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# THE ROLE OF ASSOCIATIVE FORMS IN STIMULATING AGRICULTURAL INNOVATION AND INCREASING ECONOMIC PERFORMANCE - A BIBLIOMETRIC APPROACH

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***Abstract***

*In this article, we have analyzed how innovation in agriculture is reflected and articulated in the international scientific literature, with a special focus on the role of associative forms, such as cooperatives and producer groups. The main goal was to understand how types of agricultural innovation are defined and disseminated and to what extent they are influenced or facilitated by collective farmer organizational structures. The approach was guided by two objectives: identifying the main types of innovation applied in agriculture and carrying out a bibliometric analysis that would highlight the structure and dynamics of scientific knowledge in this field. The methodology was based on querying the Scopus database, using relevant terms such as agricultural innovation, farmer associations and economic performance. The data obtained were processed using VOSviewer, to generate thematic maps that analyze networks of co-citation, keyword co-occurrence, international collaboration and bibliographic coupling. The results obtained show that, although the topic of agricultural innovation is intensively treated, the relationship with associative forms remains peripheral in the specialized literature. The bibliometric networks show a pronounced conceptual fragmentation, with thematic clusters evolving in isolation, some focused on technology and adoption, others on rural development or sustainability, without a coherent integration of the organizational dimension. In addition, the lack of common theoretical sources and insufficient standardization of terminology affect the coherence of the scientific field and its capacity to produce transferable explanatory models. The general conclusion emphasizes the need for interdisciplinary and integrative approaches, which more clearly connect technological innovation with social and institutional processes in agriculture. It is also recommended to valorize associative forms as active vectors of innovation, not just as an organizational background, in order to advance towards a more complete understanding of the transformations in contemporary agriculture.*

***Key words:*** *innovation, agriculture, association, economic performance, bibliometric analysis*

## INTRODUCTION

In a global context marked by major transitions, climate change, demographic pressure, food crises and accelerated technological transformations, agriculture remains not only a strategic sector, but also a space in which the dynamics of innovation become vital for sustainability and competitiveness [13]. At the same time, the excessive fragmentation of agricultural holdings, the lack of individual resources and the asymmetry of access to technology have led to the need for forms of cooperative or associative organization, which allow the aggregation of interests, resources and innovation capacity. This dual framework, the need for innovation and the imperatives of collaboration, underpin the present scientific approach, which explores the interdependencies between innovation in agriculture and associative forms.

Agricultural innovation is not only about introducing new technologies, such as high-performance machinery, digital monitoring systems or innovative biological solutions [15, 16, 17]. It also includes organizational processes, new cooperation models, access to knowledge and support services for farmers. Innovation is thus both a technological and a social and institutional process [19, 20]. Associative forms, such as cooperatives,

producer groups or inter-farmer partnerships, can be essential catalysts for these processes. They reduce the isolation of farmers, facilitate the exchange of good practices and increase the absorption capacity of European funds for investment and innovation [4].

In Romania, innovation challenges are exacerbated by the structural specificity of agriculture. High fragmentation, the dominance of subsistence farms and weak organization in associative forms have long limited the sector's capacity to adopt modern technological solutions. Despite the high agricultural potential, the economic performance of Romanian farms remains modest compared to the European Union average [5, 7]. Also, the innovation rate is significantly lower among individual farms than those organized in associative forms, according to data from international sources. These discrepancies justify a deeper analysis of how association forms influence the adoption of innovation and, implicitly, the economic performance of the sector.

In the specialized literature, there is a growing consensus on the idea that associative forms constitute a favorable framework for innovation. Agricultural cooperatives in particular are frequently cited as examples of success in facilitating access to markets, technologies, vocational training and financing. By sharing risks and costs, they can stimulate the process of adopting new technologies and transitioning to sustainable agricultural practices. However, the effect of these forms of organization on economic performance is not always linear or guaranteed. Success depends on factors such as the quality of internal governance, the level of trust between members, institutional support and the regional socio-economic context.

A first objective of the research is to identify the main types of innovation that can be adopted in the agricultural sector – from technological innovations (precision farming systems, drones, sensors, etc.) to organizational innovations (e.g. short supply chains, collective contractual models, digital sales platforms). In parallel, the research aims to assess the degree of diffusion of these innovations in Romania and other European countries, focusing on the differences between individual and associated farms.

The second objective aims to carry out a bibliometric analysis to understand how this topic is approached in the international scientific literature. Thus, a map of key concepts (agricultural innovation, farmer associations, profitability) will be built, the main authors, citation networks and existing research gaps will be identified.

The relevance of the topic is also given by the current context of European policies. The new Common Agricultural Policy (CAP 2023–2027) emphasizes innovation, digitalization and cooperation as pillars of the sustainable development of European agriculture. Initiatives such as the European Innovation Partnership in Agriculture (EIP-Agri), Smart Villages or the Horizon Europe programs offer concrete opportunities for promoting associative forms as vectors of innovation. Romania, with an agriculture marked by structural polarization and underutilization of associative potential, has the chance to capitalize on these directions through a strategic and integrated approach. At the same time, it is important to understand that innovation is not a neutral process, but a deeply contextual one. The adoption or rejection of innovations depends not only on their technical efficiency, but also on cultural, institutional and economic factors. Thus, in an agricultural community with a low level of mutual trust or with negative experiences related to forced cooperatives from the communist period, associative forms develop with difficulty, and innovations penetrate fragmentedly. Therefore, a deep analysis must take into account both objective and perceived barriers to the process of innovation and association.

The approach to this topic also has an important practical component. Understanding how agricultural innovation is supported by cooperation can underpin more effective public policies, support programs adapted to local realities, and bottom-up interventions, in which farmers become active agents of transformation. Also, highlighting the performance differences between associative and individual farms can constitute a solid argument for promoting voluntary

cooperativization and for consolidating the agricultural associative sector in Romania.

## MATERIALS AND METHODS

To achieve the established objectives, the present research was structured in two main methodological stages: an empirical-descriptive one, based on the exploration and classification of relevant statistical data sources, and a documentary-analytical one, based on the bibliographic analysis of international scientific production in the field.

In the first stage, the emphasis was placed on understanding how innovation is conceptualized and applied in the agricultural context. Not only the technological side was taken into account, such as the adoption of modern equipment, the digitalization of farms, precision agriculture, but also the organizational, institutional and social dimensions of innovation, being analyzed secondary data sources, such as thematic databases, but also public policy documents.

To support the theoretical approach and calibrate the directions of empirical analysis, an applied bibliometric component was integrated, aiming to evaluate the current state of scientific research in the targeted field. At this stage, the Scopus database was used, recognized for the accuracy and timeliness of indexing scientific publications in fields such as social sciences, economics, agriculture, rural development and innovation. The search conducted on July 25, 2025 targeted three key terms, strategically selected for their relevance to the objectives of the paper: agricultural innovation resulting in 18,334 identified articles; farmer associations, resulting in 219 articles and economic performance, with 6 identified articles (in combination with the other terms).

These results reflect a significant contrast between the intense interest shown by the academic community for agricultural innovation in the broad sense and the still limited presence of research that analyzes in depth the role of associative forms in this process. The low number of articles that simultaneously integrate the three dimensions – innovation, association and economic performance – signals the existence of a conceptual and applicative void that can be capitalized on through research oriented towards the relational analysis of these phenomena.

The query was performed on the standard Scopus fields (title, abstract, keywords), with minimal delimitations regarding the publication period, precisely in order to obtain the most complete picture of the conceptual dynamics over time. The resulting articles were subsequently qualitatively filtered, based on relevance to the research object, and were to be analyzed in depth in the section dedicated to the literature review and bibliometric synthesis.

To visualize thematic relationships and scientific networks, bibliometric data were processed using the VOSviewer software, which allows the graphical representation of concept clusters, co-citations and institutional or international collaborations. Thus, bibliometric analysis was not used only as a descriptive tool, but as a mechanism for mapping the scientific field, providing a clear picture of the hard core of research in the field, but also of emerging or poorly covered frontiers.

This dual approach allowed us to anchor the research in the existing literature, while providing us with starting points for a critical analysis of the degree of thematic coverage, consolidated research directions and existing gaps in the field of innovative associative agriculture. Through this methodology, the research proposed a contextualized and integrated understanding of the phenomenon of innovation in agriculture, in a framework in which forms of collective organization become not only logistical supports, but essential vectors of transformation of the contemporary agri-food sector.

## RESULTS AND DISCUSSIONS

The bibliometric analysis of the 219 selected articles and the results of the application of the 2 key terms used aimed to identify the main concepts, trends and scientific networks that structure the field, providing a systematic perspective on how the topic is treated in the

specialized literature. The results visualized in the form of thematic maps allow not only to highlight active subfields, but also to delimit research gaps. In the study, 9 conceptual maps were constructed, each focusing on a specific aspect of agricultural innovation and cooperation in this field, including the analysis of the co-occurrence of keywords, co-authorship networks and the way in which these important fields have developed.

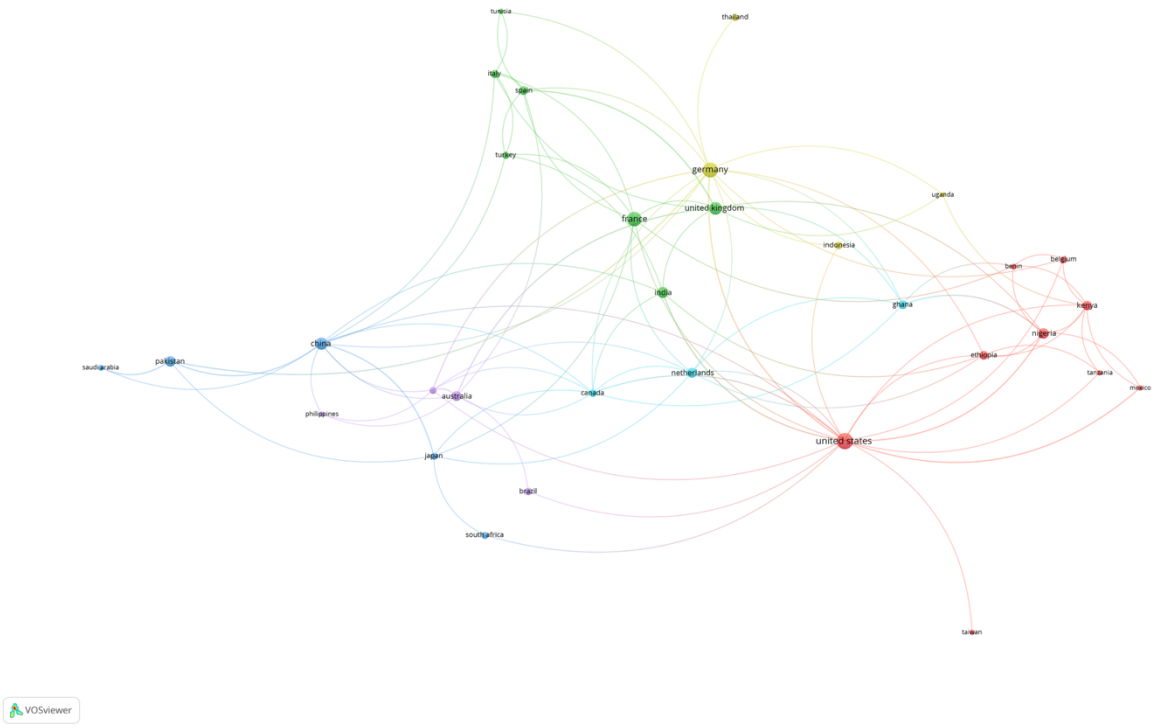


Fig. 1. Geographical distribution of scientific collaboration on innovation in agriculture: bibliometric analysis of countries
Source: own processing [18].

The map of international scientific collaborations highlights the co-authorship networks between countries in the field of agricultural innovation research. The analysis shows the existence of well-defined scientific centers of gravity, dominated by a few states with a high volume of academic production and a high capacity for transnational collaboration. The United States of America occupies a central role in the collaboration network, acting as a major interconnection node, especially with countries in Africa (Kenya, Nigeria, Tanzania, Ethiopia) and Western Europe (Belgium, the Netherlands). This position reflects both the capacity to coordinate international projects and the strategic interest in emerging agriculture and global rural innovation. China forms an important pole in the east of the network, with strong collaborative relationships in Asia (Pakistan, Philippines, Japan), but also with Australia and South Africa. Unlike the USA, Chinese collaborations are more strongly anchored in the Asia-Pacific area, indicating a regional dimension of research. France, Germany and the United Kingdom are emerging as a European research cluster, interconnected with Italy, the Netherlands and Turkey. These countries demonstrate intense domestic and cross-border scientific activity, in line with European policies on rural development and the green transition. The European cluster is also visibly connected with states in Africa and Southeast Asia, which shows a dual interest: fundamental and applied research, with a development cooperation component. Countries such as Kenya, Ghana, Nigeria and Ethiopia frequently appear in connection with researchers from the USA and Europe, which also indicates an orientation of research topics towards the context of developing agriculture. At the same time, African countries play a rather passive role in the network, being included in collaborations,

but rarely acting as independent poles of co-authorship. Australia and Canada have moderate links with China, the USA and Europe, but without significant centrality in the network, which demonstrates a selective involvement in international consortia.

This structure highlights the asymmetry in the production and dissemination of scientific knowledge in the field of agricultural innovation and indicates the need to strengthen institutional capacities in underrepresented countries.

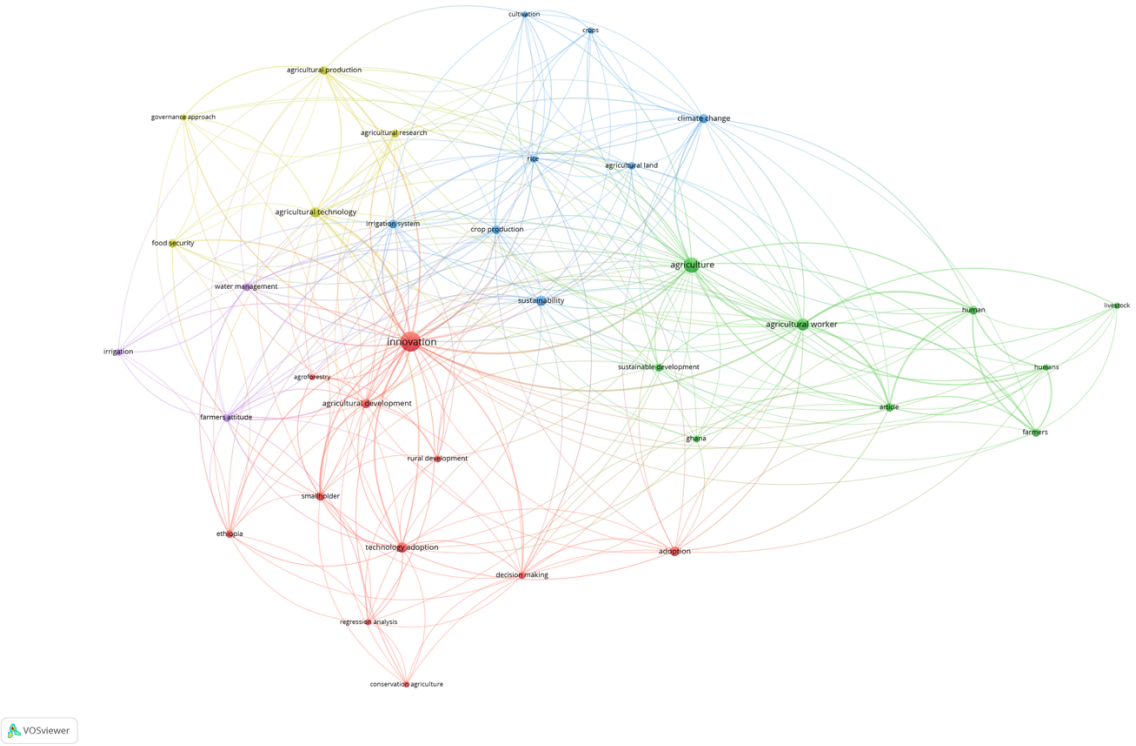


Fig. 2. Terminological structure of the scientific literature on agricultural innovation
Source: own processing [18].

The keyword co-occurrence map (Figure 2) highlights the conceptual organization of the scientific literature on agricultural innovation. The central term, "innovation", is connected to a variety of sub-themes, signaling a complex and interdisciplinary approach. Several thematic clusters are emerging around it. The first major cluster, dominated by terms such as "agricultural development", "technology adoption", "rural development" and "smallholder", shows that innovation is understood in direct relation to the modernization of small-scale agriculture. The emphasis falls not only on technology, but also on the decision-making, adoption and adaptation processes at the farmer level, which reflects an applied and pragmatic orientation of the research. Implicitly, innovation is perceived as a tool for reducing vulnerability and stimulating local development. A second relevant cluster, focused on terms such as "agriculture", "farmers", "gender" and "livestock", brings to the fore the social dimension of agriculture. The presence of gender and agricultural worker themes indicates an increasingly visible concern for equity, inclusion and the differential impact of innovation on different categories of rural actors. Innovation is thus not only a technical process, but a social one, with implications for the structure of communities and roles on the ground. A third cluster groups terms such as "sustainability", "climate change", "agricultural land" and "crop production", reflecting the integration of innovation into the discourse on sustainability and climate change. Here, innovation appears as a response to environmental crises, especially in the context of smart agriculture and resource conservation.

Fig. 3. Co-occurrence network of authors' keywords in the literature on agricultural innovation
Source: own processing [18].

The co-occurrence map of the author keywords reveals an extremely fragmented thematic network, with only a few weakly connected nodes, which reflects a low level of conceptual convergence in the scientific literature dedicated to the relationship between agricultural innovation and associative forms. The terms present, such as "technology adoption", "smallholders", "innovation", "climate change", "sustainable agriculture", appear grouped in linear chains, not in dense clusters, which demonstrates the lack of a consolidated thematic core.

This dispersion has multiple causes. First, the researched themes are often treated in isolation: innovation is studied predominantly from a technological perspective, and associative forms rarely appear as explicit vectors of it. Second, the relevant literature is fragmented between several disciplines (agronomy, economics, rural development, public policies), which reduces terminological coherence between authors.

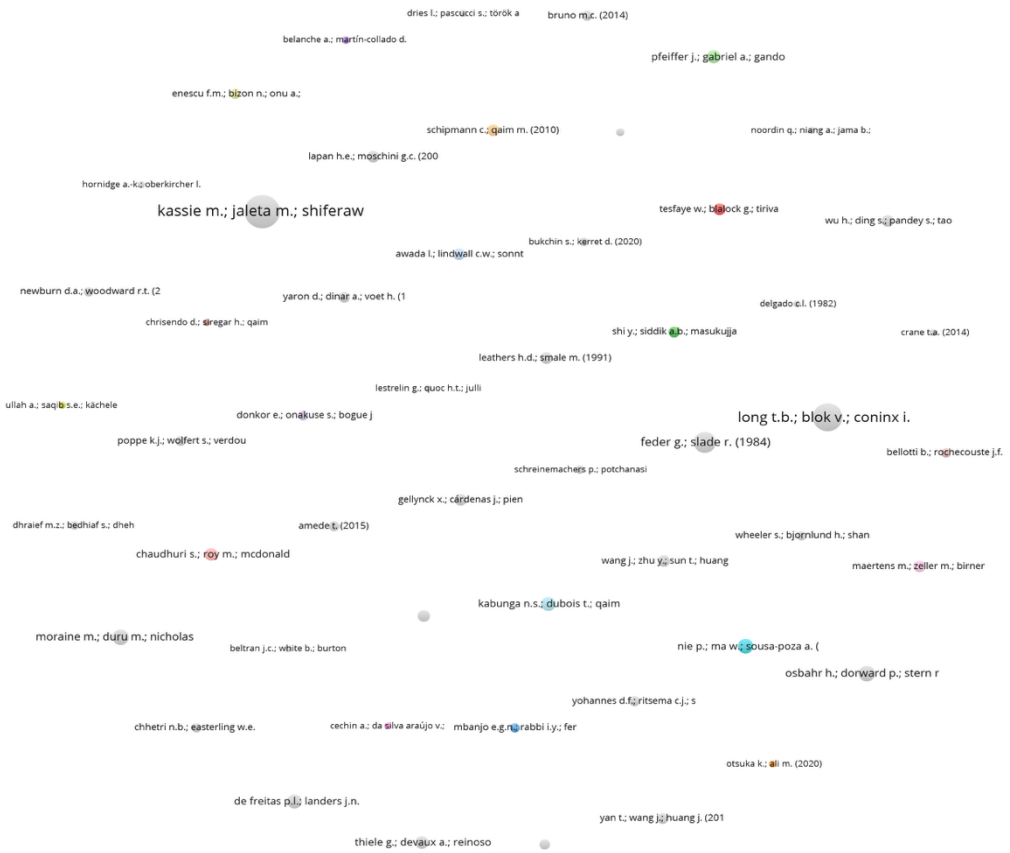


Fig. 4. Citation network in agricultural innovation and cooperation research
Source: own processing [18].

The consequence of this dispersion is the absence of a common language that facilitates the accumulation of knowledge and solid theoretical construction in the field. Without recurring terms and strong semantic correlations, the field remains poorly integrated and with reduced academic visibility.

To correct this fragmentation, a gradual standardization of thematic vocabulary, a better anchoring in theoretical concepts and a stimulation of interdisciplinary research that integrates technological innovation with organizational and social aspects are required. International initiatives such as EIP-Agri or European networks for rural development can be fertile environments for the development of a common research core, in which terms such as "cooperation", "farmer organizations" or "collective innovation" become part of the frequently used vocabulary.

The map of the most cited articles (Figure 4) highlights a series of seminal works that have shaped major research directions in the field of agricultural innovation. The most prominent papers, such as those by Kassie et al., Long et al. [10], and Feder et al., indicate recurrent and converging themes, with a clear focus on technology adoption, farmer behavior, and the economic efficiency of innovation. The work by Kassie et al. (focused on Africa and smallholder farmers) is notable for its high network connectivity, which signals a sustained interest in innovation in subsistence agriculture and the determinants of adoption [8]. The frequently cited papers by Feder and Umali played a founding role in the formulation of theoretical models of the adoption decision and are still relevant in the contemporary literature [6].


Fig. 5. Cross-country citation network in agricultural innovation and cooperation research
Source: own processing [18].

The most cited articles are predominantly anchored in empirical contexts from the global South (Asia and Africa), which indicates a dominant concern for rural development, poverty reduction and the adaptation of technologies at the local level [3, 12]. In contrast, the dimension related to associative forms appears marginal and works focused on

agricultural cooperatives or partnerships do not figure among the most influential, which shows a thematic space under-represented in the impact literature [2, 21]. This concentration of citations around topics such as technology adoption, economic behavior, and farm-level analysis reflects the dominant orientation towards efficiency and economic performance, rather than towards the institutional, social, or collaborative dimensions of innovation [1, 9, 11, 14].

To balance this thematic imbalance, we believe it is necessary to promote research that analyzes the role of associative forms as a medium for the production and diffusion of innovation, integrating indicators of collaboration, trust, governance, and social capital. Such approaches could complement the current literature, offering a more systemic and inclusive perspective on the innovation process in agriculture.

Figure 5 highlights that, although several countries are active in publishing relevant research (United States, China, India, United Kingdom, Nigeria), there is no consolidated co-citation network between them. Each country seems to operate in isolation, without significant bibliographic interdependence. This lack of connections signals a global fragmentation of the scientific field: researchers from different countries do not frequently read the same reference works or build on common literature bases. In practice, this reflects the existence of several "academic islands", where themes and approaches are developed in parallel, but do not converge in a coherent international dialogue.

The causes can be multiple: language barriers, regional differences in research priorities, unequal access to indexed publications, but also different institutional orientations (they place greater emphasis on local empirical studies in the Global South vs. theoretical research in the Global North).

The absence of a solid co-citation network reduces the chances of theoretical synthesis, fragmenting the global understanding of agricultural innovation. Furthermore, associative forms, often dependent on local contexts, remain poorly connected between international studies, which limits the transferability of good practices and successful models. Solutions could include promoting international collaborative projects (Horizon Europe, ERANet), creating meta-analyses and synthesis articles with transregional visibility, and encouraging publications with international co-authorship and cross-citation.

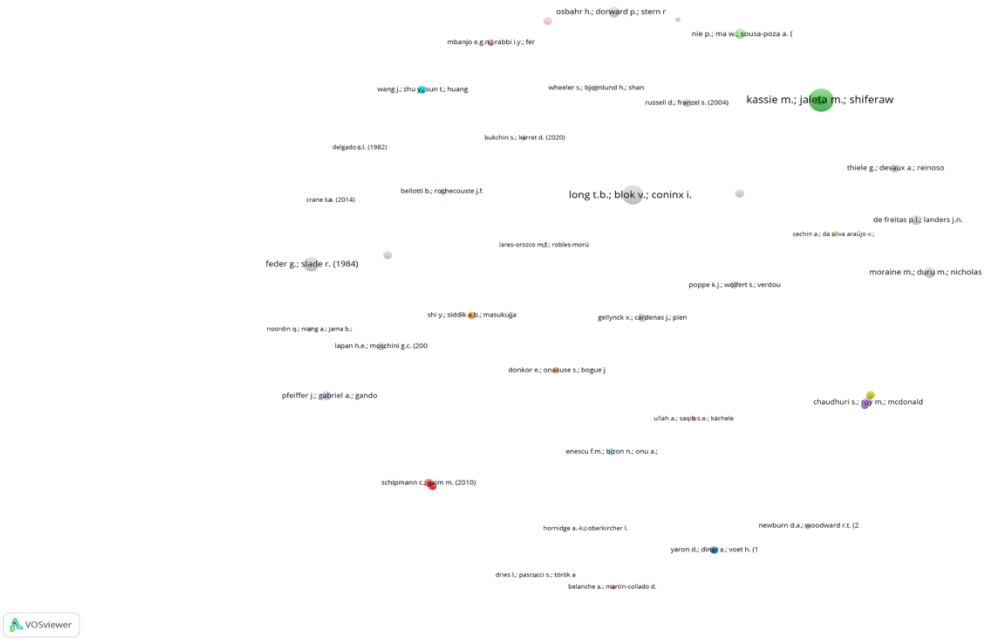


Fig. 6. Bibliographic linking network of documents in agricultural innovation and cooperation research
Source: own processing [18].

The analysis of bibliographic coupling provides a picture of how documents in the scientific literature are linked to each other through common cited sources, reflecting the intellectual proximity and thematic convergence of research. In Figure 6, the network highlights the formation of several distinct groups of works that share similar bibliographic bases, suggesting the existence of consolidated subdomains within the general theme of agricultural innovation and cooperation. A first group is shaped around research focused on the adoption of technologies in small-scale farms, with an emphasis on economic variables, farmer attitudes and access to resources. A second cluster is centered on sustainable development practices and conservative agriculture, and a third on institutional models of cooperation and rural governance. These subthemes show a healthy diversification of research directions, but also the tendency of authors to work with common sources within a narrow framework, which may limit the dialogue between complementary perspectives.

However, the absence of dense connections between clusters indicates a fragmentation of the literature. Works in the field of agricultural cooperation appear weakly linked to those oriented towards technological innovation, which shows a dissociation between the social-organizational and the technical-economic dimensions of research. This thematic gap is due to the excessive specialization of the authors, the lack of integrative theoretical frameworks or the underrepresentation of associative forms in dominant studies. The result is an active scientific field, but one that risks evolving into disciplinary clusters, without a coherent vision on how agricultural cooperation influences, and is influenced by, innovation processes. Therefore, we believe that there is a need to promote interdisciplinary research and synthesis studies that connect the fields of governance, innovation and rural development. International initiatives and European policies can provide the right context for the emergence of an integrative sector of literature.

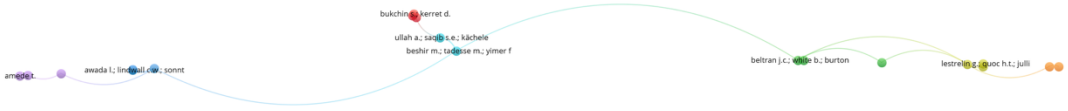


Fig. 7. Bibliographic coupling network of sources in agricultural innovation and cooperation research
Source: own processing [18].

The bibliographic coupling network of sources reflects the connectivity between scientific publications based on the common references used by the authors. In Figure 7, a linear network is observed, made up of a few isolated or weakly interconnected nodes, signaling a low degree of bibliographic cohesion in the field of agricultural innovation and cooperation.

The presence of several Authors, such as Beltrán, Lestrélin, Kächele, Awada, in intermediate positions, but with few links between clusters, indicates independent thematic groups, each operating with its own set of sources. This fragmented structure reflects a lack of theoretical consensus and common framework sources, which limits the development of an integrative scientific discourse.

In the long term, this dispersion may reduce the visibility and impact of research related to agricultural cooperation, especially if it does not connect to well-consolidated bibliographic corpora. It is necessary to consolidate central reference sources and promote synthesis works that connect isolated research and facilitate the formation of a clear epistemological identity in this emerging field.

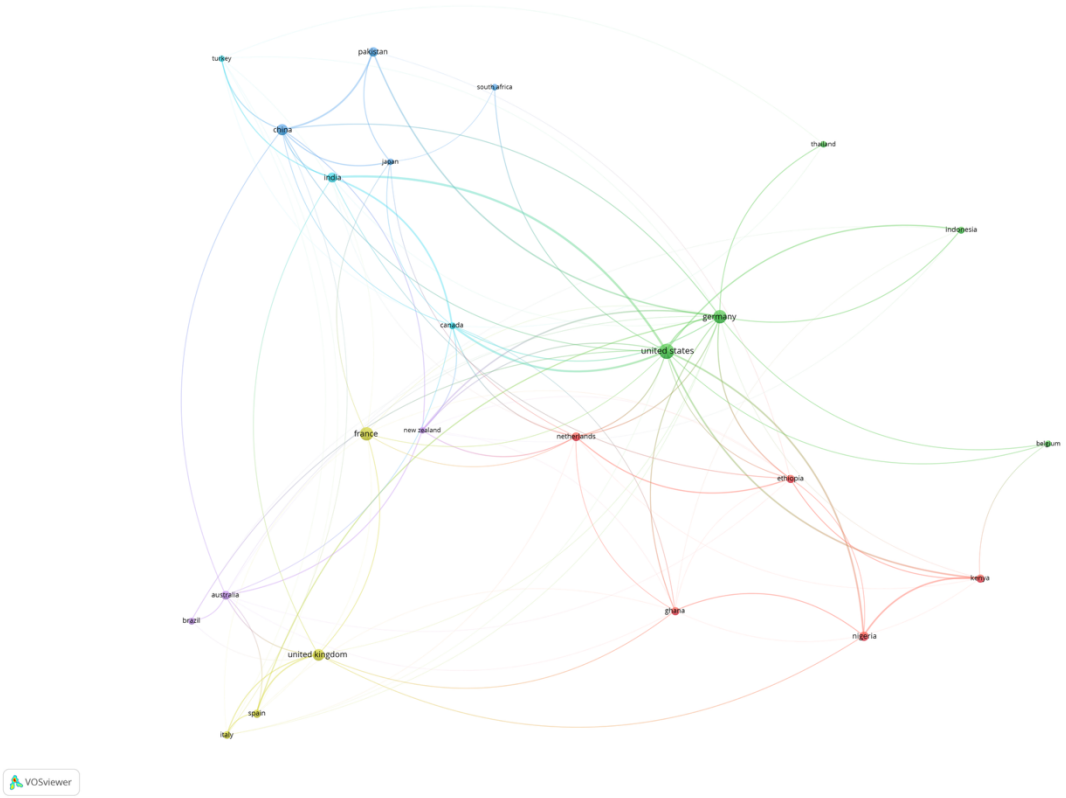


Fig. 8. Bibliographic coupling network between countries in agricultural innovation research
Source: own processing [18].

Figure 8 highlights a bibliographic coupling network between countries, in which countries are connected according to the similarity of bibliographic sources used in their publications. Unlike co-authorship maps, this network shows the extent to which researchers from different countries read the same sources and, implicitly, participate in the same global scientific conversations. The network shows a polarized structure around highly connected countries, such as China, the United States, Germany, and the United Kingdom, which act as central nodes. These countries frequently share the same reference sources, suggesting an epistemic and thematic convergence among researchers in these academic spaces. Other regional groups, such as African or Asian countries (Nigeria, India, Pakistan), appear indirectly connected, with a more modest participation in the common bibliographic corpus, but with visible links to dominant centers. This shows an assimilation of the "central" literature without sufficiently visible theoretical contributions of their own, reflecting an imbalance in global scientific influence.

It was found that from the perspective of agricultural innovation, only certain geographical spaces actively participate in shaping a common scientific discourse, while others remain in peripheral areas, despite the growing volume of scientific production. We consider it essential to promote transnational collaborative research and relevant local bibliographic sources, in order to reduce dependence on dominant literature and balance theoretical influences in the field of innovative agriculture.

The network highlights the conceptual structure of the scientific literature by analyzing authors who are frequently cited together, suggesting theoretical, methodological, or thematic affinities. The presence of several densely connected clusters, each represented by a distinct color, indicates a diversity of schools of thought or emerging subfields. The central, red cluster brings together fundamental authors in the theory of agricultural technology adoption and rural economics, while the green and blue clusters integrate authors associated with sustainable development, agricultural policies, and rural

governance. The presence of an isolated group on the far left, purple, indicates a minority line of research or an alternative approach, possibly from another geographical region or discipline. The co-citation network shows a growing scientific coherence around canonical authors, which indicates the stabilization of the thematic field. However, the fragmentation into several clusters also reflects a lack of transversal integration between technological innovation and associative forms, which often remain treated separately. We believe that strengthening the dialogue between clusters through synthesis research and interdisciplinary works can facilitate the articulation of a unitary paradigm on agricultural innovation in associative contexts, capable of underpinning more efficient and inclusive public policies.

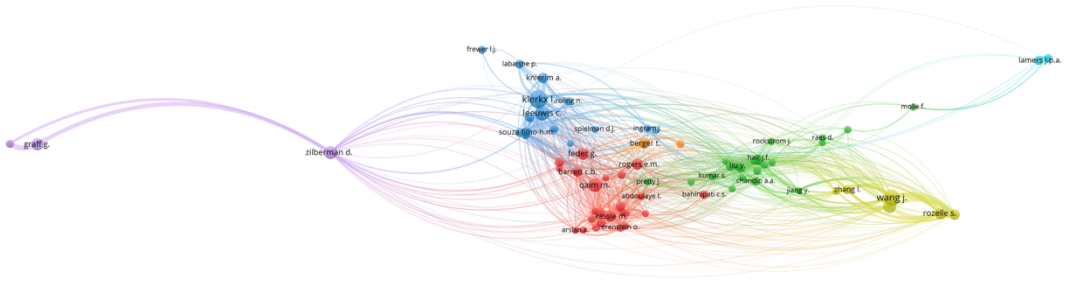


Fig. 9. Co-citation network between authors in the literature on agricultural innovation and cooperation
Source: own processing [18].

The network highlights the conceptual structure of the scientific literature by analyzing authors who are frequently cited together, suggesting theoretical, methodological, or thematic affinities. The presence of several densely connected clusters, each represented by a distinct color, indicates a diversity of schools of thought or emerging subfields. The central, red cluster brings together fundamental authors in the theory of agricultural technology adoption and rural economics, while the green and blue clusters integrate authors associated with sustainable development, agricultural policies, and rural governance. The presence of an isolated group on the far left, purple, indicates a minority line of research or an alternative approach, possibly from another geographical region or discipline. The co-citation network shows a growing scientific coherence around canonical authors, which indicates the stabilization of the thematic field. However, the fragmentation into several clusters also reflects a lack of transversal integration between technological innovation and associative forms, which often remain treated separately. We believe that strengthening the dialogue between clusters through synthesis research and interdisciplinary works can facilitate the articulation of a unitary paradigm on agricultural innovation in associative contexts, capable of underpinning more efficient and inclusive public policies.

## CONCLUSIONS

The bibliometric analysis carried out in this research allowed us not only to explore the quantitative structure of scientific production in the field of agricultural innovation and its associative forms, but also to conduct an in-depth investigation of how knowledge is organized, disseminated and connected internationally. The results obtained from the networks of co-authorship, co-citation, co-occurrence and bibliographic coupling highlight some defining features of the analyzed field.

The literature on agricultural innovation is expanding, but dominated by a few geographical and epistemic centers, especially in the United States, Western Europe and East Asia. Countries from the global South are active mainly in applied and contextual research, but rarely contribute to the formulation of dominant theoretical frameworks, which reflects an imbalance

between the generation and application of knowledge.

Another aspect found shows that, despite a high density of works and active authors, the field suffers from conceptual fragmentation. Clustering by themes, sources and authors highlights a lack of integration between complementary dimensions, such as technological and organizational innovation, digitalization and agricultural cooperation, sustainable development and economic efficiency. This fragmentation affects the theoretical coherence of the field and limits the transferability of results to practice and public policies. Another important observation concerns the absence of standardized terminology, especially regarding associative forms in agriculture. Keywords such as cooperation, farmer organizations, collective action, associative structures are used inconsistently, and this makes it difficult to retrieve information and build a solid thematic core. Also, associative forms are not treated as autonomous vectors of innovation, but rather as secondary or contextual factors.

At the same time, the bibliographic coupling analysis highlighted a lack of common theoretical sources in the specialized literature, which may indicate an emerging, not yet settled field, but also a lack of synthesis works or meta-analyses that connect existing approaches. In this sense, the absence of theoretical “bridges” between applied studies and normative or critical ones is felt, which reduces the literature’s capacity to formulate coherent paradigms for understanding agricultural innovation in associative contexts.

From a methodological perspective, the results indicate a high dependence on local case studies and applied quantitative analysis models, to the detriment of comparative, transnational or historical-institutional approaches, which could contribute to explaining the differences in performance between agricultural cooperation models and levels of innovation adoption.

Last but not least, the bibliometric maps show a desynchronization between scientific production and its applicability in contemporary agricultural policies, especially those promoted at European level. The lack of integration between academic literature and policy documents indicates a gap between theoretical research and the operational dimension of innovation in agriculture.

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