EU projects on adaptation to climate change in agriculture:

- AgriAdapt (AWA webtool: https://awa.agriadapt.eu/en/) and,
- Adapt2Clima (Adapt2Clima tool: https://tool.adapt-2clima.eu/en/home/).

They both provided a relevant overview for the design of CAMBIA as they were aimed at facing the vulnerability to climate change of the agricultural sector through the implementation of adaptation measures and plans. For instance, the AWA tool, which is characterized by filters for the identification of the most suitable adaptation measures for farms, offered a meaningful starting point for the structure of the library: as described above, the use of filters is in fact a key element for CAMBIA as well, even if it is applied to different entities. On the other hand, the Adapt2clima tool was relevant for its contents and goals: it consists of a decision support tool based on extreme climate scenarios and indicators related to several dimensions, such as climate, hydrology, agriculture and socio-economic aspects in order to provide adaptation to climate change measures for the agricultural sector.

To be consistent with the final objective of ADA project, namely supporting farmers in the adoption of farm adaptation plans, a second step followed: the application of further attributes and evaluation methods for the description of each adaptation action. The selection of contents and design of the library (i.e., adapta-

tion measures) were performed by referring to the main reports by the European Environment Agency and according to the support of experts within the Environmental Agency of Emilia-Romagna (ARPAE) and project partners.

As a final stage, the structure and contents of CAMBIA were validated by means of twenty interviews with experts in the three food chains involved in ADA and during a workshop of co-design. During this event, three focus groups were organized in order to provide an in-depth review of the tool focused on a selection of the most relevant climatic risks and best adaptation measures. This meeting was the occasion for a second evaluation, after the editing stage.

To conclude, CAMBIA is the result of a development process composed by different levels of review and it remains open to further implementation and enrichment. The on-going project activity on CAMBIA library is two-fold: the collection of adaptation actions and the release of a web tool based on the library. The first point will be carried out for the entire duration of the Life ADA project; so far, the number of collected measures is 78 actions for the fruit and vegetable sector, 61 for the wine production sector, 58 for the dairy (Parmigiano Reggiano) sector. The second activity is addressed to integration of the CAMBIA database into the ADA web app.

2.2. A methodological framework on cost and benefit assessment of the measures listed in the CAMBIA library.

Each adaptation measure collected in the library will also have information on the costs and benefits of its adoption. Based on this information, an assessment of its cost-effectiveness is provided.

To collect the information, a questionnaire was sent to various experts in the sector, surveyors of the Agricultural Accounting Information Network – RICA, using the CAWI methodology (Computer Assisted Web Interviewing (Giuca *et al.*, 2022).

A total of 82 questionnaires, divided by measure group, were compiled. Therefore, each surveyor completed several questionnaires. In order to obtain as much information as possible and to investigate the issues and specificities that emerged from the answers to the questionnaires, more than 30 operators in the sector were interviewed: thematic experts, agronomists, researchers, manufacturers of technical means – of crop protection – of irrigation systems. At the same time, a bibliographic research was conducted in order to survey existing studies on the impact of adaptation measures on specific production activities. The investigations performed by means of questionnaires, interviews and bibliographical research enabled us to provide the following information for each individual measure:

Information on costs to be incurred:
- investment cost (if any):
- average annual cost per hectare;
- cost compared with usual practice (if relevant).

Costs vary according to multiple variables: farm characteristics (physical and economic size of the farm, farm location), region, altitude, soil and climate characteristics of the farm territory. Consequently, we provide an average reference cost, varying in range, useful to guide the farmer's possible decisions in the choice of adopting the measure.

Information on benefits:
- degree of effectiveness of the measure with respect to climatic risk as already reported in the CAMBIA library: high, medium, low;
- influence on production quality and yield: i.e. positive effect of the measure on production quality and yield even in the absence of an adverse climatic event;
- environmental benefits;
- possibility of receiving public support.

Evaluation

On the basis of the above-mentioned information, a qualitative assessment of the costs/benefits of adopting the measure is provided. Furthermore, a graphical representation of the degree of convenience in adopting the measure is reported based on an exemplificatory estimation model.

The exemplary estimation model is based on entity of avoided damage by means of the adaptation measure. The damage could come from adverse climatic events.

Considering the average of the yield losses in agriculture in the last years with a strong effect on income (European Environmental Agency, 2021), our model assumes that adverse climatic events can with a high likelihood cause an average damage equal to or greater than 30% of the value of the farm's production. It has been taken into account that adverse climatic events are increasingly frequent and are causing always greater damage. Furthermore, they are more unpredictable, so they can strike anywhere. The economic damage is calculated using FADN data: the average farm value Gross Production is calculated on type of farming and its economic size (we considered three classes: small, medium, large). The benefit of each measure, deriving from damage avoided, is calculated on a qualitative degree of effectiveness of the measure in relation to the risks

(high, medium, low), derived from CAMBIA library to prevent/reduce such damage.

The following assumptions were made regarding effectiveness of the measure:

- High = capable of reducing the damage from 70% to 100%.
- Medium = capable of reducing the damage from 30% to 70%.
- Low = capable of reducing the damage from 10% to 30%.

In our approach we considered the average damage reduction based on the previous assumptions. Furthermore, other economic benefits are identified and added to the description of the form: benefits related to the improvement of production quality, the possibility of benefiting from CAP payments, the environmental benefits that can have positive economic impact, as they are increasingly appreciated and requested by consumers. Finally, the overall benefit is compared to the annual average cost to be incurred for the adopted CAM. In order to test this methodological approach, the CAM *agro-meteorological software system for phenological forecast measure* has been analysed according to the costs and benefits assessment presented. In the next section a discussion about the results is provided.

3. RESULTS AND DISCUSSIONS

The methodological approach for cost-benefit assessment was applied to one of the measures of the CAMBIA library: the agro-meteorological software system for phenological forecasting. This adaptation action uses observed weather data as input, namely temperature and precipitation, in order to simulate crop development (phenological stages), soil water content and crop pests or pathogens. This measure counteracts damage from drought, extreme maximum and minimum temperatures, and crop diseases. The implementation of the measure could be achieved in two ways: the software service could be fed by data owned by the service provider or by data collected by weather stations installed by the farm owner. The collected data showed that if the measure is implemented as indicated in the second option the investment cost is between 1,000 and 3,000 euros per installation. The estimated weather stations network density is on average one station every 5 ha in hilly areas and one station every 10 ha in plain areas. The annual cost per hectare is estimated between 80 and 130 euros, considering the linear depreciation of the investment (duration 10 years) and maintenance, while it is estimated to be less than 20 euros, if the weather data are provided by the software service. The effectiveness of the measure is high in counteracting the associated climatic risks, therefore, according to our assumption, it can prevent/reduce damages from 70% to 100%. According to the methodological approach, the evaluation is optimal for its application by the farmer.

According to FADN data the economic benefit, deriving from avoided damage, is higher than the costs to be incurred for the adoption of the measure in the three ADA food chains and in the three economic size classes. Moreover, the measure offers additional economic and environmental benefits.

In detail, the benefit, deriving from avoided damage, results higher for both the options described above. In addition, the cost for its implementation has a marginal impact on farms total output. We found that in the fruit and vegetable chain and in the wine chain the benefits are higher than cost (>100%) and cost impact on total output is lower than 10%. In the SME of livestock chain the benefits with respect to costs are lower/equal to 50%. These considerations suggest that this measure is highly recommended.

4. CONCLUSIONS

Climate change directly affects productivity and profitability of farmers, especially small and medium-sized farmers, and their ability to survive, also negatively affecting the quality of production. Therefore, adaptation to climate change plays an important role in counteracting possible damage by adverse weather events. Our study contributes to this research topic, on the one hand by providing an innovative tool that collects a significant number of climate change adaptation measures, and on the other by providing an assessment of the degree to which it is cost-effective to implement the individual measure. Consultation of several adaptation measures at the same time, together with their possible costs and benefits, allows farmers to choose effective adaptation plans suited to their characteristics. To the best of the authors' knowledge, our research uses the FADN sample to explore the costs and benefits assessment of adaptation measures. With regard to the limits of the proposed methodology to assess the economic convenience in adopting a measure, it has to be mentioned that implementation of the measures involves a wide spectrum of costs depending on different factors, such as farm size, farm location, methods of implementation and others. Another limit concerns the investments to adopt the measures, as a large number of solutions with a wide range of prices is offered by the market. As the model consists of estimations derived

from the use of average data it cannot represent the peculiarity of a specific context. However, the strength of this methodology is the lean approach of the cost and benefits assessment able at the same time to provide valuable information about adaptation measures. Thus, in future research our findings could be applied to a wide spectrum of climate risks and a large number of adaptation measures and have a more integrated view on the issue. According to the EU adaptation strategy (EU COM 2021/82), the present study contributes to the scientific literature that investigates farms' resilience and adaptation to climate change, central themes of scientific research, and on the combination of different approaches to assess the resilience of farming systems (Martino *et al*., 2016; Meuwissen *et al*., 2019; 2022). The effort of this study is to provide a contribute on methods to evaluate climate change impacts on the economic vulnerability of farms and their resilience in tackling climate change impacts in a continuous development context.

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