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Keynote article

The new challenges of agricultural policy: new actors and redefined development paradigms

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Abstract
The role of the agricultural sector has had to evolve as our global social economic system has been changed by drivers such as climate change, demographics, ecosystem depletion, changes in dietary patterns and rising food demand. A key characteristic of 21st century agriculture is the reaffirmation of its primary function: producing sustainable food for a growing global population living in increasing inequality and political instability. However, the role of agriculture also goes beyond feeding the planet; it increasingly involves maintaining the environment. Meeting these challenges will require significant changes in the sector's organisational and operational boundaries and bold intervention from the research community and public sector alike to generate new knowledge and innovation systems.
This paper aims to describe and analyse, where possible, the changes this transition will entail in terms of stakeholders, policy interventions, governance, development models and, finally, the role research should play in future scenarios.

Keywords: Innovation ecosystem, stakeholder mapping, science-policy-society interface
JEL codes: Q18**,** E61, O13

Highlights:

- The drivers of economic system transformation are social, political, and also environmental.
- The agricultural sector has redefined its role and scope.
- Multidimensionality of roles and development objectives can only be achieved through a systemic vision of the agricultural sector.

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1. Introduction

Our economic system, and society are in a rapid state of change that shows no signs of slowing in the near future. The drivers of this transformation are social, political, and also environmental. The big issues facing society, referred to in the scientific debate as the Grand Challenges (Davidson *et al*., 2015; Bock *et al*., 2020; De Bernardi *et al*., 2020), include climate change, global demographic trends, the depletion of natural resources and ecosystems (Foley *et al*., 2011), changes in dietary patterns, and rising food demand. In addition to these elements, we must consider the recent shocks that have impacted both the developed and developing world, such as the COVID-19 pandemic and ongoing conflicts.

The Food and Agriculture Organization (FAO) (2022) has recently identified 18 interconnected drivers for the future Grand Challenges of agrifood systems that affect three interconnected systems: the environmental system (including scarcity of natural resources, ecosystem degradation, pandemics, climate change, and overfishing), the socio-economic system (including population growth, urbanization, economic growth, big data collection and data ownership, geopolitical instability, urban and rural poverty, and inequality), and the food system (rising food prices, science and innovation, capital intensity, investments, market concentration, and dietary patterns).

Within this context, the agricultural sector has redefined its role and scope. A key characteristic of 21st century agriculture is the reaffirmation of its primary function: producing food for a growing global population living in increasing inequality and political instability. Agriculture must meet this rising global demand whilst respecting sustainable development principles which are underpinned by ever more complex ethical values, including waste management, human rights protections, and the pursuit of circular production models.

The role of agriculture also goes beyond feeding the planet; it increasingly involves maintaining the environment. Climate change, fragile and marginal rural areas, increasing urban and peri-urban agriculture, farmland abandonment (even on the plains) and the consequent forest encroachment are all issues that can only be managed if agriculture is given a new role in territorial planning and protection, as well as in broader economic development models.

Knowing the precise future role and nature of modern agriculture is also complicated by its social and cultural functions, which have historically underpinned the European model of agriculture (Cardwell, 2004). Within this framework, the primary sector – recognized for

producing positive externalities and providing a unique and resilient multifunctionality – must increasingly prioritize the needs of not only farmers and consumers but society as a whole. The expanded and diversified roles of modern agriculture make it uniquely positioned to create a "safe and just operating space for humanity" (Rockström *et al*., 2009; Rockström *et al*., 2023). Achieving this goal demands enhanced sustainability and competitiveness, a stronger contribution to food security and sovereignty, and greater resilience, elements that simultaneously present both synergies and conflicts. Furthermore, the new challenges and demands placed on the primary sector, in its broader and modern context, are driving agriculture and the entire rural world towards a transition that is not only ecological and digital (Brunori, 2022), but also social. This transition entails changes and adaptations in technology, and governance structures, as well as changes to the types and roles of stakeholders, including both long-established and newly introduced stakeholders (Gava *et al*., 2022).

In this context, the objective of this study was twofold. The first is to identify the needs and potential implications of change in the agricultural sector as it undergoes a complex process of transition. The second objective is to link these changes with new research needs, in order to better understand present and potential events and to implement tailored public intervention in future scenarios. The paper explores changes in different research topics. These are intervention policies, stakeholders in modern agriculture, governance structures and development models. The remainder of the paper is organised as follows. Section 2 outlines the role and characteristics that current and future public intervention should have. In particular, the need for policies based on an ecosystem approach will be discussed, which is essential when defining objectives and tools for ecological, digital and social transitions. Section 3 deals with stakeholders in the modern agricultural context, for which new mapping and new definitions of roles and dimensions are needed in order to better calibrate intervention policies. Section 4 analyses how policies and new stakeholders affect governance models in agricultural systems. Section 5 discusses how the described changes are changing development models and their theoretical frameworks. Section 6 provides discussions that stem from previous considerations, concluding with suggestions for future research needs.

2. Policy intervention between ecosystemic approach and policy mix

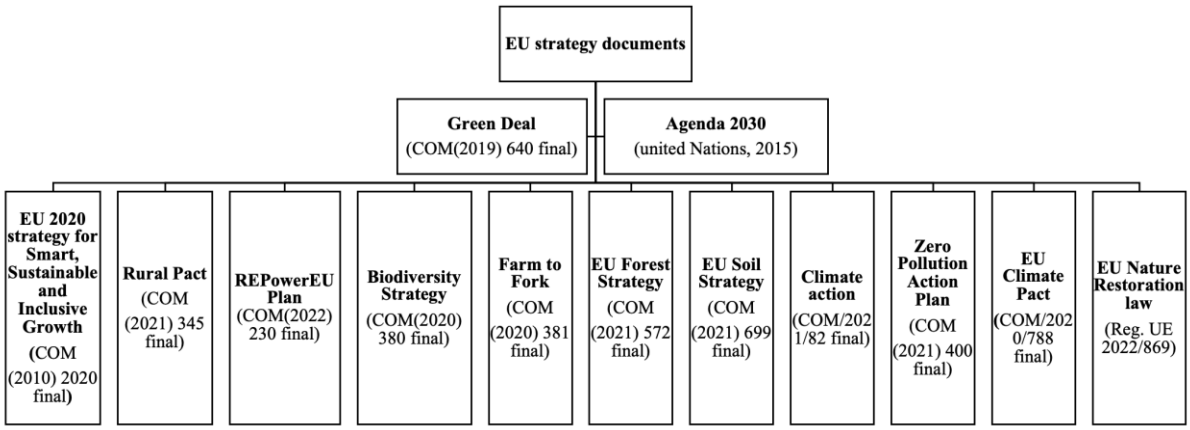
The current context requires agricultural and rural policy intervention that can meet ambitious environmental targets but also work towards social equality goals to ensure fairer and more inclusive development. In light of this, an analysis of the European policy framework, and in Italy in particular, reveals four main observations:

1. The scope of agricultural policies has widened as the domains and functions of the agricultural sector have expanded;
2. Policy interventions focus on the operational phase of guidance documents for long-term European economic development, including intergenerational goals;
3. Current policies were implemented or updated during a period marked by significant shocks, such as the pandemic and ongoing conflicts;
4. The central role of innovation as a cross-cutting strategy for all interventions

The first observation concerns the classification of policy interventions earmarked for agriculture or rural areas. As the domains and functions of the agricultural sector have expanded, an ever more diverse array of policy interventions has become available. A new categorisation of existing policies will be required if food policy is to meet the challenges of prioritising food safety, nutrition, and health, while also addressing the social and environmental dimensions of agriculture. This is essential to tackle environmental challenges, meet energy supply demands, and strengthen rural communities within a place-based framework (OECD, 2023).

The second observation is that most current policy interventions focus on the operational phase of guidance documents, designed to outline a path toward long-term European economic development, including intergenerational goals. The effectiveness of this approach depends on each Member State's ability to implement these interventions and the extent to which these principles and objectives are shared across nations. The central EU long strategy vision is described in two main documents: Agenda 2030 (United Nations, 2015) and the European Green Deal (COM(2019) 640 final). Many other intervention policies have been implemented to achieve the identified objectives. In addition to these, a myriad of other guidance documents that set out strategies for policy direct and indirect intervention for agricultural systems have been added, including the seven lighthouse initiatives under Europe 2020 "A Strategy for Smart, Sustainable and Inclusive Growth" (COM(2010) 2020 final), the Farm to Fork Strategy (COM(2020) 381 final), Biodiversity Strategy (COM(2020) 380 final), the EU Forest Strategy 2030 (COM(2021) 572 final), the REPowerEU Plan (COM(2022) 230 final) for the transition to clean energy, the European Soil Strategy 2030 (COM(2021) 699 final), the Climate Action Strategy (COM/2021/82 final), the Zero Pollution Action Plan (COM(2021) 400 final) for air, water and soil, the European Climate Pact (COM/2020/788 final), the Rural Pact (COM(2021) 345 final), the EU Nature Restoration law (EU Regulation 2022/869), and the upcoming EU Directives on sustainability (EU directive 2022/2464) (Figure 1).

Figure 1. Main EU strategy documents



Source: rearranged by authors from EU documents

The third observation is related to the timeframe of policy programming. Many of the current policies were implemented or updated during a period marked by significant shocks, such as the pandemic and ongoing conflicts. These events have profoundly altered our vision of development, political balance, globalization meaning, and the prioritization of contemporary societal needs, which often clash with the perspectives outlined in earlier documents. This observation applies to the broad range of interventions under the Recovery Fund, and especially to the new Common Agricultural Policy (CAP) 2023-2027, whose foundational regulations were established in 2018, before these shocks and before the introduction of the Farm to Fork strategy.

The final observation, and perhaps the most innovative aspect of the current intervention landscape, is the central role of innovation as a cross-cutting strategy for all interventions aimed at transforming and transitioning the agricultural systems. Digitalisation, in particular, is highlighted as a key tool for enhancing the resilience and sustainability of the entire agricultural and rural sector. However, addressing the Grand Challenges requires innovation not only in terms of technology but especially innovation in social and institutional domains (Kok and Klerks, 2023; Herrero *et al*., 2020), therefore what is required is a socio-technical regime transition. This multidimensionality can only be achieved through a systemic vision. From this standpoint, Agricultural Innovation Systems (AIS) have emerged as the best approach to studying and building diverse stakeholder networks, bringing in actors from the areas of production, advisory services, research, institutions, and civil society (Klerkx *et al*., 2010). These networks are essential for co-producing research, innovation, and intervention policies that address increasingly complex needs (Annosi *et al*., 2022; Klerkx *et al*., 2012; Pigford *et al*., 2018, Vecchio *et al*., 2024). Recently, the scientific debate has shifted from a systemic perspective to an ecosystemic one, viewing innovation as a co-evolutionary process (Pigford *et al*., 2018; Maria *et al*., 2021). This shift acknowledges that in scenarios marked by high degrees of uncertainty and change, policies must exhibit a high degree of adaptive capacity (Folke *et al*., 2011).

Ecosystem approaches involve a complex network of interconnected actors (Wolfert *et al*., 2023). In essence, innovation systems focus on the types of interactions and governance mechanisms in operation between actors deriving value from innovation, while the ecosystem perspective highlights the co-evolution of innovation and the co-creation of value (Lioutas *et al*., 2021). Integrating dynamism into the theoretical framework makes the ecosystem a valuable tool for analysing the ecological and digital transitions of the agricultural and rural sectors, and for examining the synergies or conflicts that may arise between these processes (Wittman *et al*., 2020; Schnebelin *et al*., 2021). One of the most fitting definitions, which underscores the strong potential for empirical analysis, comes from Granstrand and Holgersson (2020: 3): "An innovation ecosystem is the evolving set of actors, activities, and artefacts, and of institutions and relationships, including complementary and substitutive relationships, that are important for the innovative performance of an actor or a population of actors".

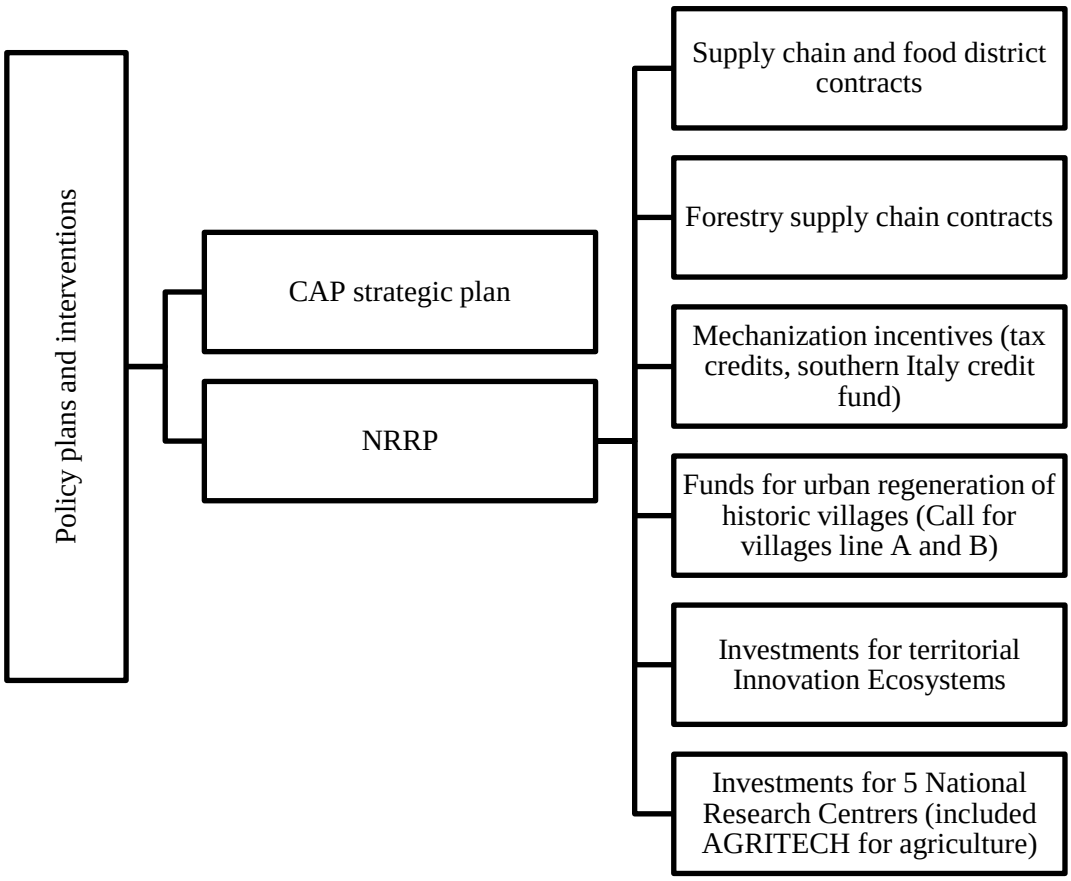
Agricultural innovation ecosystems are integral to both planning a policy vision and the practical implementation of policy interventions. During the previous European programming period of 2014-2020, the European Partnership for Innovation, Agricultural Productivity, and

Sustainability (EIP-AGRI) aimed to connect the agricultural and research sectors at regional, national, and community levels through the creation and funding of Operational Groups. In the new CAP 2023-2027, the Agricultural Knowledge and Innovation System (AKIS) serves as a transversal objective and a preferred approach in implementation procedures and interventions. This framework necessitates the involvement of all relevant actors, whether at the sectoral, problem-specific, or territorial level (CREA, 2023).

Additionally, both in Europe and in developing countries, there are established networks that facilitate knowledge-exchange networks and the creation of innovation ecosystems. Examples include the Strategic Working Group on Agriculture Knowledge and Innovation Systems (SCAR AKIS) from the European Commission (Poppe, 2012) and the Consultative Group on International Agricultural Research (CGIAR) with its "systems transformation approach for food, land, and water systems" which focuses more on developing countries (McIntire Dobermann, 2023).

From this analysis, two key observations emerge. The first is the sheer amount of policies and measures available to beneficiaries, some potentially leading to convergent or conflicting change pathways. Indeed, policy interventions are not limited to those cited as the CAP 2023-2027 (EU Regulation 2021/2115) itself, the New Delivery Model (EU Regulation 2021/2116)- namely the shift from a compliance-based to a performance-based system of the CAP - offers a wide range of measures. In Italy, the CAP Strategic Plan (PSP) for the 2023-2027 planning period includes a total of 173 interventions, including sector-specific ones. The national AKIS strategy is detailed in chapter 8 of the PSP, featuring 9 interventions – 3 under "Cooperation" (REG 2021/2015, art. 77) and 6 under "Knowledge and Information Exchange" (REG 2021/2015, art. 78). Additionally, there are intervention programs financed by the Italian government within the EU Recovery Fund- NextGenerationEU (e.g. the National Recovery and Resilience Plan - NRRP in Italy (EU Regulation 2021/241)), such as supply chain and food district contracts, forestry supply chain contracts, mechanization incentives (tax credits, Southern Italy credit fund, etc.), energy efficiency initiatives (Agrisolar Park 2023, etc.), funds for urban regeneration of historic villages (Call for villages line A and B), investments for territorial Innovation Ecosystems, and investments for 5 National Research Centrers, among these AGRITECH focusing on agriculture (Figure 2). In details, AGRITECH is an innovation ecosystem composed by 28 Italian University, 19 research centres, 14 important and strategic companies. The main objectives are to combine the top multidisciplinary research expertise to develop and apply the most suitable technologies. Using a multi-actor approach, AGRITECH brings together universities, companies and farmers to co-design innovations, human capital and skills for the future of agri-food supply chains.

Figure 2. Policy plans and interventions.



Source: rearranged by authors from EU documents

The second key observation, from a theoretical perspective, is that the current constellation of policy interventions requires a multi-faceted approach to policy analysis. Traditionally, the actions and interactions of all involved actors form "the policy market" and so also decisions (Lechi, 1993). Today's policy market is unique due to the complex nature of available interventions. Beneficiaries are not targeted on a single-issue basis, but instead are selected from a policy mix designed to address multifaceted needs (intangible benefits, investments, ecological transition, etc.). The composite nature of the possible intervention choices is identified, in scientific literature, as a policy-mix that highlights the importance of combining various policies to form a coherent strategy that coordinates the activities and roles of all involved actors (Flanagan *et al*., 2011; Lindberg *et al*., 2019).

To meet the types of challenges previously described and drive the necessary changes, the agricultural and rural sectors require models that can bring not only technological transformations, but also political and social ones. Furthermore, as previously mentioned, the approach must be multi-actor and ecosystem-based with a long-term vision (Geels, 2019). In this context, the policy mix concept is crucial. Achieving complex objectives such as climate resilience, social equity, or sustainability necessitates a combination of interventions that blend different existing policies into a unified strategy that can coordinate activities and roles across

various actors (Mugabe *et al.*, 2022). To better define the concept, Rogge and Reichard (2016) described policy mixes using 4 characteristics: a) consistency captures the extent to which the elements of the policy mix are mutually synergistic in achieving the identified objectives; b) coherence refers to policy implementation processes able to achieve policy objectives; c) credibility is the policy mix degree of credibility and reliability; d) comprehensiveness of the policy mix refers to the exhaustiveness of its elements and to the extent of the decision-making process. Moreover, achieving common goals may involve integrating different action plans through governance that fosters cooperation across different decision-making levels.

3. Stakeholders in rural system and the need for new mapping

An analysis of the current policy framework, as described in the previous paragraph, reveals a common theme: the ecosystemic approach, the socio-technical transition and the need for a policy mix all emphasise the involvement of stakeholders from various sectors and fields. The profound changes affecting the agricultural and rural world – such as digitalization, genetic innovation, new business models, and the unprecedented spread of services (organizational, logistical, digital, legal aspects) offered to the sector – have also impacted the actors involved, increasing their diversity and changing and expanding their roles and potential connections.

Given this, a new kind of stakeholder analysis has to consider stakeholders as integral parts of building knowledge ecosystems and to take into account different stakeholder roles and potential instances of synergies and/or conflicts in the context of profoundly dynamic and unpredictable future scenarios. Following the most recognized definition of stakeholder: "A stakeholder is defined as persons, groups, organizations, systems, etc., that have a 'stake' in a change effort (eg. a development project) and that are either likely to be affected by the change, whose support is needed or who may oppose the change" (Morgan and Taschereau, 1996: 4), it is clear that the first focus of analysis must be on farmers. The current scientific and political debate is focused primarily on exploring future scenarios for agriculture, including the challenges of food production and consumption patterns.

However, the changes that will directly affect the socio-economic characteristics of farmers in the medium and long term are still under investigation. This research gap is particularly significant given that only 11% of all farm holdings in the European Union are run by farmers under 40 (Eurostat, 2022), suggesting that discontinuity will play a major role in reshaping this group of stakeholders.

According to recent work by Bock *et al*. (2020), it is evident that future farmers will be much more diverse than those of today. The study identifies 12 profiles for farmers in 2040. The main characteristics of these profiles are shown in Table 1. The diversity of farmer profiles is a direct result of both the impacts of the sociotechnical transition on the world of farming and the expanding functions that define modern agriculture. The wide range of skills, objectives, business models, and the material and immaterial resources utilized, along with the intrinsic connection between farmer profile and their local territory, illustrate the complexity of future ecosystems in terms of actors, connections, and knowledge flows.

Table 1. Farmer Profiles in 2040.

Farmer profiles	Keywords
Adaptive farmer	Diversification; systemic approach; innovative skills
Corporate farmer	Corporate; Automatization; business unit; agricultural knowledge management
Intensive farmer	Intensive; Farm efficiently; production focused; specialisation
Patrimonial farmer	Tradition; family; heritage
Controlled environment farmer	Agritech start-up; indoor agriculture
Cell farmer	Biotech start-up
Social care farmer	Social and health sector; community; social inclusion
Lifestyle farmer	Farm as service; neo-rural; new entrant
Regenerative farmer	Planetary health; conservation; agroecology
Urban farmer	Entrepreneurial; micro-farm; local
Serious hobby farmer	Recreational; non profit; passionate
Community provisioning farmer	Subsistence

Source: Adapted from Bock *et al*., 2020

In the recent literature, stakeholder analysis has been employed as a methodological approach to address research questions relating primarily to future development scenarios or policy interventions. Analysts have long sought to understand how information, institutions, decisions, and power shape political agendas for interest groups within social networks. Stakeholder analysis represents an approach to deepen the knowledge of the actors in the system analysing their behaviours, interests, objectives and influences on the system processes. Specifically, stakeholder mapping proves particularly useful for assessing the interests, relationships, and conflicts among different actors within a given system of reference. In recent years, this type of analysis has gained widespread use across various disciplines and is now standard practice among businesses, policymakers, and international organizations (Friedman and Miles, 2006; Reed *et al*., 2009).

According to Grimble and Wellard's (1997: 175) definition, which is particularly relevant to this discussion, stakeholder analysis can be viewed as "a holistic approach or procedure for gaining an understanding of a system, by means of identifying the key actors or stakeholders and assessing their respective interest in the system".

In the new scenario of change for agricultural and rural systems, implementing innovative stakeholder mapping in order to find new actors and link these to the characteristics of ecosystems becomes a strategic element. From an analysis of the literature relating to the context of our interest, what emerges is still a strong focus on the production chain as a conceptual and physical boundary for the identification of relevant stakeholders. To give just a

few examples, Graef *et al*. (2014) identify farmers, processors, traders, transporters and technical assistance services as relevant actors in a study of the cereal sector;, as well as Benedetto *et al*., (2014) in the case of the wine supply chain, Vellema and Van Wijk (2015) in cases of agri-food certification, Lokesh *et al*. (2018) in cases of circular economy, Surucu-Balci and Tuna (2022) in managing food waste and losses. Other examples are Saint Ville *et al*. (2017) in the context of food security in a specific geographical area and D'Agostino *et al*. (2020) for water management.

The same ecosystem approach is also needed to map stakeholders in the rural and agricultural sectors if it is to adapt successfully to change and adopt suitable policies. This approach is already evident in other research fields, where the ecosystem defines the ideal boundaries for identifying key actors (Li *et al*., 2022; Del Vecchio *et al*., 2021; Nylund *et al*., 2021). However, many studies still provide a static view of stakeholders and their connections (Frooman, 1999; Friedman and Miles, 2002; Rowley and Moldoveanu, 2003), which does not reflect the co-evolutionary nature typical of ecosystems. An exception is the method suggested by Barquet *et al*. (2022), where stakeholders are mapped based on their involvement in the co-creation process.

Building a resilient agricultural system means encouraging co-creation processes in which actors learn to use each other's skills to develop new strategies aimed at grand and shared challenges (Voorberg *et al*., 2017). Considering the nature of the ecological and digital transition and the presence of a highly diversified structuring of policy interventions, it is reasonable to expect that stakeholders must include traditional actors endowed with both old and new functions and also new actors, with roles both already defined and yet to be identified. Examples are the different public institutions at different decision-making levels, the whole world of AKIS (production, research, consultancy, public institutions, civil society), all the new producers of digital and genetic technologies, providers of innovative services such as data management, marketing, traceability (blockchain, food passport, etc.), as well as all the producers of alternative technologies for energy production, third sector companies, the tourism sector, the material handling sector, etc.

Intermediate stakeholders must also be considered, such as those being developed and supported by specific intervention models like the Local Action Groups (LAGs) in the LEADER field, the European Innovation Partnership (EIP) – AGRI Operational Groups, the food districts in all their present forms (quality, food, rural organic etc.), the National Research Centers operating with RRNP funds, the European Startup Village Forum, the Regional Innovation valleys, the Living labs, the Lighthouse Initiative, the business Accelerators and Incubators, all the countless forms of international and digital networks, etc.

Deepening existing connections, and especially levels of cooperation between actors, is fundamental to lead the system towards a more equitable and inclusive development without making the mistakes already made during other important transformations (mechanics, chemistry, genetics, etc.) which have seen the agricultural and rural system worsen both in terms of economic and social performance.

4. Governance: from sector to system

The ecological, digital, and social transitions impacting the agricultural-rural system demand institutions and governance that are stronger, more transparent, and accountable, as well as highly adaptable and effective (FAO, 2022). In today's context, describing, analysing, and supporting the evolution and improvement of governance is crucial for both research and policy implementation (Dwyer, 2022). This is vital because crafting and implementing policies for sustainability and resilience involve complex interactions between government and society (Glass and Newig, 2019). Moreover, the long-term development perspective necessitates governance that fosters ecological transition processes that are not only efficient but also legitimate and socially just, tightly interweaving technical and economic evolution with social progress. In short, transitioning from a sector-specific or place-focused approach to a more holistic and multidimensional perspective in governance is the desirable path.

Theoretically, the concept of governance has evolved in this direction. According to Stoker (1998), governance encompasses a range of institutions and actors, both within and outside of government, that address social and economic issues in a framework where the boundaries between the state and society, as well as between the public and private sectors, become more blurred, as do the definitions of their respective responsibilities. However, the most recent literature (Lockwood *et al*., 2010; Glass and Newing, 2019; de Boon *et al.*, 2022)) characterizes governance by emphasizing values, power dynamics, sustainability, social justice, and legitimacy in relationships between actors.

The growing importance of networks and systems of actors, due to their ability to facilitate complex objectives like environmental goals and the adoption of composite innovations, is gradually transforming relationships between public institutions and local actors, as well as between elective and participatory democracy. This shift necessitates the improvement or development of linkage mechanisms that better integrate top-down public intervention with bottom-up local initiatives (Knickel *et al*., 2018).

Furthermore, it is important to emphasize that with the expanded functions of agriculture and the need for a mix of intervention policies, governance becomes crucial both within and outside agri-food systems, following the a forementioned transversal approach. The FAO (2022) continues to update the concept of governance by explicitly referring to formal and informal rules, as well as the organisations and processes through which public and private actors articulate their interests and implement decisions. Including rules within this concept addresses the need for agricultural and rural systems to establish not only adaptable governance but also clear regulations to manage new challenges such as climate change, risk management, digitalisation and data ownership, genetics and ethics, negotiating intangible assets (knowledge, skills, certifications, etc.), and the increasing involvement of the private sector in traditionally public services (e.g. natural resource management, advisory services etc.).

Developing new governance models is also made more complex by the evolving role of actors, particularly the evolving role and vast expansion in the functions of public institutions. In the European context, the already mentioned interactive and multi-actor model for innovation, known as AKIS, is central to the ecological and digital transition. This model

assigns the public sector the role of a "*coordinating agent in an increasingly pluralistic innovation system*" (EU SCAR, 2015). Moreover, the new delivery model of the CAP, which requires national level strategic plans to tailor support instruments to specific territories, tasks public institutions at varying levels with choosing the appropriate policy mix, both within CAP interventions and among other potential policies.

Referring to the FAO definition of governance, the public sector also faces the challenge of adapting a large and highly specific body of legislation to an operational context where the boundaries between sectors, activities, and territorial zones are becoming less distinct. Complex interventions often cause different regulatory areas to converge and sometimes conflict (e.g., urban planning, agricultural, commercial, security, immigration, and training regulations). Resolving these conflicts necessitates a role for public institutions as administrative facilitators.

Another element shaping future governance is the increasing importance of knowledge and innovation on power (im)balances among key stakeholders. Some studies have highlighted the emergence of "expertification" processes, and the formation of a European lobby made up of professionals who gain legitimacy and power, by possessing specialized knowledge. This situation is particularly relevant in discussions about future governance given the roles of new service providers, advisors, and tech-experts in digital technologies in knowledge and innovation ecosystems.

Finally, it is important to emphasize once more that governance should have a transversal dimension that spans economic sectors, intervention programs, and development trajectories. The so-called "horizontal dimension of European governance", where civil society plays a significant role, has been extensively studied in literature (Eversole and Campbell, 2023). However, despite being a frequently highlighted necessity by analysts and policymakers, it has often been overlooked. In the new scenario, the involvement of private and public-private intermediary actors – such as well-known Local Action Groups (LAGs), districts, and networks of smart villages – offers an opportunity to enhance integration and address this gap.

5. Development models: new visions for new actors

It is now widely recognized that stakeholders of agricultural-rural systems care about aspects such as the quality of their environment and food, social cohesion, recognizability and autonomy not just because of economic benefits but because of improved quality of life (Riviera *et al*., 2018; Knickel, 2018). This paradigm shift must, consequently, also affect the development models pursued by policy intervention in agricultural-rural systems. Giving space to a vision of the future that is not only multidimensional (environmental, social, economic, institutional), but is also dynamic because it evolves with the adaptive capacity of the stakeholders and related governance, means a move away from a singular focus on economic efficiency or the valorisation of only endogenous system resources.

The elements that help build strong connections between endogenous and exogenous growth models are closely connected with the ecological, digital and social transition and the central role played by innovation and knowledge in these processes, as well as the need to refer

to systems of complex agricultural-rural actors and not only to individual supply chains or sectors (Cowie *et al*., 2020). The ecosystems described above, in fact, present both exogenous and endogenous knowledge flows and actors. This feature is amplified by the type of innovation introduced, often by producers, advisors, and other operators who are external to the sector and the reference area. The changes described in the make-up and roles of stakeholders, as well as in the characteristics of the related governance structures, also translate into an approach to development where geographical and sectoral boundaries become blurred.

The Organization for Economic Cooperation and Development (OECD) has argued that "the opportunities in rural areas go far beyond agriculture" (OECD, 2019) and possible solutions to the challenges we face seem to reinforce this observation. Different studies have provided empirical evidence to support the long-held belief that the top-down development model that for the last 30 years has been so ardently pursued by the EU, and which is largely responsible for the model of agriculture we find in the EU today, is simply not capable of bringing about the change and growth needed for agricultural-rural systems. In response, a debate has opened up on a different form of development defined as "neo-endogenous development" (Ray, 2000) of which the LEADER community initiatives continue to spearhead (Chatzichristos and Perimenis, 2022). This model sees rural development as an action of change that starts from actors within rural areas and communities, since their on-the-ground knowledge makes them the best stakeholders to implement and guide strategies. The drivers and actors that influence the change process are considered external to the local context. However, the actions needed for change cannot feasibly be undertaken by local communities alone, either due to lack of funds or lack of knowledge. To fill this gap, policy action intervenes with a top-down process, giving rise to a neo-endogenous policy-driven development. Following this approach, the LEADER community initiative had the objective of valorising endogenous resources and encouraging local actors to innovate and network through policy intervention. However, recent studies have highlighted that the proposed model has encountered obstacles due to too much red tape, an insufficient transfer of decision-making power by institutions to the LAGs, and a poor uptake by local actors of the initiatives on offer (Navarro *et al.,* 2016; Cejudo and Navarro, 2020).

As discussed earlier, the foundation for policy intervention and the basis for creating growth strategies should be a community of actors that form an ecosystem. This vision should also be integrated into discussions on development models. Both the scientific debate and empirical analyses increasingly reveal development models that do not fit into these paradigms.

The challenges facing the agricultural-rural system necessitate a transition towards new social models, often explained within the framework of the so-called "Social Innovation". The European Commission (2010: 9) defines social innovation as "the development and implementation of new ideas (products, services, and models) to meet social needs and create new social relationships." This concept is increasingly prominent in discussions on development models (Bock, 2016; Bosworth *et al*., 2016; Neumeier, 2017; Arnold *et al*., 2022) because it encompasses all components of innovation systems, including institutions, universities, producers, and civil society, while emphasizing values such as responsibility for change, social cohesion, and co-creation. According to Bock (2016), this increasingly requires

development models that facilitate connections with stakeholders that go beyond the local dimension. The need for exogenous actors becomes evident when considering the ecological and digital transitions. As described in the section on stakeholders, innovation and knowledge ecosystems involve actors beyond traditional geographical boundaries and zoning, transcending the urban-rural divide. Building an ecosystem with local and extra-local connections among various groups fosters a community united by shared cultural, scientific, and interest-based concerns.

Empirical studies (Gkartzios and Lowe, 2019) strongly indicate that a new model of rural development, termed "nexogenous" in its embryonic form (Bock, 2016), is emerging. This model's strength lies in linking and collaborating across spaces, accessing exogenous resources that, when combined with endogenous forces, enable revitalization. A defining feature is the "breaking down silos" process, not only geographically but also in areas of intervention. Often, the contributions of non-local actors are immaterial (knowledge, external networks, skills, interpretative tools), supporting the development of supra-local networks able to connect resources not available at the local level (Olmedo and O'Shaughnessy, 2022).

As discussed in previous paragraphs on new stakeholders, governance and development models, using a single theoretical framework, such as bottom up approach, to describe rural development could be no longer appropriate. This increased complexity is something public policy intervention will need to take into account. This scenario emphasises the growing importance of connections between research, policies, and society. This calls for a new interface between science, policy, and society. Significant attention has been given in the literature to the science-policy interface to support policymakers in implementing new and complex policies (Webb *et al*., 2022). However, the fundamental role of society in the ecosystem vision necessitates including this actor at the heart of connections. The science-policy-society interface must involve all key stakeholders to effectively address the challenges of designing and implementing complex policies. This approach ensures that the knowledge produced and transferred has political legitimacy, broad participation, equity, transparency, and democratic decision-making (Webb *et al*., 2022).

At both European and international levels, the effort to establish a science-policy-society interface has seen progress through the creation of various committees, expert panels, hubs, and networks by governmental and non-governmental bodies. However, this institutional dimension doesn't diminish the need for a constructive and operational interface at other decision-making levels – national, regional, and local (Singh *et al*., 2023). Particularly at these levels, a new science-policy-society interface can enhance the performance of the research community in co-creating knowledge that is more tailored to social needs and in effectively communicating results and potential strategies.

6. Conclusions

The aim of this work was twofold. The first objective was to describe and analyse the primary sector and its changes as it undergoes a complex transition process. The second one was to try to connect these changes with new research needs in order to bridge deep knowledge

gaps. To do this, four areas of analysis were investigated: intervention policies, new and traditional stakeholders in modern agriculture, governance structures, development models and their evolution.

Polices for the agricultural sector have a reach that goes beyond the primary sector. To face the challenges ahead, the interventions models have to support not only technological transformations, but also political and social ones. This requires a policy-mix, that is an integration between the plans and the actions, following a multi-actor and ecosystem-based approaches. New and traditional stakeholders populate and design agricultural and rural ecosystems in which co-creation processes are becoming strategic to develop new solutions for ecological and digital transition. To manage new dimensions and actors, governance becomes crucial and more complex as well as the organisations and processes through which public and private actors articulate their interests, regulations and implement decisions. The role of a "coordinating agent in an increasingly pluralistic innovation system" (EU SCAR, 2015) is primarily up to the public sector. It is also facing the challenge of adapting a large and highly specific body of legislation to an operational context where the boundaries between sectors, activities, and territorial zones are disappearing. This scenario asks for a governance model characterized by a crossing-cut dimension that includes economic sectors, intervention programs, and development trajectories. The future vision is multidimensional (environmental, social, economic, institutional) and dynamic because it evolves with the adaptive capacity of the stakeholders and related governance, meaning a move away from a singular focus on endogenous system resources. These profound changes also shape the kinds of development models that emerge from rural and agricultural systems. What can be seen is that knowledge flows and actors are both external and internal to the local territory and also to the agricultural sector. This creates strong connections between endogenous and exogenous growth models, highlighting the need for theoretical and empirical studies on innovative processes of development.

As discussed previously, co-producing knowledge with all actors in the agricultural and rural ecosystem through a multidisciplinary approach is now crucial. This challenge is fully embraced by the model designed by the European Commission, known as "Science for Policy 2.0" (Šucha and Vladimir, 2020) which breaks from the traditional linear model of knowledge diffusion. In this new approach, science must provide practical answers for the implementation of intervention policies, moving beyond "comfortable, well-defined scientific boxes." Given this, the relevant question, which still remains partially unexplored, is what characteristics scientists should possess to be key actors in the scenario described and, in particular, what the role of agricultural economists should be in guiding the implementation of policies in agricultural-rural ecosystems in the Science-policy-society interface. Surely the current context requires new roles and skills from researchers in terms of scientific communication methods, co-planning and mediation in multi-actor groups in which knowledge takes on different forms and different languages (van den Hove, 2007).

In order to respond to the dynamism of the context, research in agricultural policy has also evolved. According to some authors (Matthews, 2021; Dwyer, 2022), there are at least three factors that describe the change: a broadening of the areas of analysis in relation to the

differentiation of the objectives of policy intervention, an equal enrichment of the research questions deriving from the new tools used in policy intervention and the introduction of new methodologies deriving from the fields of economics, statistics and psychology, which has given space to new forms of analysis.

The profound change we are witnessing requires us, however, to reflect on how research must further evolve and with it the skills and roles of the scientists involved. The question becomes urgent when the following is noted in the literature: "the most cited papers that are driving the broader food systems and food policy agenda are not published in the traditional agricultural economics journals and often do not include economists among their authors" (Matthews, 2021: 197). There are several reasons why this is the case; a perceived lack of credibility, a lack of legitimacy of scientific knowledge (Cash *et al*., 2002), diversity of values, objectives and language between researchers and policy-makers, different time-scale perspectives (Eistrup *et al*., 2019), all of which relegate science and politics to separate worlds (Cash *et al.*, 2002).

There are various strategies to make the contribution of agricultural economists more impactful in the transition process affecting the rural-agricultural sector. In addition to an increasingly multidisciplinary approach, enhancing the ability to analyse the processes characterising the functioning of agricultural-rural systems of innovation and knowledge in order to achieve economic, environmental, and social objectives is essential. This requires embracing different analyses and evaluation approaches and engaging in a learning process that brings researchers closer to the transformation processes of agricultural and rural systems. This strategic choice is crucial for better understanding and analysing a reality that is becoming increasingly complex and multifaceted.

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Declaration of Competing Interest

The authors declare no conflict of interest in this manuscript.

Data Availability

Data will be made available by the corresponding author upon request.

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