

KNOWLEDGE AND INNOVATION SYSTEMS IN AGRICULTURE - A.K.I.S. -
CHALLENGES FOR LAGs

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Abstract: Agricultural Knowledge and Innovation Systems (AKIS) play a key role in promoting innovation, sustainability and resilience in agriculture and rural development. This paper explores the challenges and opportunities of AKIS for Local Action Groups (LAGs), particularly in the context of the European Innovation Partnership (EIP-AGRI) and the Common Agricultural Policy (CAP). Although AKIS aims to connect researchers, advisors, farmers and policy makers, significant barriers persist, such as fragmented knowledge flows, weak links between research and practice and low uptake of innovation by small and medium sized farms. LAGs are strategically positioned to facilitate co-creation processes, promote interactive innovation projects and integrate digital tools to support local development. For them to effectively contribute to AKIS performance, institutional support, capacity building and cross-sectoral collaborations are needed. Thus strengthening advisory services and including AKIS strategies in the CAP Strategic Plans are essential steps towards a more inclusive and effective innovation ecosystem at European level.

Key words: innovation, rural development, farm advisory, European policies, local partnerships

INTRODUCTION

Innovation is one of the key challenges facing agriculture in Europe, however, information on the effectiveness and functioning of agricultural knowledge and innovation systems (AKIS) is still limited. The structure and functioning of these systems vary significantly from one area to another and between different agricultural sectors, although diversity and ongoing transformations can support innovation and transition processes, there is uncertainty whether these systems are sufficiently well adapted to meet the growing need for productivity and sustainability in agriculture and the food industry [9,13,15].

AKIS components such as agricultural education, extension services and research activity face distinct challenges and are influenced by varying incentives. This fragmentation can limit the effectiveness of collaboration and synergy between stakeholders. In many cases, the educational system has weak links with scientific research, extension activities or the entrepreneurial environment, also applied research tends to be evaluated on scientific impact rather than practical relevance to farmers [1,4,5].

The concept of AKIS (Agricultural Knowledge and Innovation Systems) is an evolution of the classic AKS (Agricultural Knowledge Systems), which has been around since the 1960s. Initially, AKS referred to centralized structures, consisting of research, agricultural education and extension services, usually coordinated by public authorities, in particular Ministries of Agriculture, within an interventionist agricultural policy. These structures aimed to accelerate the modernization of the agricultural sector by coordinating knowledge transfer and innovation processes.

In the 1970s, the system was conceptually broadened to include the concept of "information", thus becoming AKIS: Agricultural Knowledge and Information Systems. This update reflected the growing interest in information processing and management in the context of the expanding use of information technology and the emergence of computers. The term AKIS has been enshrined in policy discourses and documents

produced by international organizations such as OECD and FAO, and has subsequently been reformulated as "agricultural knowledge and innovation systems", emphasizing the dynamics of innovation.

The shift from the traditional AKS approach to the complex and adaptive AKIS model was driven by four major developments (Figure 1).

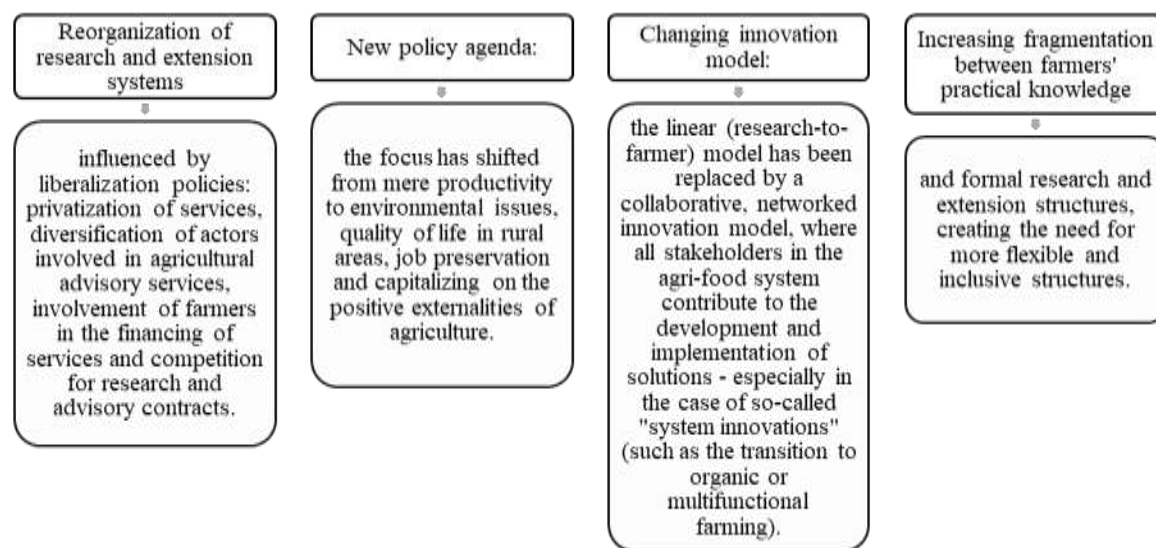


Figure 1. Developments between AKS and AKIS

According to the classical formulation, an AKIS is "a collection of organizations and/or individuals, together with the linkages and interactions among them, involved in the generation, transformation, storage, transmission, integration and use of knowledge and information, working together to support decision-making, solve problems and stimulate innovation in agriculture" [3,6,7,11].

To increase the effectiveness and applicability of results, it is essential to encourage collaboration between researchers, agricultural advisors and producers, more than simply passing on research results to farmers, it is important that they together with actors in the agri-food chain actively contribute to setting research directions. This requires a clear differentiation between research oriented towards scientific knowledge and that focused on practical innovation. These two approaches differ both in the way they are planned and in the degree of involvement of farmers and economic actors, as well as in the role played by European institutions, and recognizing these differences in the motivation and purpose of research could lead to more effective policies and better management of innovation activities in agriculture [7,10,11,17].

In recent decades, innovation processes in agriculture have become professionalized and agricultural research, training and advisory activities have been largely outsourced to universities, research institutes, government structures and professional organizations. The social impact of these interventions has been significant particularly in Europe, where access to safe, varied and affordable food has become the norm, but the current context poses new challenges. Issues of environmental sustainability, food security and climate change have generated a broad debate around the future of agriculture and the food system. In this new framework, the effectiveness and relevance of Agricultural Knowledge and Innovation Systems (AKIS) are being questioned, in particular for Local Action Groups (LAGs), which play an increasingly important role in rural development, the need to adapt AKIS to local specificities and to support the transition towards a more sustainable and innovative agriculture is emerging. LAGs are at

the intersection between farmers' needs, public policies and research initiatives, becoming a key actor in facilitating the flow of knowledge and innovative ideas at the local level [2,3,16].

One of the weaknesses identified is the fragmentation of the AKIS components, (education, research, advice) which often operate in parallel without sufficient interconnections, in addition, applied research is sometimes evaluated solely on its scientific impact without considering its direct benefits for practitioners. In this context, it is essential that LAGs promote collaborative networks between researchers, farmers, agricultural extension and other local actors, they can support a paradigm shift where innovation is guided by the real needs of the rural community and where knowledge is adapted to local conditions. This implies not only the transmission of scientific results, but also the active involvement of farmers in defining research directions and evaluating proposed solutions.

MATERIALS AND METHODS

In the present work, the AKIS concept is used as a methodological foundation to analyze how Local Action Groups (LAGs) can facilitate innovation in agriculture by stimulating collaboration between local actors, researchers, farmers and consultants. The AKIS model is thus adapted to local specificities and applied as a functional network for knowledge generation and transfer in rural territories. AKIS is not just a system for the dissemination of scientific results, but an interactive framework in which innovation emerges from the continuous dialog between research, practice and policy. In this context, LAGs can play a key role in activating local resources and connecting them to national and European innovation networks.

RESEARCH RESULTS

Naturally, with the social, economic and technological transformations that have affected agriculture, the theoretical concepts that define the knowledge infrastructure in agriculture have also evolved. Agricultural knowledge systems (AKS) were influenced by the dominant agricultural policies of the time. Thus, according to Leeuwis and Van den Ban (2004), the origins of AKS can be traced back to the interventionist agricultural policies of the 1960s, which emphasized the modernization of the sector through tight coordination of research, training and extension services, often under the direct coordination of central authorities.

In an attempt to adapt agricultural knowledge and innovation systems to the new realities of rural development, some authors have proposed an extension of the traditional AKIS concept, resulting in an integrated model known as AKIS/RD (Agricultural Knowledge and Innovation System for Rural Development) [6,8,12]. The proposed model recognizes that innovation in agriculture cannot be separated from broader rural development processes, being dependent on a more comprehensive network of actors and institutions. Thus, four key pillars are identified that interact in the process of innovation generation and dissemination (Figure 2).

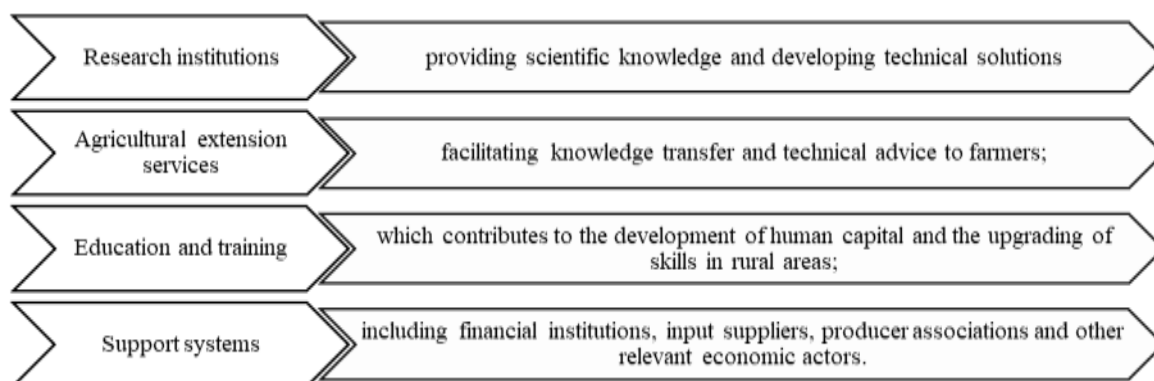


Figure 2. Interacting pillars in the process of innovation generation and dissemination

These four categories of actors act in a coordinated way, drawing on local knowledge and the direct experience of farmers and other members of rural communities. Innovation emerges in response to identified problems and opportunities, expressed social needs, but also in the context of public policies and regulations. An important point to emphasize is that problems are not exclusively determined by the economic or natural context, but are interpreted and defined differently, depending on the paradigms and perspectives of the actors involved [13,18]. The same applies to material resources and knowledge, which can be perceived and valorized in different ways depending on ideological or professional orientation. These differences in perception play a crucial role in formulating research priorities, setting development agendas and shaping public accountability.

In this dynamic, Local Action Groups can play a catalytic role. Thanks to their strategic positioning between local actors and regional or national decision-making structures, LAGs can facilitate dialogue between the four components of the AKIS/RD model, thus contributing to the co-creation of solutions adapted to territorial needs and to participatory, sustainable innovation rooted in rural reality.

Learning is understood as a complex social and cognitive process that occurs in the interaction between individuals and institutional environments, influenced by paradigms and cultural norms. It can manifest itself through practical, social, transdisciplinary or transformative learning all essential for adapting to current challenges in agriculture.

Innovation, according to the Oslo Manual, is the successful implementation of a new product, process, marketing model or organizational method. It is the result of a complex process involving scientific, technological, financial and commercial activities. Innovations can be product, process, marketing or organizational [6,9].

A farm is considered to be innovative if it has implemented at least one of these forms of innovation over a given period.

In recent decades, the concepts that define the knowledge and innovation infrastructure in agriculture have evolved significantly, reflecting the transformations in the rural environment and the increasingly complex needs of farmers and local stakeholders. From classical AKS-type systems based on linear knowledge transfer to more complex and interactive models, such as AKIS, AIS and LINSAs, which emphasize collaboration, learning networks and co-creation of innovation. Table 1 highlights the key differences between these concepts, highlighting features such as the type of actors involved, the way they relate to each other, the approach to knowledge and the role assigned to innovation within each model.

Table 1.

Developments and differences in approaches to knowledge and innovation in agriculture

Concept	Definition	Main actors	Type of relationships	Approach to knowledge	The role of innovation
Agricultural Knowledge System (AKS)	Network of researchers, advisors and educators involved in knowledge generation and transfer to farmers	Public research, agricultural education, extension services	Linear (research to farmer)	Knowledge is a stock to be transferred	Limited, modernization-oriented
Agricultural Knowledge and Innovation System (AKIS)	Network of organizations and individuals involved in producing, sharing and using knowledge to support agriculture and innovation	Researchers, advisors, farmers, input suppliers, authorities	Interactive, collaborative	Knowledge is created and used in networks	Central, driver of rural development
Agricultural Innovation System (AIS)	Network of organizations, enterprises and individuals focused on the introduction of new products, processes or models in agriculture	Public + private sector, farmers, industry, financial institutions	Dynamic and multi-directional network	Knowledge is a resource for innovation and competitiveness	Essential, main objective
Learning and Innovation Networks for Sustainable Agriculture (LINSAs)	Thematic networks including diverse actors co-producing knowledge for sustainability	Farmers, extension, NGOs, researchers, policy makers	Thematic, participative networks	Knowledge is built through interaction and adaptation	Innovation is co-created, oriented towards sustainability

In the current context of rural development, agricultural knowledge and innovation systems are called upon to respond to increasingly complex challenges that go beyond the boundaries of traditional agriculture. LAGs, through their strategic positioning between local communities, public administration and socio-economic partners, can play a key role in the revitalization and reorganization of AKIS at territorial level.

AKIS must now include new areas: healthy food, public health, local economic resilience, social innovation, and work with a diverse range of actors: local entrepreneurs, cooperatives, NGOs, rural youth and women. This openness implies going beyond the institutional boundaries of the former AKS and functioning as a collaborative, adaptive and open network.

In many regions, AKIS faces major problems of fragmentation lack of cooperation between research, extension and practice, as well as lack of effective linking mechanisms. Applied research is not always oriented to the real needs of farmers or rural entrepreneurs and access to information is limited for many beneficiaries. This is where LAGs can act as "connecting nodes" between AKIS sub-systems. They can create bridges between farmers, researchers, advisors and the educational environment by organizing initiative groups, participatory workshops, pilot projects or local innovation hubs [4,8,13].

LAGs can play a catalytic role in promoting social and collaborative learning, bringing farmers, teachers, consultants, young people and government representatives into the same space. In many cases, rural women and young entrepreneurs bring innovative perspectives, and LAGs can support their initiatives through funding, mentoring or facilitating access to markets. In this sense, LAGs can transform agricultural education from a formal process into a living, practical and interactive learning environment, integrating current concerns: agroecology, economic diversification, circular economy, food security.

One of the current weaknesses of the AKIS system is the weak capitalization of research results, and knowledge transfer is often blocked by the lack of a "translator"

between the academic language and the concrete needs of farmers. This is where LAGs can act as knowledge brokers, organizing meetings between researchers and farmers, translating scientific results into practical terms and helping to field test innovative solutions. By supporting mixed public and private extension initiatives, LAGs can encourage the adoption of best practices, increase productivity and harness local resources in a sustainable way.

Innovation is, by definition, a risky process and requires openness to change, and many current AKIS structures discourage innovation, either through lack of funding, bureaucracy or institutional rigidity, so in this context LAGs can support the creation of a climate that is conducive to innovation (Figure 3).

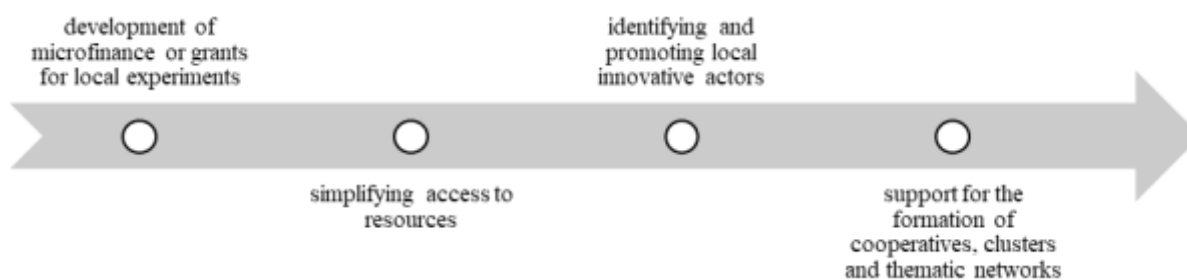


Figure 3. Key stages of the innovation process and the role of LAGs in facilitating them in AKIS

In the current landscape of rural development, Local Action Groups are becoming essential actors in facilitating the transition from traditional farming systems to an innovative model based on collaboration and collective learning. Within this framework, knowledge and innovation systems in agriculture must respond to more complex needs than mere technology transfer, they must become active tools for territorial development.

Innovation, in this context, is no longer limited to new products or technical processes, but extends to the organization of the food chain, local governance and community involvement. In practice, farmers innovate not just by using modern inputs, but by recombining knowledge, adapting market strategies and creating customized local solutions. LAGs, by their participatory and multi-sectoral nature, are ideally positioned to support this type of systemic innovation. In the past, the AKS system relied on a linear relationship between research, extension and farmer adoption. Now, in the AKIS system, the emphasis is on co-production of knowledge and partnerships between local actors, universities, NGOs, firms and public institutions. The role of LAGs is fundamental here: they can activate and mediate these networks at local level, stimulating collaboration between often isolated parties.

For AKIS to become truly functional, a restructuring of governance is needed. LAGs can support this transformation by:

- promoting participatory governance, where decisions on innovation are taken together with local actors;
- creating living labs for testing solutions under real-life conditions;
- monitoring and disseminating the social benefits of local knowledge and innovation;
- working with public administration to make the regulatory framework more flexible.

Innovation is essentially a social process and learning, especially collective learning, plays an essential role in this process, which becomes the key to the success of innovative initiatives. Thus, innovation takes place in learning cycles: an actor perceives an

opportunity or identifies a problem, seeks a solution, applies it and, following implementation, returns to the system with new knowledge acquired.

The Local Action Groups (LAGs) have the capacity to formalize and support these cycles by creating spaces for dialogue, collaboration and applied experimentation on the ground. Moreover, LAGs can create and manage "niches", i.e. protected spaces where innovative solutions tailored to local needs and context are tested and refined. In this equation, LAGs can position themselves as links between the wider socio-political context (public policies, regulations, European funds) and the internal dynamics of local communities. They can adapt external strategies to the specificities and resources of each rural area.

At the same time, there is a paradigm shift in rural development from an approach focused on technological modernization towards a vision that emphasizes sustainability, local resource use and active community participation. This new paradigm promotes endogenous innovation, both social and organizational, that relies more on local creativity and collaboration rather than simple technology transfer. In this paradigm, LAGs become architects of the rural transition, contributing not only to technology deployment but also to the reorganization of local actor networks, economic diversification and the strengthening of communities' social capital.

CONCLUSIONS

In the current context of European agriculture, characterized by pressures related to sustainability, climate change, food security and global competitiveness, innovation can no longer be treated as an isolated process, but as an integral part of a complex ecosystem of knowledge and action. Agricultural knowledge and innovation systems are called to respond to these challenges through an integrated, transdisciplinary and locally adapted approach. However, in many regions these systems remain fragmented, with weak links between research, extension, agricultural education and rural economic actors. In this landscape, Local Action Groups (LAGs) can play a key role in bringing these components together into a functional, interactive network oriented towards the real needs of the community.

LAGs, by their participatory and multi-sectoral nature, are well positioned to act as intermediaries between the different AKIS subsystems. They can facilitate collaboration between farmers, researchers, agricultural advisors, educational institutions and local decision-makers, creating spaces for dialog and collective experimentation. Instead of being just passive recipients of scientific results, farmers can become co-creators of innovation, actively contributing to the formulation of the research agenda and testing solutions in the field. In this way, knowledge no longer flows one-way, but is developed collaboratively and adapted to realities on the ground. In addition, LAGs can support the transition to a new paradigm of rural development, which is no longer based exclusively on technological upgrading but integrates social, organizational and environmental dimensions. They can support the emergence of innovation 'niches' - protected spaces where innovative solutions can be tested, refined and then scaled up. They can also help to make the regulatory framework more flexible and create participatory governance mechanisms that are essential for community-driven innovation.

Making AKIS systems more effective and relevant to today's challenges requires the strategic involvement of LAGs, which become catalysts of territorial innovation, facilitators of collective learning and architects of sustainable, resilient agriculture deeply connected to the needs of rural communities.

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