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Systematic Review

The Role of Knowledge and Innovation in Organic Farming Systems: A Systematic Literature Review

Roberta Milardo

Department of Agricultural and Food Sciences, University of Bologna, Viale Giuseppe Fanin 50, 40127 Bologna, Italy; roberta.milardo2@unibo.it

Abstract

Organic agriculture is a complex, knowledge-intensive system, deeply aligned with sustainability goals. While the field has seen promising growth and innovation, it still grapples with significant challenges, particularly in how knowledge is shared, applied, and supported structurally within sustainability-oriented frameworks. To fill this gap, a systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, screening publications from the Web of Science and Scopus databases. A total of 39 scientific studies were analysed using content analysis and a bibliometric methodological approach. Findings reveal a balanced geographical distribution of studies and a dominance of qualitative methodologies. While farmers, advisors, and researchers are frequently involved in data collection, broader stakeholder engagement is limited. Key actors—research institutions, advisory services, and sectoral organisations—emerge as central to driving innovation and enhancing farmers' access to actionable knowledge. However, the analysis identifies three core challenges: tailoring knowledge and innovation to diverse farming contexts; strengthening the intermediary role of advisors to bridge science and practice; and integrating organic agriculture more explicitly within the frameworks of sustainability and agroecology. Future research should focus on improving participatory dissemination strategies and strengthening intermediary roles to advance sustainability-driven innovation in organic agriculture.

Keywords: organic farming; knowledge; innovation; source of knowledge; content analysis; literature review; sustainable agriculture; knowledge gaps

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1. Introduction

The current global food system is under increasing pressure due to a convergence of environmental, social, and economic challenges. Climate change, biodiversity loss, resource depletion, and food insecurity highlight the urgent need to transition toward more sustainable and resilient food systems [1]. Organic agriculture has emerged as a key pillar of sustainable food production [2,3]. Recognised as a driver of sustainable rural development and a response to climate and ecological crises, it aligns with major global sustainability frameworks, thereby promoting circular food chains, minimising waste, ensuring fair value distribution across the supply chain, and reducing dependency on non-renewable inputs [4–10].

Over the past two decades, organic agriculture has experienced significant global growth in both area and market value. From 14 million hectares in 2000, organically managed land expanded to nearly 100 million hectares in 2023, representing 2.1% of total global farmland [9], not considering the approximately 32 million hectares worldwide that

are used for wild collection, beekeeping, aquaculture, and grazing on non-agricultural land. Moreover, the growing awareness of environmental and health issues is reflected in the increasing demand for organic products among consumers [9]. Despite its rapid expansion and clear environmental benefits, organic farming still faces several challenges that limit its wider adoption. Converting from conventional to organic farming is not simply a matter of replacing chemical inputs with organic alternatives; it requires systemic changes in farming practices, mindsets, and market structures. Farmers often encounter barriers such as higher labour requirements, reduced yields during transition periods, limited access to organic inputs, and complex certification processes [11]. As emphasised by Gliessman [12], transforming food systems through organic agriculture involves both agroecological redesign and the reestablishment of relationships based on principles of equity, locality, and participation. A truly sustainable food system requires transformative approaches that not only enhance environmental performance but also strengthen the social and economic tissue of rural communities [3,13].

As a regulated, knowledge-intensive, and well-established farming system, organic agriculture has developed basic structures along the entire value chain [5,14]. However, significant potential remains for improvement, particularly in enhancing structural capacities, advancing technical and practical knowledge, and fostering social and institutional development [3,15,16]. Rahmann et al. [5] argue for a redesign of the organic agriculture system, emphasising the need to strengthen the social dimension, fostering collaboration among stakeholders, and bridging gaps between large-scale and smallholder farms. Achieving these goals calls for a nuanced understanding of the evolving relationships within agricultural systems. Several variables play a role in this context, including the geographical context, stakeholders' dynamics, national challenges and objectives, governance structures, policies and instruments applied to achieve them, the level of decentralisation of decisions taken, and the interplay of private and public actors.

The Agricultural Knowledge and Innovation System (AKIS) offers a structured approach to addressing these challenges. Defined as 'a set of organisations and/or people, including linkages and interactions among them, working in the generation, transformation, transmission, storage, retrieval, integration, dissemination and use of knowledge and information, with the aim of working synergistically to support decision-making, problem-solving, and innovation in agriculture' [17], the AKIS is the cross-cutting tool proposed for the new European Union Common Agricultural Policy to provide knowledge, advice, expertise, and innovation within agricultural systems. At the heart of this framework lies the farmer, who draws on a broad spectrum of knowledge and innovation sources to inform decision-making [2,9–11]. To fully understand the agricultural knowledge and innovation systems, it is essential to explore the diverse individuals and organisations that farmers interact with, ranging from formal channels such as agricultural advisors, subject-matter experts, and governmental institutions to informal sources like fellow farmers, family members, friends, and consumers [8,10,11,13,14,18–21]. The interplay between these formal and informal networks is critical, as farmers may place varying degrees of trust in each, depending on context and experience. Each actor can contribute a distinctive perspective to the exchange within agricultural systems. Research institutions, advisory and extension services, and sectoral organisations are crucial in facilitating knowledge acquisition and innovation and accessible sources for farmers [10,22–24]. For example, educational and research institutions are well-suited to play a central role in facilitating the acquisition of technical knowledge [23]. On the other hand, advisory services—spanning a range of institutions from the public, private, and third sectors—provide farmers with practical knowledge, expertise, and tailored information to address problems and improve their economic well-being [23,25], as well as facilitating local and scientific knowledge exchange

between stakeholders [22]. Identifying key actors within the supply chain who can significantly contribute to knowledge acquisition is the core of the support itself. Equally important is the development of structures that promote the learning of both scientific and non-scientific knowledge, fostering collaboration and innovation across the agricultural sector [5,26,27]. Strengthening these interactions is key for enhancing the AKIS and for supporting farmers in their transition toward more sustainable and resilient production models [21].

Despite the increasing interest in knowledge exchange and stakeholder interactions within farming systems, the practical implementation of the AKIS framework remains relatively limited to the European context and is even less frequently applied to sustainable production systems. Moreover, there is a notable lack of systematic reviews critically examining how knowledge and innovation have been addressed in the organic farming literature over the past decade. This gap has been underscored in recent conferences on organic agriculture, which have identified a lack of cross-disciplinary and participatory research approaches, mechanisms for knowledge transfer and dissemination, and the development of robust research methodologies [28]. This study aims to fill these shortcomings by critically exploring the roles of knowledge and innovation within organic farming systems. Specifically, the review investigates key sources of information and support available to farmers, the dynamics of knowledge exchange, and the contributions of different stakeholders within agricultural systems. Ultimately, the research aims to offer a comprehensive synthesis of how knowledge in organic and sustainable farming is produced, shared, and applied, while identifying areas for improved collaboration, unresolved challenges, and directions for future research.

The review is guided by the following research questions (RQs):

RQ1: To what extent is the role of knowledge and innovation in organic farming addressed in the literature?

RQ2: Which actors are referenced as sources of knowledge and innovation for organic farms?

RQ3: What does the literature overlook or leave unclear?

The paper is structured as follows: Section 2 describes the methodologies employed to identify and analyse the literature. Section 3 presents the findings, including results from the content analysis and a visualisation of the keywords network through bibliometric analysis. Section 4 discusses the results and provides recommendations for future research.

2. Materials and Methods

A systematic review was conducted to identify and analyse the existing literature on knowledge and innovation in organic agriculture. The review was conducted in two stages. Firstly, relevant publications were selected using the PRISMA method (Supplementary Materials) (https://www.prisma-statement.org/, accessed on 30 May 2025). The PRISMA flow diagram illustrates the flow of information through the different phases of a systematic review (Figure 1). It maps out the number of records identified, included, and excluded, and the reasons for exclusions. Secondly, data analysis was applied through content analysis, highlighting recurring themes and key areas of interest. Additionally, keyword co-occurrence mapping was conducted using VOSviewer (Version 1.6.20) software to visualise prominent concepts and relationships within the literature.

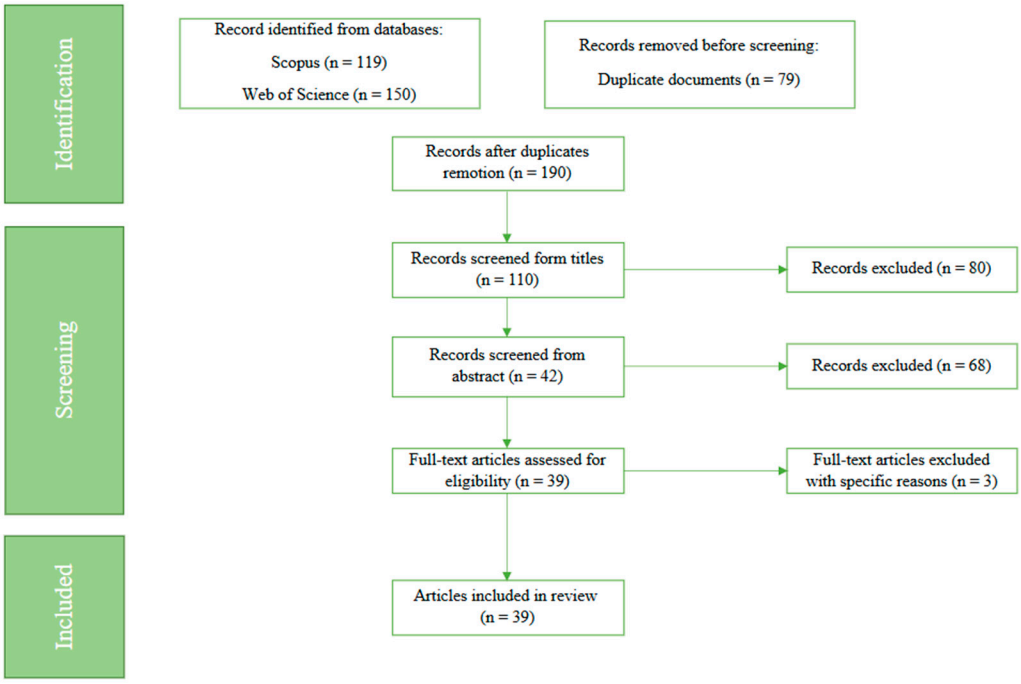

Figure 1. Research design, screening, and selection criteria (PRISMA flow diagram). Source: author.

Screening and Selection Criteria

The literature was collected from two databases: SCOPUS and Web of Science. These databases were selected based on their extensive coverage of scientific papers and documents, particularly those about economics and agricultural sociology. The keywords employed for the document research are presented in Table 1. The combination of words aimed to recover papers focused on knowledge acquisition and innovation in the organic agriculture value chain.

Table 1. Terms used for the database research. Source: author.

Database	Search String	Results
Scopus	(TITLE-ABS-KEY (knowledge AND innovation) AND TITLE-ABS-KEY (organic AND (agric* OR farm*))) AND PUBYEAR > 2011 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (LANGUAGE,"English"))	119
Web of Science	TOPIC: (knowledge AND innovation) AND TOPIC: (organic AND (agric* OR farm*)) Refined by: DOCUMENT TYPES (ARTICLE OR REVIEW) Timespan: 2012–2024	150

* the asterisk was used to include all word variations with the same root. For example, agric* includes "agriculture", "agricultural", etc., and farm* includes "farming", "farmers", etc.

Finally, restrictions have been applied to the document type. The limits applied to the research are year (2012–2024), document type limited to article and review, and language limited to English. The research paper databases were consulted in September–November 2024.

Searching the Scopus and Web of Science databases returned 119 and 150 documents, respectively. After eliminating duplicate documents, the remaining 190 articles were screened from titles and abstracts (Figure 1). The records screened from titles were 110 (80 were removed). The records screened based on their abstract were 42 (68 were removed). Studies not covering the main topic of this review have been excluded from the analysis. Three papers were excluded for specific reasons (two were unavailable in English, and one

was a conference proceeding). Consequently, a definitive list of 39 comprehensive papers has been thoroughly examined for the data analysis.

An Excel database has been constructed to collect information about each study to facilitate the content analysis. Two categories of data have been gathered. Firstly, descriptive information was identified for each paper, including the author, year of publication, research question, geographical distribution, stakeholders involved in the data collection, data collection method, data elaboration, main findings, policy implications, and recommendations. Secondly, information has been selected to structure and justify the results chapter, which aligns with the literature review's objective.

3. Results

The following chapter presents the results of the analysis, including descriptive information of the selected papers (geographical distribution, methodological approaches of selected papers, data collection and analysis, actors involved in the research), the findings from the content analysis, and the visualisation of co-occurrence networks based on article keywords.

3.1. Description of Papers

Organic farming is frequently linked with broader concepts such as sustainable agriculture and agroecology. While numerous studies in the current literature address aspects of organic agriculture, many do so indirectly, often focusing on farmers' use of organic fertilisers or how to increase sustainability within agricultural farms. Of the 39 papers, 31 deal specifically with organic farming, 3 deal with agroecology, and 3 explore connections with sustainable agriculture. In addition, six papers focus primarily on sustainable agriculture, while two focus on agroecology.

The information gathered from reading the full texts revealed that three papers analyse the European context, with multiple European countries included in the same paper (Table 2). Twenty studies adopt a country-specific focus, with Italy and Germany being the most frequent. The extra-European studies included countries in Africa, Asia, and South America.

Table 2. Geographical distribution and year of publication of primary research topics. Source: author.

Geographical Distribution	Number	Source
International	1	Olowe & Somefun [28]
European	3	Bliss et al. [29], Malusà et al. [22], Sacchi et al. [30]
Europe		
Italy	7	Colombo et al. [16], Ciaccia et al. [31], Butti Al Shamsi et al. [32], Orlando et al. [33], Milardo & Bertazzoli [34], da Rocha Oliveira Teixeira et al. [35], Dal Ferro et al. [36]
Germany	4	Kernecker et al. [37], Leonnig & Nielsen [20], Blochet et al. [38], Vicente-Vicente et al. [39]
Spain	2	De los Ríos et al. [40], Sáenz et al. [23]
France	1	Lefèvre et al. [41]
Romania	1	Lianu et al. [42]
Sweden	1	Swiergiel et al. [43]
Denmark	1	Noe et al. [44]

Table 2. *Cont.*

Geographical Distribution	Number	Source
Serbia	1	Simin et al. [45]
Hungary	1	Rust et al. [46]
UK	1	Rust et al. [46]
Extra-European		
French Polynesia	1	Surchat et al. [47]
USA	3	Kernecker et al. [37], Cardona et al. [48], Brock et al. [49]
California	2	Klein et al. [50], Kalaitzoglou et al. [51]
Africa		
Mali and West Africa	1	Nicolay [52]
Nigeria	1	Adebiyi & Olabisi [53]
Senegal	1	Bottazzi et al. [54]
Ghana	1	Wuepper et al. [55]
Burkina Faso	1	Iyabano et al. [56]
Malawi	1	Bentley et al. [57]
Uganda	1	Mutebi Kalibwani et al. [58]
South America		
Brazil	1	Bernardes-de-Souza et al. [59]
Argentina	1	Frank et al. [60]
Patagonia	1	Frank et al. [60]
Uruguay	1	Groot-Kormelinck et al. [61]
Costa Rica	1	Bentley et al. [57]
Asia		
Nepal	1	Bentley et al. [57]
United Arab Emirates	1	Butti Al Shamsi et al. [32]
Indonesia	1	Wijaya & Offermans [62]
India	1	Kernecker et al. [37]
China	2	Liu et al. [63], Lv & Li [15]

The authors' methodology was summarised, including the procedures used for data collection, data analysis, and identification of the individuals directly involved in the research process.

As outlined in Table 3, the literature has employed various data collection methods. Of these, qualitative data collection has been the most prevalent. In particular, among the various categories of qualitative data collection, 25 papers employed interviews, while 16 papers utilised participatory approaches, including focus groups, workshops, and plenary meetings. Furthermore, direct observation at the farm, field visits, literature reviews, and seminars have been employed. Some authors employed a combination of techniques for the collection of qualitative data, utilising a variety of tools such as interviews, workshops, and focus groups (e.g., [16,22,33,37,41]).

The primary quantitative data collection tool is the survey, frequently distributed to participants in person or via email. This approach was employed 15 times in total.

Data analysis employs various techniques, including qualitative and quantitative analysis methods and tools. The evidence indicates that using mixed data collection methods (e.g., interviews and surveys) preceded the application of mixed data analysis using qualitative and quantitative analysis software.

NVivo, ATLAS, and MAXQDA are the most commonly used software for qualitative data analysis, particularly following transcription and text coding for context and thematic analysis. In contrast, Excel, SPSS, SAFA, and PLS are the tools and software employed for quantitative analysis.

Table 3. Summary of methodological approaches used in the literature: data collection. Source: author.

Data Collection	No.	References
A. Qualitative		
Interviews	25	Surchat et al. [47], Colombo et al. [16], Bernardes-de-Souza et al. [59], Swiergiel et al. [43], Orlando et al. [33], Iyabano et al. [56], da Rocha Oliveira Teixeira et al. [35], Malusà et al. [22], Kernecker et al. [37], Klein et al. [50], Mutebi Kalibwani et al. [58], Leonnig & Nielsen [20], Lefèvre et al. [41], De los Ríos et al. [40], Bloch et al. [38], Cardona et al. [48], Simin et al. [45], Rust et al. [46], Brock et al. [49], Kalaitzoglou et al. [51], Bentley et al. [57], Vicente-Vicente et al. [39], Groot-Kormelinck et al. [61], Wijaya & Offermans [62], Lv & Li [15]
Participatory approach (Focus group, workshop, plenary meetings)	16	Bliss et al. [29], Colombo et al. [16], Orlando et al. [33], Malusà et al. [22], Kernecker et al. [37], Dal Ferro et al. [36], Leonnig & Nielsen [20], Lefèvre et al. [41], de los Ríos et al. [40], Bloch et al. [38], Noe et al. [44], Cardona et al. [48], Frank et al. [60], Vicente-Vicente et al. [39], Wijaya & Offermans [62], Adebiyi & Olabisi [53]
Direct observation at the farm/field visit	3	Orlando et al. [33], Bentley et al. [57], Groot-Kormelinck et al. [61]
Literature review	1	Sacchi et al. [30]
Seminars	1	Bloch et al. [38]
B. Quantitative		
Survey	15	Bliss et al. [29], Ciaccia et al. [31], Bernardes-de-Souza et al. [59], Butti Al Shamsi et al. [32], Lianu et al. [42], Swiergiel et al. [43], Wuepper et al. [55], Milardo & Bertazzoli [34], Malusà et al. [22], Dal Ferro et al. [36], Mutebi Kalibwani et al. [58], Liu et al. [63], Sáenz et al. [23], Bottazzi et al. [54], Lv & Li [15]

As illustrated in Table 4, various actors across the organic food chain were involved in the data collection process. Most papers included one or two/three categories of actors. At the same time, notable exceptions can be found in the works of Colombo et al. [16], Swiergiel et al. [43], da Rocha Oliveira Teixeira et al. [35], Dal Ferro et al. [36], Leonnig and Nielsen [20], de los Ríos et al. [40], Bloch et al. [38], and Wijaya and Offermans [62], with four or more categories of stakeholders. For example, Colombo et al. [16] collected data from researchers, farmers, advisors, and suppliers for their research.

The primary categories of actors are farmers, advisors, and researchers. A total of 35 papers included farmers as participants, with few focusing on the analysis of specific production chains. Two examples are organic horticulturists [60] and winegrowers [35]. A total of 15 papers involved advisors, including those from advisory companies, extension services, agronomists, technicians, and plant doctors. Twelve papers involved researchers and academics. Other actors that have played an important role are farmer and producer organisations/associations, public and private institutions/organisations, and managers of cooperatives or companies. To a lesser extent, other stakeholders in the supply chain have also been involved in the research process, including representatives from the Ministry of Agriculture, intermediary organisations, non-governmental organisations (NGOs), suppliers, and organic inspectors.

Table 4. Summary of methodological approaches used in the literature: actors involved. Source: author.

Actors Involved	No.	References
Farmers	35	Bliss et al. [29], Surchat et al. [47], Nicolay [52], Colombo et al. [16], Ciaccia et al. [31], Bernardes-de-Souza et al. [59], Butti Al Shamsi et al. [32], Lianu et al. [42], Swiergiel et al. [43], Orlando et al. [33], Wuepper et al. [55], Sacchi et al. [30], da Rocha Oliveira Teixeira et al. [35], Malusà et al. [22], Kernecker et al. [37], Klein et al. [50], Dal Ferro et al. [36], Leonnig & Nielsen [20], Liu et al. [63], Lefèvre et al. [41], de los Ríos et al. [40], Bloch et al. [38], Sáenz et al. [23], Noe et al. [44], Simin et al. [45], Rust et al. [46], Brock et al. [49], Kalaitzoglou et al. [51], Bottazzi et al. [54], Frank et al. [60], Bentley et al. [57], Vicente-Vicente et al. [39], Wijaya & Offermans [62], Lv & Li [15], Mutebi Kalibwani et al. [58]
Advisors	15	Bliss et al. [29], Nicolay [52], Colombo et al. [16], Swiergiel et al. [43], Orlando et al. [33], Milardo & Bertazzoli [34], Sacchi et al. [30], Malusà et al. [22], Dal Ferro et al. [36], Leonnig & Nielsen [20], Bloch et al. [38], Rust et al. [46], Brock et al. [49], Kalaitzoglou et al. [51], Bentley et al. [57]
Researchers/scientists	12	Swiergiel et al. [43], Orlando et al. [33], Sacchi et al. [30], da Rocha Oliveira Teixeira et al. [35], Malusà et al. [22], Dal Ferro et al. [36], Leonnig & Nielsen [20], Lefèvre et al. [41], Bloch et al. [38], Kalaitzoglou et al. [51], Wijaya & Offermans [62]
Farmer or producer organisations/associations	5	Nicolay [52], Iyabano et al. [56], Bloch et al. [38], Groot-Kormelinck et al. [61], Wijaya & Offermans [62]
Public and private institutions/organisations	5	Nicolay [52], Dal Ferro et al. [36], Leonnig & Nielsen [20], De los Ríos et al. [40], Wijaya & Offermans [62]
Cooperatives or companies' managers	4	Swiergiel et al. [43], da Rocha Oliveira Teixeira et al. [35], Kernecker et al. [37], De los Ríos et al. [40]
Board/Ministry of Agriculture	2	Swiergiel et al. [43], Wijaya & Offermans [62]
Intermediary organisations	1	Cardona et al. [48]
NGOs	1	Dal Ferro et al. [36]
Suppliers	1	Colombo et al. [16]
Organic inspectors	1	Milardo & Bertazzoli [34]
Industry	1	Dal Ferro et al. [36]
Sommeliers	1	da Rocha Oliveira Teixeira et al. [35]
Donors	1	Nicolay [52]
Civil society	1	De los Ríos et al. [40]

3.2. Content Analysis

3.2.1. RQ1: To What Extent Is the Role of Knowledge and Innovation in Organic Farming Addressed in the Literature?

Knowledge Exchange and Cooperation: Bringing Together Knowledge and Experience

Butti Al Shamsi et al. [32] argue that organic cultivation is ethically inherently collaborative. However, Adebiyi and Olabisi [53] posit that a lack of awareness and understanding of organic practices among farmers has constituted an obstacle to its adoption. In particular, the rapid expansion of organic production has placed significant pressure on farmers, who

are unable to meet the challenges they face without external support [22]. Farmers need the system's support in order to achieve their objectives.

The literature has identified the role of knowledge exchange and innovation among actors as a key factor in developing local networks [30,31]. Several papers have highlighted the necessity for effective collaboration among actors [20,32,35,36,38–40,43,45,46,48–50,54,60,62]. However, Surchat et al. [47] identify a gap in the literature concerning the importance of increasing access to information and knowledge exchange within farmers' networks.

As Iyabano et al. [56] posit, the combination of knowledge sources necessitates an active mobilisation of diverse actors with multiple perspectives, including farmers, advisory services, and agro-companies, which can enhance the role of each stakeholder in the value chain [31,49]. The combination of experience and action (e.g., fieldwork, experiments) and knowledge is important to define, among stakeholders, practices best suited to specific place capacities [30,36,40]. In particular, it is relevant for farmers to acquire external knowledge from multiple sources and combine it with their existing knowledge, thereby generating novel insights and competencies [59].

The papers under consideration identified several providers regarding the source of knowledge and innovation. It is, however, important to underline that the specific characteristics of the farm may influence the type of knowledge source. In particular, Lv and Li [15] identified significant differences in the levels of trust placed in formal and informal information sources across farm-scale groups. Large-scale farmers are more likely to be influenced by trust in formal information sources. In contrast, those involved in small-scale farming are strongly influenced by trust in informal sources (e.g., traditional local knowledge and experience channels). Furthermore, Swiergiel et al. [43] indicate that small sectors often lack adequate and sufficient access to advisors and professionals.

As indicated by Leonnig and Nielsen [20], farmers tend to rely extensively on the private sector for knowledge exchange within the organic sector. However, the data collected highlight that farmers utilise a range of sources to obtain new information, including advisory and extension services (e.g., [42,45,55,58]), other farmers and neighbours [20,46,55], researchers [58], public individuals [46], and farmer associations [45].

In a few cases, digital and online platforms have been indicated as sources of information [36,37] and as instruments that can supplement face-to-face knowledge exchange and facilitate the sharing of experiences between relevant parties [29].

Farmers Networks and Partnerships/Co-Creation

Participatory approaches (e.g., partnerships, innovation hubs, farmer involvement in research projects, multi-actor platforms, and on-farm experimentation) are often mentioned as solutions to increase access to information and knowledge exchange within farmer networks (e.g., [30–32,35–37,39,42,51,54]). An interesting definition is provided by the research of Vicente-Vicente et al. [39], where these networks are seen as knowledge co-creation or co-production processes, specifically as "a collaborative process involving two or more actors, who are intentionally integrating their knowledge and learning, resulting in the development of insights and solutions that would otherwise not be reached independently".

Firstly, farmer networks should allow the scaling out of good practices from farmer to farmer and ensure that farmers' knowledge and experience, as well as sharing best practices, reducing costs, and collectively advancing sustainability efforts, can yield positive outcomes [35]. Secondly, farmers' networks promote the active involvement of farmers in experimentation and innovation [22,49]. The contribution of farmers in testing and validating scientific experiments could generate scientific knowledge and the local diffusion of new practices [50,51].

Positive effects also include an increase in the successful extension of research findings and two-way communication between farmers, extension, and researchers [51], where each

actor could benefit from the involvement of the other. Despite the benefits of knowledge co-creation and farmer involvement, Vicente-Vicente et al. [39] identified several barriers, such as the lack of transferable knowledge due to its context specificity, the lack of resources, mainly time and human resources, and the lack of structures and platforms.

Adaptation to the Farm's System and Local Conditions

The literature repeatedly emphasises the need to adapt knowledge and innovations to the specific agricultural and local context to ensure that innovations are widely adopted [31,32]. The perspective on problems varies from farm to farm [38]. A challenge that one farm may perceive as problematic may represent an opportunity for another [44]. As illustrated by the cases presented in the Noe et al. [44] study, there is no universally applicable trade-off or balance within specific farming systems. Furthermore, external factors to the system, such as fluctuating market prices, weather conditions, and other environmental or socio-economic dynamics, must also be taken into account when evaluating innovation strategies.

3.2.2. RQ2: Which Actors Are Referenced as Sources of Knowledge and Innovation for Organic Farms?

Advisory and Extension Services

Advisors are seen as integral figures in knowledge exchange and in the success of organic farming practices within the community by providing expertise, facilitating learning, offering tailored solutions, promoting sustainability, addressing challenges, supporting transitions, and enhancing market access [49,54,56]. They could also play an important role within farmers' organisations [56] and facilitate face-to-face networking [22]. In contrast, the results of the study by Sáenz et al. [23] show that the degree of dependence of organic farmers on advisory organisations for the acquisition of relevant knowledge is relatively low. In particular, organic farmers do not perceive advisory organisations as relevant providers of continuous education.

In qualitative and quantitative terms, the lack of advisors and technicians is particularly noticeable (e.g., [16,33]). Colombo et al. [16] emphasise the dearth of technical and economic knowledge and references and the weakness of advisory services in Sicily (Italy). Another example is provided by Bottazzi et al. [54], for whom advisors sometimes lack a focus on systemic barriers and local contexts. Furthermore, at other times, advisors may have their interests and seek to prioritise the implementation of certain types of knowledge over others deemed less beneficial [44].

On the other hand, the obstacles that advisors encounter in their work are equally important. In addition to the barriers that advisors often have to overcome in transferring knowledge to farmers [62], they often experience high levels of stress and a significant increase in workload, as evidenced in the Italian organic system [34].

Researchers and Academic Institutions

Research is important in supporting innovation for farmers and other interested parties. Researchers could speed up the transition toward organic agriculture by supporting the dynamics of bottom-up innovation [33] and integrating farmer knowledge with scientific understanding [46,50,60].

The benefits of bringing farmers and researchers together include the combination of different types of knowledge (e.g., scientific, local, specific, and empirical knowledge), the use of various methodological supports [41], and the identification of novel research questions that are specific to farmers and their local realities. Farmers can act as data suppliers, land providers, and knowledge producers [38]. Additionally, they can help

identify local, regional, and farm-specific problems to guide the development of targeted research topics [38,41,60].

However, a widespread lack of trust in research institutions has been highlighted as the primary constraint for farmers. The main barriers are time, incentives, and the lack of a common language between scientists and farmers [32,47,51]. Farmer knowledge is not always aligned with scientific standards, leading to communication challenges and the implementation of best practices [50]. In particular, farmers sometimes feel disconnected from universities and public and private institutions [20]. The findings of Rust et al. [46] highlight that farmers perceive researchers to have different objectives from their own, more related to scientific publications and research funding than to creating direct benefits for farmers.

Cooperatives

Cooperatives have been demonstrated to have the capacity to support farmers' networks by establishing community relationships, organising breeding activities, coordinating marketing activities, and formulating policy advocacy [30]. Furthermore, Liu et al. [63] found positive feedback on the technical training provided by agricultural cooperatives on farmers' adoption of organic fertiliser.

Farmer Organisations and Associations, and Sectoral Organisations

Although farmers obtain information from various sources, in Simin et al.'s [45] research, advisors and farmer associations emerged as the most common sources. In particular, the study by Iyabano et al. [56] revealed the active involvement of farmers' organisations in fulfilling knowledge and innovation intermediation functions, as they act as facilitators for introducing and developing innovations and connecting various actors. As intermediaries, they can provide technical support and enable farmers to overcome market barriers [58,61]. According to Sáenz et al. [23], sectoral organisations are the most important actors for farmers, as they can promote the acquisition of technical knowledge through different learning pathways.

Public Institutions

Public institutions can act as a source of information for farmers and play an important role in collaborative networks, creating space for sustainable innovations [32]. For example, the Chamber of Agriculture and the Direction of Agriculture in French Polynesia have a role in implementing farmer-to-farmer knowledge exchange and supporting on-farm demonstrations through local extension services [47]. Conversely, Vicente-Vicente et al. [39] note a lack of active government role in promoting agroecological knowledge co-creation or regulating land access to support smallholder farmers.

Intermediary Actors

Cardona et al. [48] observe that the diffusion of innovation in agriculture has shifted in recent decades from linear models to more integrative and systemic approaches. A central element of this evolution is the emergence of intermediary actors, who play a pivotal role in facilitating collaboration among scientists, specialists, extension agents, and farmers. In their study, these intermediaries contribute to the development of more sustainable agricultural practices and a more integrated knowledge system. Similarly, Rust et al. [46] emphasises the importance of intermediaries or knowledge brokers in enhancing the exchange of ideas, innovations, and knowledge among diverse actor groups that may not naturally interact or build trust due to social or professional boundaries. These intermediaries add value by empowering both farmers and scientists who are actively engaged in developing local and sustainable agri-food systems. By facilitating knowledge

sharing and inclusive participation, they help foster a sense of ownership and responsibility for outcomes among all stakeholders [46,48].

Farmers Sometimes Prefer Farmers' Advice

As evidenced by the literature, farmers have been found to prefer the advice of fellow farmers over that of advisors or experts (e.g., [20,29,46]). This choice may be due to declining trust in conventional agricultural advisors [46] and the greater need for farmers' experiential knowledge [20], which advisors may not possess. However, Rust et al. [46] acknowledge that expert advice still has value, particularly in complex scenarios where specialised knowledge is crucial for informed decision-making.

3.2.3. RQ3: What Does the Literature Overlook or Leave Unclear?

The third research question aims to identify areas within the existing literature that remain unexplored or require further investigation. Three points have emerged from the literature. Accordingly, three specific questions have been developed to address these gaps, which will be examined in detail in the discussion chapter.

The first point concerns the adaptability of knowledge. A recurring theme in the literature is the importance of adapting knowledge and innovations to specific agricultural and local contexts to ensure their broad adoption [35,37,38,41]. Knowledge and research application must be tailored to specific production chains and geographic contexts [32,43], ranging from regional and sub-regional levels to individual farms. The absence of a universally applicable balance or trade-off within farming systems highlights the need for context-specific approaches [44]. This includes engaging individuals within these contexts with first-hand knowledge and technical expertise about their unique conditions.

Despite the recognised importance of adaptability to local and specific agricultural contexts, the geographical focus of the 39 studies reviewed reveals a persistent reliance on broader, country-specific contexts (or multi-country) contexts. This makes it easier to generalise the findings, but it tends to gloss over the reality of greater detail, such as regional/local or individual farms. On the other side, studies conducted in highly localised areas provide a great understanding of the micro-level but negatively impact the replicability and transferability of the results. The harmonious range of these two scales still poses a significant challenge to agricultural knowledge and innovations. This prompts the following question: What methodological strategies can be developed to ensure the adaptability of agricultural knowledge and innovations to specific environments while facilitating their application in other regions?

The second point refers to the need for qualified and current personnel within different spatial contexts. The literature adequately addresses the involvement of different actors in disseminating knowledge, from farmers, advisors, researchers, public institutions, and cooperatives to other relevant stakeholders. However, there is a lack of clarity on the roles and responsibilities of these actors at different levels within agricultural systems and how they collaborate to facilitate knowledge exchange at local, regional, and national scales. A notable example of this dynamic is the critical role of advisors and extension services in bridging the gap between scientific research and practical application. Advisors are required to function as intermediaries, translating researchers' scientific knowledge into technical, actionable insights for farmers. However, advisors face several barriers, such as resource limitations, outdated training, and insufficient institutional support (e.g., [16,28,41,51]). In parallel, researchers are often perceived as outsiders to the agricultural domain, disconnected from the practical realities faced by farmers and advisors (e.g., [20,22,43,46]). In this context, farmers, as the end users and applicators of knowledge, have expressed a decline in trust in both parties, attributed to a divergence in communication approaches and a perceived lack of expertise and knowledge by researchers and

advisors. The growing distance between those actors adds to the challenges of integrating cutting-edge research into agricultural practice. This raises a significant question: if advisors and researchers are fundamental to the agricultural knowledge system, what solutions can be implemented to increase their effectiveness and valorise their contributions?

The third point emerges from how organic agriculture is treated in the literature. In particular, it is frequently linked with broader concepts such as agroecology and, more frequently, sustainable agriculture. For example, Lianu et al. [42] highlight the enthusiasm among organic farmers for adopting agroecological practices, reflecting a strong connection between the two approaches. In contrast, Cardona et al. [48] emphasise the role of intermediary actors in fostering innovation and collaboration in sustainable agri-food systems. Here, organic agriculture is positioned as both an innovation and a sustainable production method, but it is not an assumption derived from the results or data collection.

Despite the occasional direct or indirect connection, the paper's absence of a clear focus on organic agriculture reduces its representativeness, thereby risking a loss of sight of its particularities and singularities. This prompts the following question: What are the advantages or disadvantages of integrating organic farming into the broader contexts of agroecology and sustainable agriculture in academic research?

3.3. Bibliometric Analysis: Keyword Networks Visualisation

A bibliometric analysis was employed using VOSviewer (version 1.6.20) to construct and analyse co-occurrence networks of article keywords [64]. This method allowed for the visual mapping of thematic structures within the reviewed literature and improved the interpretability of the interrelationships among key concepts.

A minimum threshold of two keyword occurrences was set for inclusion in the analysis, and a thesaurus file was applied to consolidate synonyms and harmonise terminology. The resulting network visualisation, based on 24 keywords, is presented in Figure 2. In the network, the size of each label and its corresponding circle reflects the weight of the item—i.e., the higher the frequency of a keyword's occurrence, the larger its representation. Lines connecting keywords indicate co-occurrence, with shorter distances typically implying stronger relationships. Thicker lines represent a higher frequency of co-occurrence between keywords [65].

In addition to the evident thematic links between organic farming, sustainable agriculture, and agroecology, the clustering of keywords further highlights key concepts that emerged from the content analysis. Each keyword is colour-coded according to the cluster it belongs to, thereby visually distinguishing thematic groupings within the network.

Cluster 1 (red) includes adoption, agricultural practice, agricultural worker, farmers, human, sustainability, sustainable agriculture, and technology adoption. This cluster focuses on the practical implementation of sustainable agriculture at the farm level. Key themes include the adoption of new technologies, the central role of farmers and agricultural workers as agents of change, emphasis on the human dimension and social sustainability, and the overarching goal of improving agricultural practices for sustainability.

Cluster 2 (green) includes adaptive management, agricultural ecosystem, agricultural management, agricultural production, farmers' knowledge, and innovation. This cluster centres on management strategies and innovation within agricultural systems, particularly emphasising adaptive approaches and the integration of farmer knowledge in improving production systems.

Cluster 3 (blue) includes alternative agriculture, knowledge, learning, organic agriculture, and transition. This cluster focuses on the exploration of alternative agricultural models, particularly organic agriculture, as well as highlighting the importance of learning

processes and knowledge exchange in facilitating the transition toward more sustainable practices.

Cluster 4 (yellow) includes agroecology, co-innovation, knowledge creation, and participatory approach. This group emphasises agroecology as a concept deeply rooted in collaborative knowledge creation, involving multiple stakeholders through participatory and co-innovation frameworks. Agroecology is portrayed not just as a set of practices but as a process of co-learning and shared innovation, aligning with global discourses on inclusive agricultural innovation and bottom-up development.

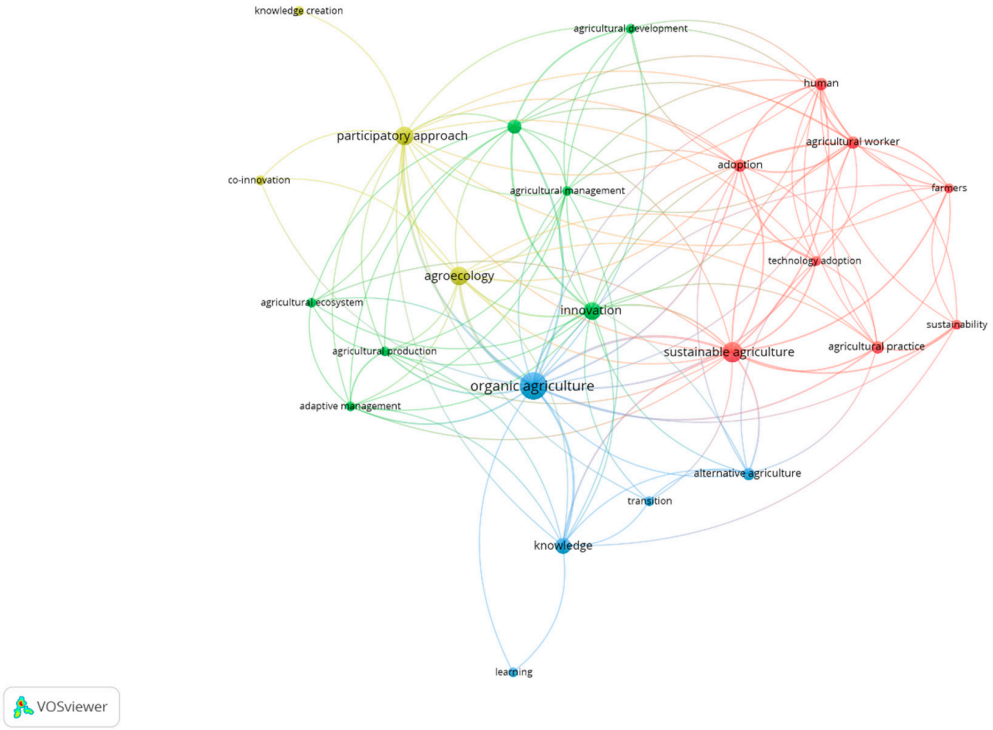

Figure 2. Co-keyword network visualisation based on occurrences. Source: author.

In summary, the four clusters identified provide a thematic map of the analysed literature and confirm the findings of the previous analysis. Clusters 1 and 2 are primarily oriented toward practical, production-level innovations and farmer-centric approaches, whereas Clusters 3 and 4 are more closely associated with learning, transition processes, and collaborative forms of innovation.

4. Discussion and Conclusions

This study aimed to explore the role of knowledge and innovation within organic farming systems through a comprehensive literature review, addressing the current lack of research that clarifies how these two concepts are understood and applied in the context of agriculture—particularly within organic farming, which is inherently a sustainable form of production.

The literature review revealed that knowledge and innovation are frequently referenced, with a growing interest in sustainable agricultural development. Additionally, the bibliometric analysis offered further insights, notably that the concept of knowledge appears in three out of the four identified keyword clusters. This finding underscores the central role of knowledge as a cross-cutting theme and a catalyst for both innovation and the adoption of sustainable agricultural practices.

Building on these findings, the following chapter discusses the main themes that emerged from the review and addresses the research question related to the identified

knowledge gaps and challenges (RQ3). The analysis revealed a balanced geographical distribution of studies across both European and non-European contexts, indicating no clear regional dominance in the literature. However, while the world's leading producers of organic products were represented in the selected literature, certain gaps remain—both in Europe, for example Austria and Greece, and worldwide, for example Australia.

Qualitative methods, such as interviews and participatory approaches, were more frequently employed than quantitative methods like surveys. Farmers were the primary actors involved in the data collection, reflecting their central role within organic systems. Advisors and researchers were also frequently involved, while the involvement of other stakeholders across the supply chain—from production to commercialisation—was limited. This highlights the need for a more inclusive approach to ensure a diversity of perspectives and a more significant system of representation.

RQ1 underlined the importance of improving information access and fostering knowledge exchange within organic farming networks. Achieving this goal requires actively engaging different actors with varying perspectives and integrating experience-based and scientific knowledge.

As demonstrated in RQ2, organic farmers rely on various knowledge sources, including advisory and extension services, researchers, cooperatives, organisations, public institutions, intermediary actors, and other farmers. Among these, the role of professional advisors emerged as particularly critical. The findings revealed a need to restructure the role of advisors and their relationship with farmers at the national and regional levels to enhance their effectiveness. A potential starting point could involve offering more specialised training programmes, focusing on organic agriculture content. An increase in organic-specific training programmes, both at the university and professional levels, may allow for a greater supply of specialised organic professionals. This will consequently promote a better distribution of workloads among advisors and enable them to regain farmers' trust. Improving the working conditions of advisors is imperative, as evidenced by the findings of Milardo and Bertazzoli [34] and Wijaya and Offermans [62], which indicate that the current conditions impede advisors' optimal performance in supporting farmers.

The review identified several knowledge gaps, which formed the basis for additional and future research questions. The primary knowledge gap pertains to adapting knowledge and innovation to the specific contexts of farms. Future research should explore the development of methodological approaches that balance the adaptability of agricultural innovations to local conditions with their replicability in broader contexts. This requires understanding how different farms acquire and apply knowledge based on their unique characteristics (e.g., the nature of the company, its dimensions, and its production specialisation). Establishing correlations between diverse knowledge sources and the farm-scale context is essential for developing effective solutions.

The second point concerns the critical role of advisors and extension services in bridging the gap between scientific research and practical application. Furthermore, the growing distance and lack of trust between farmers and advisors are concerning. Future research should investigate the role of advisors and researchers within agricultural knowledge systems and explore potential solutions to enhance their effectiveness and recognise their contributions. One potential solution is the introduction of specialised intermediaries to act as additional connectors between stakeholders. These individuals would ensure that clear, accurate, and up-to-date information reaches the target audience directly and effectively. For instance, alongside front-office advisors who work directly with farmers, intermediary professionals with dual expertise—the ability to "speak" the language of research while translating it into practice—could bridge the gap between researchers, advisors, and farm-

ers. Cardona et al. [48] state that intermediaries can add value by considering farmers and scientists equal contributors to knowledge production.

The last observation concerns the frequent association of organic agriculture with overarching concepts such as sustainable agriculture and agroecology within the literature. This raises questions about the advantages or disadvantages of integrating organic farming into the broader contexts of agroecology and sustainability in academic research. Future research should clarify organic agriculture's unique role and identity within broader sustainability frameworks.

The literature reveals that farmers obtain information from a variety of sources. To enhance adaptation to local conditions and foster practical solutions for complex challenges, it is essential to involve farmers as well as stakeholders from diverse backgrounds [10]. Indeed, developing participatory approaches and research that support a shift from individual to collective network management. This can be achieved by investing in networking opportunities, such as dedicated spaces for interaction. Given the high level of trust farmers place in informal relationships, it is crucial to recognise, support, and integrate these networks into the planning of future research initiatives. Supporting farmers' and consumers' associations is one way to give these informal networks a platform and a voice. In addition, cultivating enduring networks that persistently remain active and beneficial beyond the confines of specific project timelines is imperative. Such networks must be of paramount importance to farmers, ensuring long-term dependability.

Policy strategies should prioritise improving the systems for information access, innovation support, and, most importantly, knowledge dissemination. Ortolani et al. [10] emphasise that networking plays a crucial role in fostering innovation within sustainable farm development and in enhancing the dissemination of information and knowledge. However, a critical issue emerges: the existence of national or international strategies alone is insufficient if end users, such as farmers, are not adequately informed or engaged. Effective knowledge transfer requires targeted efforts, including training programs, seminars, shared databases and materials, group meetings, and the identification of simple, accessible tools that ensure farmers can access relevant information. In this context, advisors play a crucial role, acting as knowledge brokers; they translate complex research and policy information into practical tools tailored to farmers' needs. On the other hand, advisors serve as channels for feedback from farmers to policymakers and researchers, helping to shape more grounded and responsive political strategies.

The present study has a few limitations. Firstly, data collection was limited to papers indexed in Scopus and Web of Science, excluding those written in languages other than English. Secondly, the heterogeneity across the reviewed studies, particularly regarding their methodological approaches and the absence of a unified focus on organic agriculture across all papers, limited the generalisability of the findings. Thirdly, the literature review focused exclusively on articles published in English from 2011 to 2025, thus failing to provide a comprehensive historical perspective on the evolution of knowledge and innovation roles. This decision is due to the increased focus on knowledge and innovation systems, since one of the main definitions by Röling [66] was provided by the Organisation for Economic Cooperation and Development (OECD) [17].

In conclusion, the literature review highlights the importance of integrating diverse forms of knowledge and encouraging farmer involvement. Further research is required to identify effective methods for disseminating advice to farmers while emphasising practices most suited to each farm's specific circumstances. Addressing the identified knowledge gaps and enhancing the role of intermediaries and advisors will be crucial for advancing innovation within organic farming systems.

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Abbreviations

The following abbreviations are used in this manuscript:

AKIS	Agricultural Knowledge and Innovation System
RQs	Research questions
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
NGOs	Non-Governmental Organisations
OECD	Organisation for Economic Co-operation and Development

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