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# Agroecology as a global trend: a bibliometric analysis of studies on agroecological practices in agriculture

MERVE MÜRÜVVET DAĞ[1*], HASAN YILMAZ[1]

[1] *Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Economics, Isparta, Türkiye*

** Correspondence details: mervedag@isparta.edu.tr*

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**Abstract:** The sustainability of modern agricultural production techniques is questioned due to reasons such as environmental pollution, loss of biodiversity and dependence on chemical inputs. Agroecological practices emerge as a significant solution to meet food needs with both cost-effective and environmentally friendly methods. Agroecology is a complex and comprehensive field. In the study, data obtained from 1907 studies on agroecology conducted between January 1987 and November 2024 in the Web of Science (WOS) database were analyzed using bibliometric analysis with various parameters. The most commonly encountered keywords in the literature related to this thematic area were selected as "agroecology," and "agroecological practices". These keywords provide a comprehensive opportunity to examine the ecological, economic, and agricultural dimensions of agroecology. Bibliometric analyses were conducted using the Bibliometrix package in the R statistical software. Bibliometric analysis revealed research trends, significant publications, and leading researchers in agroecological approaches. Researchers such as Alexander Wezel, Miguel A Altieri, and Stephane Bellon have made significant contributions to agroecology and agroecological practices, receiving high levels of citations for their work. The study identified countries such as the United States, France, and Brazil as leaders in agroecology research. Affiliations such as Montpellier University, Vermont University, and Calif Berkeley University were conducted pioneering research in agroecology and agroecological practices, making valuable contributions to the literature. The increase in research and application in agroecology could contribute to making agriculture more sustainable and global food systems more safe, equitable and environmentally friendly.

*Keywords: Bibliometric analysis, WoS, Agroecology, Agroecological practices, Sustainability, Agriculture.*

## Introduction

Throughout human history, agriculture has played a critical role in sustaining life on a global scale. Agricultural production involves a range of vital activities such as food supply, economic gain, rural development, and conservation of biodiversity. The success of agricultural operations across diverse regions and climatic conditions relies on the presence of clean, healthy, and adequate natural resources (Atmaca, 2023). However, difficulties such as water resource management, soil erosion, climate change, and biodiversity loss are making it more challenging to maintain the sustainability of agriculture. Particularly, the rising interest in mitigating climate change globally is driving countries to focus on conducting in-depth research and analysis to assess their environmental performance (Çetin et al., 2020). Therefore, the requirement to

develop strategic efforts and policies on how agriculture can contribute to a sustainable future is becoming increasingly important. This circumstance requires a shift towards sustainable agricultural practices, with emerging agroecological approaches.

The use of the term agroecology is reported to have started in the 1930s, though it was considered solely a scientific discipline until the 1960s. With the rise of environmental movements from the 1960s onward, agroecology gained increasing importance and was adopted as an agricultural practice in the 1980s. This concept is defined as a movement aiming to make agriculture more ecologically sustainable, ensure social justice, and eliminate the use of hazardous chemicals (Wezel et al., 2009). A participatory methodology based on a multi-stakeholder approach for designing the agroecological transition has been proposed by Duru et al. (2015). This method supports the analysis of the current situation, the identification of external changes, and the design of agriculture based on regional biodiversity, the transition pathway, and adaptable management strategies.

Mason et al. (2021) were stated that agroecology is a complex and comprehensive discipline. Agroecology is defined as a set of principles that aim to minimize the negative impacts of human activities on agriculture by applying ecological concepts and their consequences. (Altieri, 1989). Furthermore, Kerr et al. (2023) defined agroecology as a holistic system approach that incorporates social, economic, and political dimensions. Agroecology was recognized as a discipline and defined with terms such as "the application of ecological science to design and manage sustainable agricultural ecosystems" by Gliessman et al. (1998). Agroecological methods aim to protect the environment with minimal negative externalities by limiting the use of chemical inputs. Agroecological approaches provide global integration by addressing these issues not only through scientific and practical approaches but also from a social perspective (Nicolétis et al., 2019).

The long-term benefits and sustainability of current modern agricultural strategies are being questioned for various reasons, including environmental degradation, loss of biodiversity and dependence on chemical inputs. Agroecological practices emerge as a significant solution to meet food needs that are both affordable and environmentally friendly (Uphoff, 2007). In addition, more sustainable agricultural production and resilient agricultural ecosystems are crucial for future global food security, environmental protection, and human well-being (Vandermeer & Perfecto, 2013).

Numerous studies have been conducted on sustainability and agroecology in agriculture from the past to the present. These studies were focused on various areas, including the definition and development of agroecology (Altieri, 1989; Gliessman et al., 1998; Wezel et al., 2009; Berthet et al., 2016; Hatt et al., 2016; Miles et al., 2017; Anderson et al., 2019; Iuliano et al., 2021; Ewert et al., 2023; Nikiema et al., 2023) and the identification of agroecological methods (Wezel et al., 2014; Dumont et al., 2021).

The early studies on agroecology generally focus on defining the concept of agroecology, its role, and addressing the sustainability issues in agriculture (Altieri, 1989; Edwards et al, 1993; Thomas & Kevan, 1993; Agunga, 1995; Rosset & Altieri, 1997). Studies conducted in the 2000s reveal that agroecology research aims to better define natural resource management in harmony with the needs and demands of farmers, as well as the design of individual farms in line with ecological principles (Altieri, 2002; Francis et al., 2003). Currently, efforts are being made to promote agroecological principles, with a focus on increasing their practical applicability by encouraging farmers' participation and facilitating their implementation (Simon Reardon & Perez, 2010; Dorin, 2022; Nasution et al., 2022).

In recent years, several bibliometric analysis studies have been conducted on sustainable farming systems, agroecology, and the adoption of agroecological approaches (Rocchi et al., 2020; Shah et al., 2021; Nikiema et al., 2023; Chimi et al., 2024). Nikiema et al. (2023) conducted a bibliometric analysis on the adoption of agroecological practices using the Web of Science (WOS) database. The study revealed that, although farming systems management, agricultural intensification, and biodiversity management have long been discussed, there is still

a need for in-depth research on topics such as the adoption of agroecology, the development of knowledge and innovations for food sovereignty, and the examination of climate change's impact on farm productivity. Shah et al. (2021) analyzed the Scopus database with a very broad range of keywords (agroecology, climate, weather, environment, degradation, sustainable, farming, food, development, food system, water, rural, resource, poverty, hunger, nutrition, diversity, health, social, and economic). However, this approach carries the risk of deviating from the core focus of agroecology-related articles. In contrast, this bibliometric analysis highlights that agroecological farming systems can play an intersectoral role in addressing urgent issues such as food and water security, climate change, and socioeconomic inequalities. Rocchi et al. (2020) conducted a bibliometric analysis focusing on sustainable farming systems. The keywords used in the study were ecosystem services, crop diversity, agroecology, diversified farming systems, ecoagriculture, multicropping, and agrobiodiversity. The findings of the study indicate that while ecological and environmental aspects have been extensively covered in the literature, there is still a need for social and economic research linking ecosystem services and agricultural biodiversity. Chimi et al. (2024) utilized Google Scholar data containing 376 studies for their bibliometric analysis of research on agroecological practices. In contrast, this study analyzed research on agroecology and agroecological practices using the Web of Science (WoS) database. The preference for WoS, a high-quality academic database, enhances the scientific reliability and accuracy of the analyzed studies (Van Leeuwen, 2006), distinguishing this research from others. The study determined an increasing interest in agroecology research and revealed its relationship with "sustainable agriculture," "management practices," and "soil."

The historical framing of agroecology sets the foundation for understanding the evolution of research in this field. The early studies provided crucial insights into the definitions and roles of agroecology, highlighting the sustainability issues in agriculture. This historical context is essential for the bibliometric analysis, as it allows us to identify how past research has shaped current inquiries and the direction of future studies.

Although previous studies have laid important foundations in this field, there is a need for a comprehensive analysis of the current state of agroecology and its applications. This study employs an approach that analyzes data obtained from the Web of Science database, which is recognized for its high-quality academic standards. Our aim is to provide a clearer picture of the trajectory of agroecological research.

In this study, data from 1,907 agroecology-themed studies conducted in the Web of Science (WOS) database between 1987 and 2024 were analyzed using the bibliometric analysis method based on various parameters, such as total publications, number of publication years and productivity per year, total and yearly publication numbers in scientific journals, publication data of universities, word cloud map, collaboration map, etc. This study examines the overall evolution of agroecology by analyzing its development, research trends, significant publications, and leading researchers in a comprehensive and detailed manner. Bibliometric analysis has become popular in recent years based on factors such as the development and accessibility of scientific databases (Donthu et al., 2021). The bibliometric analysis of agroecological practices in agriculture involves a systematic examination of academic literature in this field. Through bibliometric analysis, research trends in agroecological approaches, significant publications, and leading researchers in this field are identified, highlighting knowledge gaps in the sustainability and ecological compatibility of agriculture. Consequently, the present study is expected to contribute to the development of more effective and knowledge-based strategies for agroecology-based agricultural practices.

## Materials and Methods

In recent years, bibliometric analysis has become a highly popular analytical method due to its contribution to determining research trends. Donthu et al. (2021) noted that this popularity is based on factors such as the development and accessibility of scientific databases, processing large volumes of scientific data, and the ability to generate high research impact. Additionally, it is stated that effectively conducted bibliometric studies help researchers in a field by identifying their knowledge gaps and positioning their ideas and contributions in research.

Bibliometric analysis is defined as a method that interprets large volumes of unstructured data meticulously to analyze scientific knowledge and the development of scientific area (Donthu et al., 2021). However, bibliometric analyses are generally based on research conducted using databases such as WoS and Scopus. The scope and update frequency of these databases can affect the reliability of the results obtained (Moed, 2006; Donthu et al., 2021). At the same time, changes in citation dynamics over time can lead to misleading results in long-term analyses. Considering these factors, when conducted with careful analysis, bibliometric analysis serves as an important tool for understanding various research fields, providing researchers with a comprehensive overview of the topic, facilitating the emergence of new research ideas, and offering the opportunity to identify significant publications and leading researchers that contribute to the advancement of the field.

Bibliometric analysis can be conducted on any topic to provide researchers with an overview, generate new research ideas, and identify contributions to the field. In this study, it is important as it offers the opportunity to examine the development of agroecology, research trends, significant publications, and leading researchers in detail.

There are various databases such as Google Scholar, Dimensions, Scopus, PubMed, ERIC, IEEE Xplore, ScienceDirect, DOAJ, and JSTOR. However, WoS offers a wide coverage with approximately 100 million items (Tyasi et al., 2024). In this study, the Bibliometrix package in the R software was used for bibliometric analysis, with the WoS selected as the dataset. WoS is frequently preferred in bibliometric analyses due to its extensive access to scientific publications and the impact factor being one of the most widely used metrics among existing indexes (Van Leeuwen, 2006; Falagas et al., 2008). Covering various types of publications from 1900 to the present, WoS includes indexes such as the Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Conference Proceedings Citation Index, Book Citation Index, and Emerging Sources Citation Index (González-Serrano et al., 2020). This scope makes WoS a dataset capable of representing a significant portion of the relevant literature. Indeed, many bibliometric analysis studies have been conducted using the WoS database (Wang et al., 2014; Gong et al., 2019; Sun & Yuan, 2020; Bertoglio et al., 2021; Huang et al., 2022; Fauzi, 2022; Luo et al., 2022; Sarkar et al., 2022; Cardador et al., 2023).

In bibliometric analysis, the first step is to select the keywords that best match the purpose of the study. Subsequently, the necessary analyses are performed using the R statistical software (v.4.0.3), and the information related to the study is obtained, as shown in Table 1. This table presents a summary of this information by displaying the distribution of articles obtained from the WoS database based on document types, citation topics, and research areas.

Determining the best keywords related to the aim of the in question is a critical component. Attention should be paid to choosing keywords that are present in the literature and highly relevant to the thematic area of the study for the search query. In the present study, encountered keywords in the literature related to the thematic area of this study have been selected, namely "agroecology" and "agroecological practices". Keywords were carefully selected to ensure they were both commonly used in the literature and highly relevant to the study's thematic area. The terms "agroecology" and "agroecological practices" were preferred to encompass key research topics and applications within the field of agroecology. These keywords provide a comprehensive opportunity to examine the ecological, economic, and agricultural dimensions of agroecology. However, it should be noted that the selection of these keywords may exclude

some literature relating to the social dimensions of agricultural ecology. Currently, studies examining the social dimension of agroecology are quite limited, highlighting a gap in the existing research. This observation leads to the prediction that the number of studies considering the social dimension will increase in the future, as agroecology is a developing field that is likely to attract more attention from researchers seeking to address these overlooked aspects. Therefore, in future studies, researchers can add keywords that also include the social dimensions of agricultural ecology to conduct new research, in the future.

After the keyword query in the Web of Science (WoS), some filters were applied to select the most relevant articles for the research topic. Table 1 summarizes the distribution of articles obtained from the WoS database based on document types, citation topics, and research areas. Citation Topics is a classification scheme developed in the Web of Science database with the support of the Leiden Center for Scientific and Technological Studies (developers of the WOSviewer software) and the Institute for Scientific Information. This filter is based on a three-level hierarchy of macro, meso, and micro themes, allowing for the selection of the appropriate level of common features needed for the analysis (Bratiloveanu et al., 2023). Through these filters, users can more effectively choose themes that suit their research needs and deepen their analyses. In study, articles account for 91.50% of the total documents, making them the most dominant document type. Book chapters and proceeding papers follow, but their contributions are minimal compared to articles. Environmental Sciences and Ecology play a significant part, making up 32.62% of the studies. Agricultural Policy (88.10%) is the most cited topic in the studies, highlighting the significance of agriculture and agroecology at the policy level. The table shows that a large portion of agroecology-related studies has a strong connection with agricultural policy and environmental sciences. The filtering ensured the selection of studies relevant to the core focus of the topic and provided an interdisciplinary framework.

Bibliometric analyses were conducted using the Bibliometrix package in the R statistical software (Aria & Cuccurullo, 2017; Biblioshiny, 2019; RCoreTeam, 2023). As a result of the analysis, research and review articles, proceeding papers, books, and book chapters related to the topic were selected, and a total of 1907 studies on agroecology and agroecological practices were identified in the WoS database between January 1987 and November 2024.

According to Donthu et al. (2021), bibliometric analysis involves several key steps. First, the purpose and scope of the study must be clearly defined. Next, the appropriate bibliometric analysis techniques should be selected based on the study's objectives. Once the methodology is determined, data related to agroecological practices is collected from the WoS database. Finally, the results of the analysis are systematically reported, providing insights into the research landscape.

*Table 1. Distribution of selected studies by document types, citation topics, and research areas in the WoS database*

| | TOTAL | PERCENTAGE (%) |
|---|---|---|
| Document Types | | |
| Article | 1.745 | 91.50 |
| Book Chapters | 89 | 4.67 |
| Proceeding Paper | 66 | 3.46 |
| Book | 7 | 0.37 |
| Research Areas | | |
| Agriculture | 1.018 | 53.38 |
| Environmental Sciences Ecology | 622 | 32.62 |
| Food Science Technology | 140 | 7.34 |
| Development Studies | 35 | 1.84 |
| Biodiversity Conservation | 22 | 1.15 |
| Plant Sciences | 18 | 0.94 |
| Urban Studies | 17 | 0.89 |
| Public Administration | 16 | 0.84 |
| Public Environmental Occupational Health | 12 | 0.63 |
| Water Resources | 7 | 0.37 |
| Citation Topics Meso | | |
| Agricultural Policy | 1.680 | 88.10 |
| Climate Change | 107 | 5.61 |
| Sustainability Science | 49 | 2.57 |
| Environmental Sciences | 17 | 0.89 |
| Food Science & Technology | 11 | 0.58 |
| Economics | 10 | 0.52 |
| Management | 7 | 0.37 |
| Economic Theory | 6 | 0.31 |
| Political Philosophy | 6 | 0.31 |
| Artificial Intelligence & Machine Learning | 3 | 0.16 |
| Operations Research & Management Science | 3 | 0.16 |
| Sociology | 3 | 0.16 |
| Risk Assessment | 2 | 0.10 |
| Bibliometrics, Scientometrics & Research Integrity | 1 | 0.05 |
| Social Reform | 1 | 0.05 |
| Statistical Methods | 1 | 0.05 |

The current study provides a detailed evaluation based on the data obtained from bibliometric analysis, including the number of studies conducted by years, the number of articles published in study years, the number of articles published in scientific journals, the total number of articles by prominent researchers, average citation numbers by years, the countries of corresponding authors, frequently used keywords, and collaborations among researchers from different countries (Table 2).

*Table 2. Measurements and purposes of bibliometric analysis*

| MEASUREMENTS OF BIBLIOMETRIC ANALYSIS | INTENDED PURPOSE |
|---|---|
| Total publications | Identification of all related publications identified through searches using the keywords "Agroecology" and "Agroecological Practices" |
| Number of publication years and productivity per year | Determination of the number of articles published on agroecology and agroecological practices in the WoS database between January 1987 and November 2024 |
| Total and yearly publication numbers in scientific journals | Determination of the number of articles published in different journals on agroecology and agroecological practices during the relevant years |
| Total number of articles by prominent researchers | Determination of the number of articles by researchers working in the field of agroecology |
| Total citation number and most cited works by prominent researchers | Identification of the most influential articles in agroecology and examination of the relationships among articles |
| Publication data of universities | Presentation of the number of articles published by universities in the field of agroecology |
| Number of articles by country of corresponding authors and development of publication numbers over the years | Determination of the Single Country Publications (SCP) and Multiple Country Publications (MCP) article numbers by the countries of corresponding authors contributing to articles on agroecology |
| Word Cloud map | Identification of frequently used keywords in studies conducted in the field of agroecology |
| Collaboration map | Presentation of collaborations among different countries in the relevant field |

## Results and Discussion

In the WoS database, a total of 1907 scientific studies on agroecology and agroecological practices have been identified between January 1987 and November 2024. According to bibliometric analysis results, the number of studies between 1987 and 2011 was quite low, accounting for only 4.88% of the total studies. Since 2011, an increase in research on agroecological practices was observed, especially between 2017 and 2024. This tremendous leap indicating a growing interest in the subject. The highest number of studies on agroecological practices was conducted in 2023 (Figure 1), with a total of 235 studies. Among these studies, Prost et al. (2023) were presented a literature review discussing the transition to agroecology in the economies of developed countries in response to sustainability issues in agriculture. As a result of the study, it was concluded that supporting farms during the transition to agroecology is challenging due to the lack of information about farmers' change processes and the inadequacy of monitoring methods. In this context, it is emphasized that new methods should be developed that better integrate the farm level and address power imbalances. Another previous study emphasized that agroecology is a transformative approach supporting the long-term productivity and sustainability of food systems (Kerr et al., 2023). The study also highlighted the significant role of agroecology in combating climate change and preserving healthy ecosystems. Furthermore, Migliorini et al. (2020) compared the research outcomes of Agroecology Europe (AEEU) members with other global literature and addressed several controversial issues in agroecology, such as the use of chemicals in agriculture, the preference for large farms over small-scale and family farming, and the impact of technological innovations on agriculture. In the study result emphasized that there are various points of convergence in redesigning agricultural and food systems, utilizing them as leverage in different fields, and addressing agroecology with a holistic, participatory, and multi-stakeholder approach for the necessary transition.

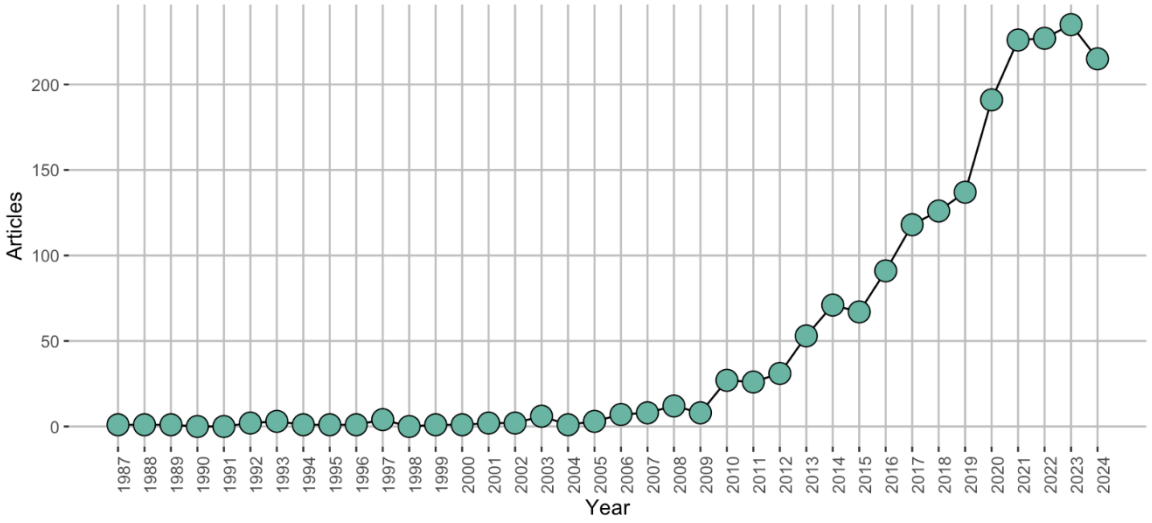


*Figure 1. Annual scientific production on agroecology between 1987 and 2024*

Figure 2 presents the number of articles published in different journals on the topics of agroecology and agroecological practices in the period between 1987 and 2024 in the WoS database. During the specified period, a total of 343 scientific journals have published studies on agroecology and agroecological practices. The journal with the highest number of publications is "Agroecology and Sustainable Food Systems," which accounts for 408 studies, representing 21.39% of the total. Other prominent journals include "Sustainability," "Frontiers in Sustainable Food Systems," "Agriculture and Human Values," and "Agronomy for Sustainable Development," respectively. In a study published which received the most citations in "Agroecology and Sustainable Food Systems," journal it was emphasized that resilient new strategies need to be developed instead of current agricultural practices due to the strong impact of climate change on African agricultural systems (Debray et al., 2019). This study demonstrates that farmers' combinations of different agroecological practices have a high potential to adapt to the impacts of climate change in African agriculture. In another study by Holt-Giménez & Altieri (2013), which received the most citations in this journal, the necessity of a powerful counter-movement like agroecology for transformative reforms against recurring global food crises was emphasized. In a study published in the most citations journal "Sustainability," another prominent journal in the field of agroecology, it was noted that a transformation like agroecological movements would require significant social and political changes (Altieri et al., 2017). The study also emphasizes that while reducing input usage is an important step, changes in agroecological practices are not necessary for redesigning more autonomous and self-sufficient farming systems.

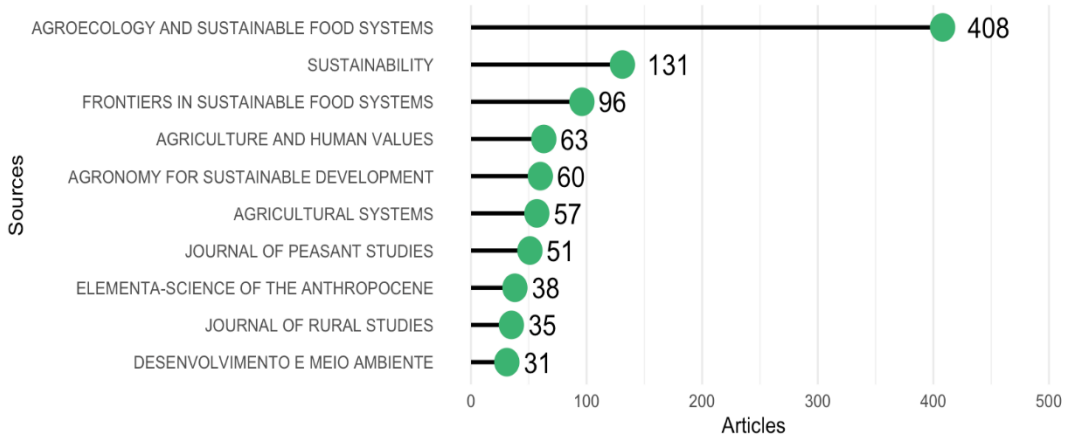


*Figure 2. The most relevant journals publishing on agroecology*

Figure 3 illustrates the number of articles published in specific journals on agroecology and agroecological practices over the years. Identifying the journals in which studies on agroecology and agroecological practices are published is important for understanding the growth in this field and contributing to researchers' future work planning. Among the relevant journals were "Agroecology and Sustainable Food Systems," "Sustainability," "Frontiers in Sustainable Food Systems," "Agronomy for Sustainable Development," and "Agriculture and Human Values." An increase in the number of articles published on agroecology and agroecological practices in these journals can be observed over time, particularly becoming more pronounced after 2013. Furthermore, there has been a significant increase in the number of articles on agroecology published in journals since 2020. The number of articles published in the "Agroecology and Sustainable Food Systems" journal has been continuously increasing over time, reaching its peak in 2023-2024. During these two years, a total of 772 articles on agroecology and agroecological practices were published in the journal. According to the latest research on agroecology, various topics have been explored, including the history, implementation, and effects of agroecology policies in France (Wezel & David, 2020), differences in crop and dietary diversity between farms practicing and not practicing agroecological methods in Malawi (Kansanga et al., 2021), and the impact of agroecological practices on pumpkin fields (Vogel et al., 2023). Wezel and David (2020) emphasized that the agricultural policies implemented by the French have failed to reduce pesticide use in conventional farming and noted a shift towards supporting agroecological transition. On the other hand, Kansanga et al. (2021) demonstrated that agroecological methods have the potential to improve nutrition in smallholder farming contexts and can contribute to achieving the Sustainable Development Goals. These results provide important findings regarding the topics and emphasis focused on in agroecology.

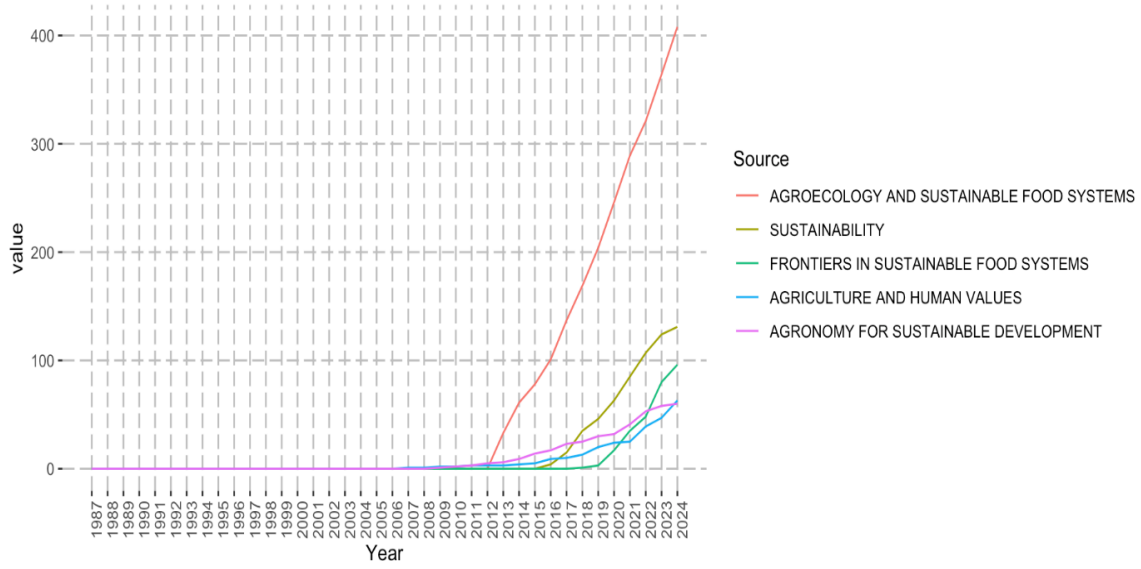


*Figure 3. Trends in agroecology publications over time by journal*

Figure 4 presents the publication data and fractional values of some prominent researchers in the field of agroecology and agroecological practices. Identification of the prominent scholars is extremely important in introducing readers to the contributors in the field and emphasizing the significance of their work. This information helps identify the primary research areas in the literature and may help for understanding where researchers have made significant impacts. It will also provide important benefits to those who work in agroecology field, such as following the publications of the pioneers of the field of agroecology in today's digital age and being quickly informed about the publications. Understanding the work of these important researchers helps lay the groundwork for contributing new insights to the field of agroecology. Researchers focused on specific topics can enhance knowledge in those areas and contribute to advancements by developing new research ideas. Miguel A Altieri has the highest number of research articles on agroecology, with a total of 24 articles. Altieri's fractional values is also significant, measuring 10.89. This indicates that Altieri is a highly influential author in this field, with each of his articles impacting multiple areas on average (Sivertsen et al., 2019). In his works, Altieri was addressed topics such as agroecology, food sovereignty, and sustainable food systems, elucidating the importance of these concepts and their interrelations (Altieri, 1989; Altieri, 2009). Alexander Wezel stands out as an active researcher with 23 articles; however, his fractional values were lower (5.62), suggesting that his studies are more specialized in specific areas. Upon examination of Wezel's works, studies on the historical development of agroecology as a scientific discipline, the usage of terms and definitions (Wezel & Soldat, 2009), the current status and development of agroecology in Europe (Wezel et al., 2018), and the impact of agroecological practices on food security and nutrition (Kerr et al., 2021) were identified. In terms of article number, Altieri and Wezel are followed by Mendez (n=20), Lieblein G (n=19) and Rachel Bezner Kerr (n=18). Other researchers such as Francis, Morales, Tittonell, Meynard and Therond also had significant numbers of articles; however, their contributions to the field of agroecology, as indicated by their fractional values, were comparatively lower than other authors.

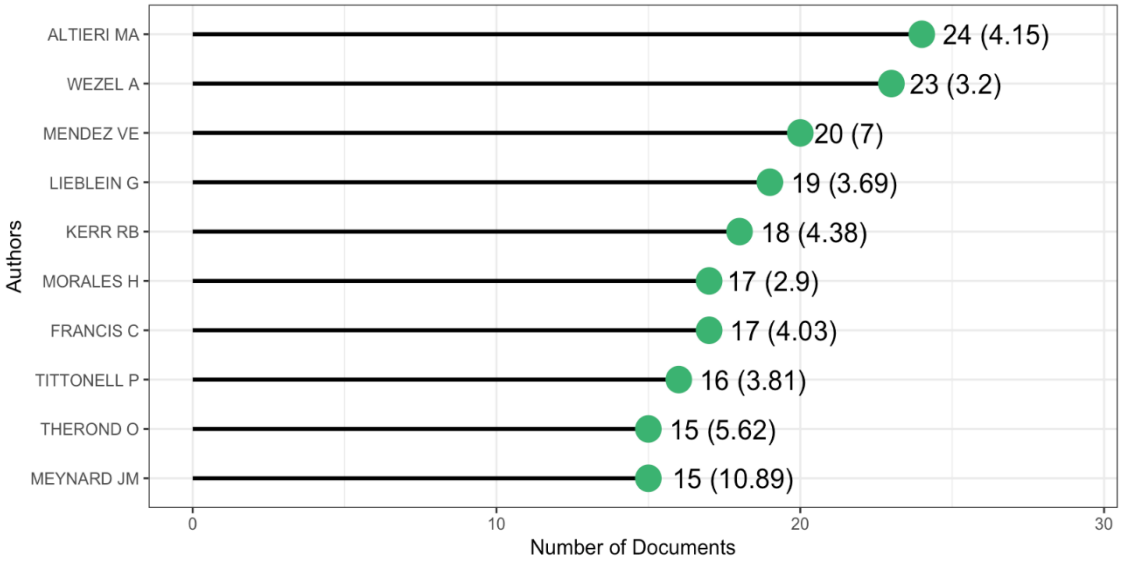


*Figure 4. Most prolific authors in agroecology research based on number of publications*

Figure 5 displays the local citation counts received by specific researchers for their studies on agroecology and agroecological practices. Here, the term 'local cited authors' refers to authors who have received the most citations within a specific topic. To avoid confusion with 'global cited authors,' which refers to the number of citations an author has received across the entire global scientific literature, the term 'local cited' has been used. Alexander Wezel has been remarked with 629 citations, indicating broad interest in his research. Miguel A Altieri follows with 439 citations, underscoring his influence in the field. Researchers such as Stephane Bellon, Charles A. Francis, Bezner Kerr, David C and Dore T also have high citation counts. Others like Vallod D., Therond O. and Duru M. have received significant citations, indicating the extensive evaluation of their work. This suggests effectiveness these authors in their respective fields and the widespread utilization of their studies in the literature. One of the most cited studies, conducted by Wezel et al. (2009), examines the various meanings of agroecology and analyzes its historical development. The study emphasizes that new perspectives on agroecology and interdisciplinary research can help address various challenges in agricultural production, such as climate change, food insecurity, and resource scarcity. Another of the most cited works in agroecology is by Altieri et al. (2015), discussing the impacts of climate change on agricultural production and emphasizing the importance of agroecological methods in mitigating these effects. Another highly cited work is by Francis et al. (2003), focusing on defining and emphasizing the significance of agroecology. According to the study, agroecology should be defined as the ecology of food systems and is crucial for the development of sustainable agriculture and food systems.

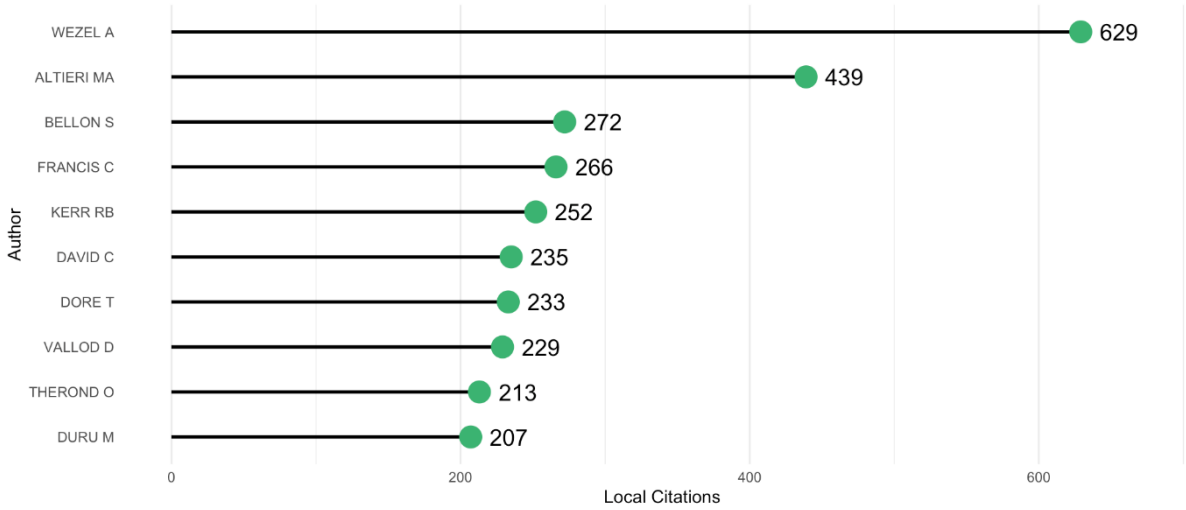


*Figure 5. Most locally cited authors in agroecology research*

The publication data from universities in the field of agroecology was presented in Figure 6. The Montpellier University leads in this area with 167 articles, demonstrating its pioneering position. The Vermont University also makes a significant contribution to the field with 128 articles on agroecology and agroecological practices. Wageningen and Toulouse Universities were followed by Berkeley University in conducting research on agroecology. Other universities given in Figure 6 have also made significant contributions to the agroecology literature. An important point to note here is that in this study, not only universities but all research institutions have been considered. However, it has been determined that the top 10 with the highest number of publications in agricultural ecology consist solely of universities.

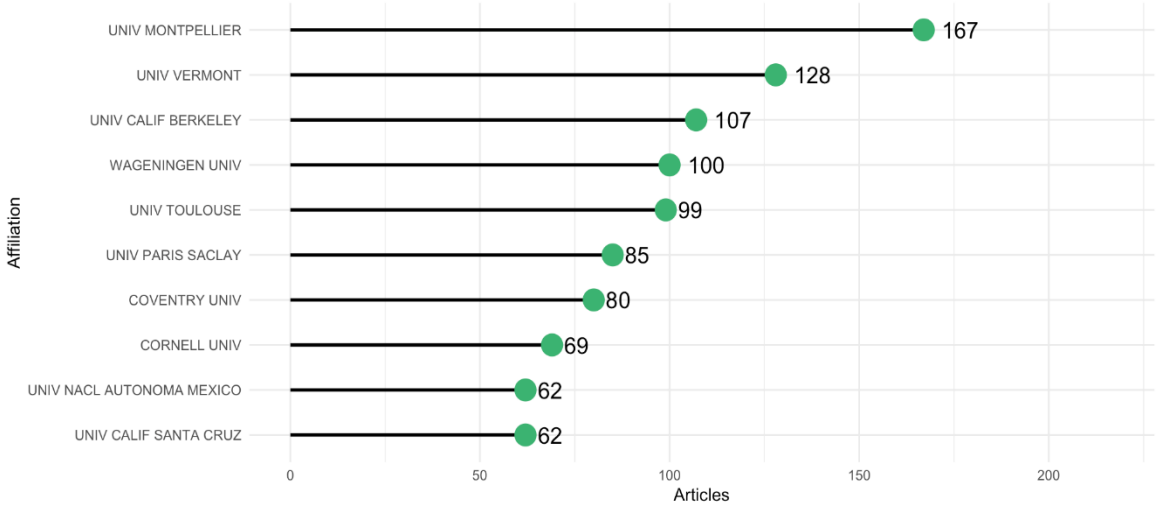


*Figure 6. Most affiliations in agroecology research based on number of publications*

Figure 7 presents data on the countries of responsible authors contributing to articles on agroecology. The SCP (Single Country Publications) and MCP (Multiple Country Publications) values in the figure indicate whether the researchers' work is specific to their country or involves participation from multiple countries. According to these data, based on the number of articles in the field of agroecology, the United States leads as the country with the highest scientific production, with 369 articles. Following the United States are France (289), Spain (110), United Kingdom (106), Brazil (97), Mexico (87), Italy (80) and Canada (75). This ranking demonstrates the broad geographical distribution of active participation in agroecology research. The MCP

value for the United States and France indicates that researchers in these countries frequently engage in international collaboration. The total number of articles serves as a quantitative indicator of each country's scientific efforts in agroecology, representing the level of contribution of these countries to research in this field.

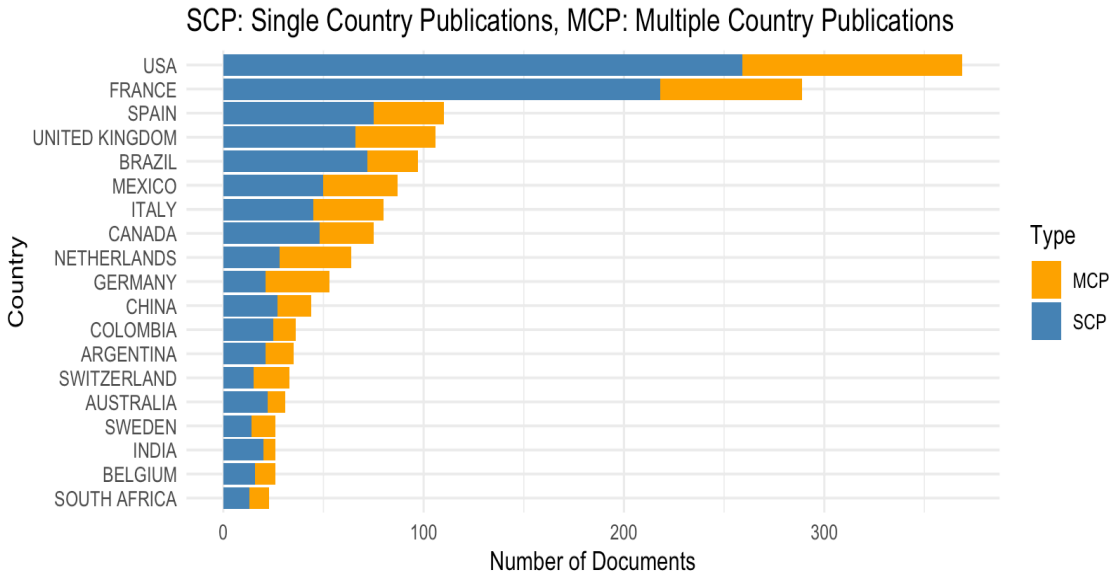


*Figure 7. Countries of corresponding authors in agroecology research*

Determining which years and countries have seen more agroecology studies is important in bibliometric research. Identifying the countries that stand out in the development of agroecology is crucial for guiding research in this field and establishing more effective international collaborations. This information contributes to the future advancement of agroecological research and the formation of broader understanding. The number of articles on agroecology, by year and country, is presented in Figure 8. The United States has been consistently increasing its number of articles on agroecology from 1987 to 2024. Following the United States, France has also shown a steady increase in the number of articles on agroecology since 2009. The reasons for the prominence of the United States and France in agroecology studies can be attributed to their extensive scientific research capacities and strong political and institutional support. Brazil, Spain and United Kingdom have increased their contributions to agroecology since the early 2000s. In conclusion, it is evident that the prominent countries in agroecology research have shown development over time, with their contributions to the scientific literature increasing.

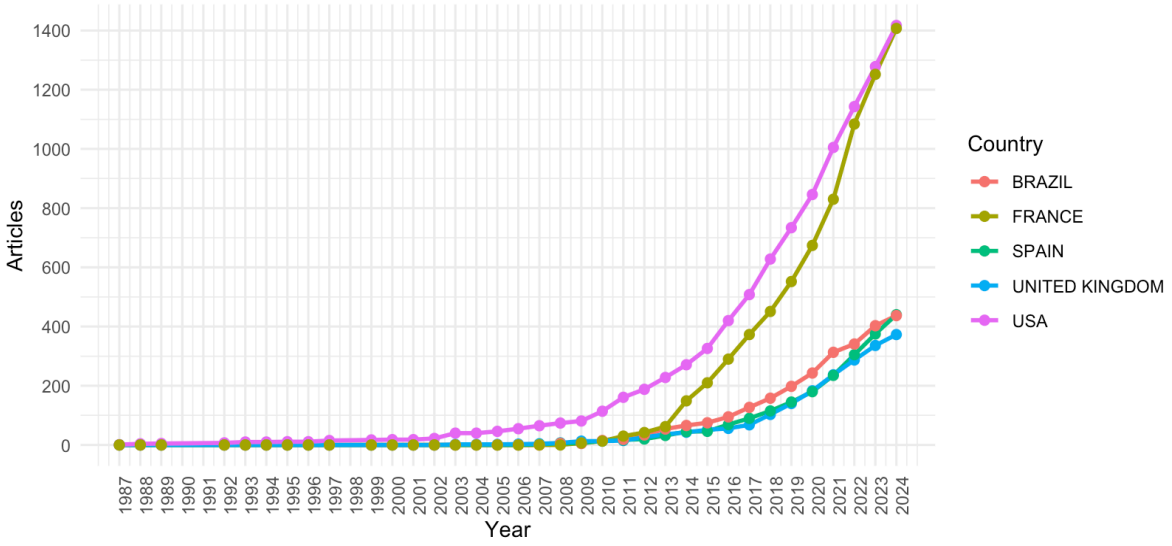


*Figure 8. Trends in agroecology research by country over time*

In Figure 9, the citation counts for prominent authors in the field of agroecology are presented. This allows for the identification of seminal works by leading scholars contributing valuable insights to the agroecology literature. It has been observed that the study conducted by Alexander Wezel that published in Agronomy for Sustainable Development in 2014 (670 citations) and study by Miguel A. Altieri in the Journal of Peasant Studies in 2011 (631 citations) have received high citation counts. The highly cited study by Wezel et al. (2014) in the field of agroecology examines agroecological cropping practices in temperate regions, focusing on their advantages and disadvantages in terms of efficiency and substitution. The study found that biofertilizers and natural pesticides are inadequately integrated into agriculture, whereas organic fertilizers and drip irrigation are well integrated. These findings provide insights for the more effective use of agroecology in future agriculture. One of the most cited studies, by Altieri and Toledo (2011), provides an overview of the process referred to as the "agroecological revolution" in Latin America. The study argues that an "agroecological revolution" has emerged, aiming to preserve agricultural biodiversity and strengthen peasant organizations. Another notable article was Pablo Tittonell's study in Journal of Field Crop Research in 2013, with 618 citations. This study examines the causes and effects of yield gaps in smallholder farming in Africa. The results indicate that development policies aimed at increasing productivity and addressing food insecurity need to be re-evaluated within the framework of ecological transformation (Tittonell and Giller, 2013). The articles by Miguel A. Altieri, published in Agriculture Ecosystems Environment in 2002 and Agronomy for Sustainable Development in 2015, with citation counts of 564 and 599 respectively, have had a significant impact on the field. These studies emphasize the importance of a more effective and inclusive approach to natural resource management, highlighting the role of agroecology in this process and underscoring the significance of agroecological approaches in designing and implementing agricultural systems that are more resilient to climate change (Altieri, 2002; Altieri et al., 2015). Additionally, works by other academics such as Claire Kremen and Charles A. Francis were also recognized as important contributions to the agroecology literature.

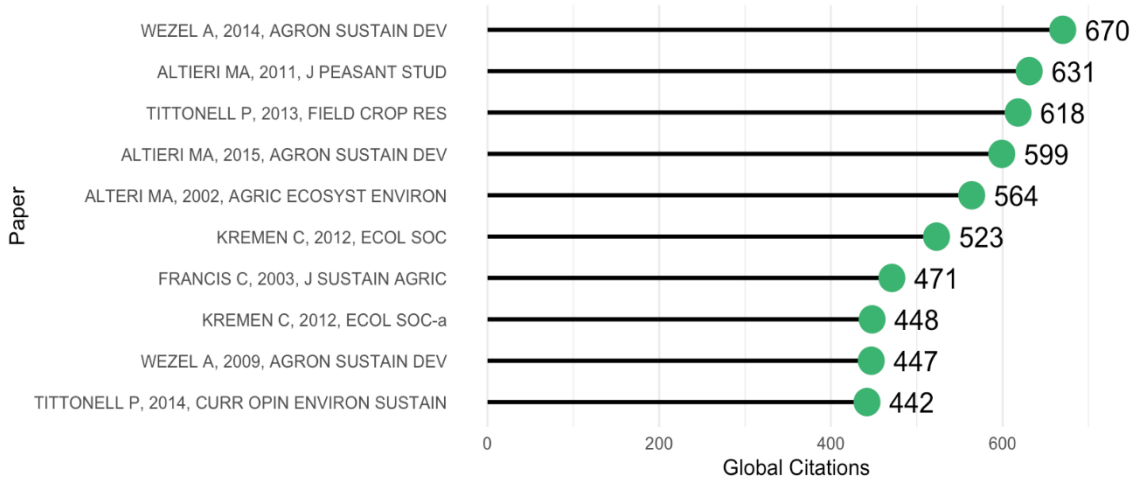


*Figure 9. Most globally cited documents in agroecology research*

The word cloud map displaying the frequently used keywords in studies conducted in the field of agroecology, provides insights into the prominent topics in this area (Figure 10). The word cloud visually represents key concepts in agroecology literature, offering researchers and readers a visual overview of important themes in this field. The terms “Agriculture” and "Agroecology" exhibit a noticeable predominance in total frequency. The term "Agriculture" indicates that agriculture is directly associated with agroecology in the studies, while "Agroecology" shows that the concept itself is frequently discussed. The terms "systems" and "management" were ranked second and third respectively, highlighting the focus of agroecology studies on strong connection between agroecology and approaches to systems and management. Additionally, terms such as "sustainability" "biodiversity," and "food" indicate emphasis on the overall dynamics of agriculture and signifies the significant theme of sustainability principles in these studies. The prominence of the terms "farmers" and "food sovereignty" indicates that agroecology highlights its social dimension and emphasizes farmer-centered policies.


*Figure 10. Most relevant words with agroecology*

Figure 11 depicts a map illustrating collaborations among researchers from different countries in studies focusing on agroecology. These collaborations were emphasized the contributions of various countries and the importance of global collaboration in international

research in the field of agroecology. Accordingly, researchers from the United States (US) engage in collaborations with various countries to a considerable extent. The countries with which researchers from the US collaborate most frequently include Canada, the United Kingdom, Mexico, and Malawi. Additionally, countries such as France, Italy, Brazil, and Germany were found other significant collaboration partners of the US.

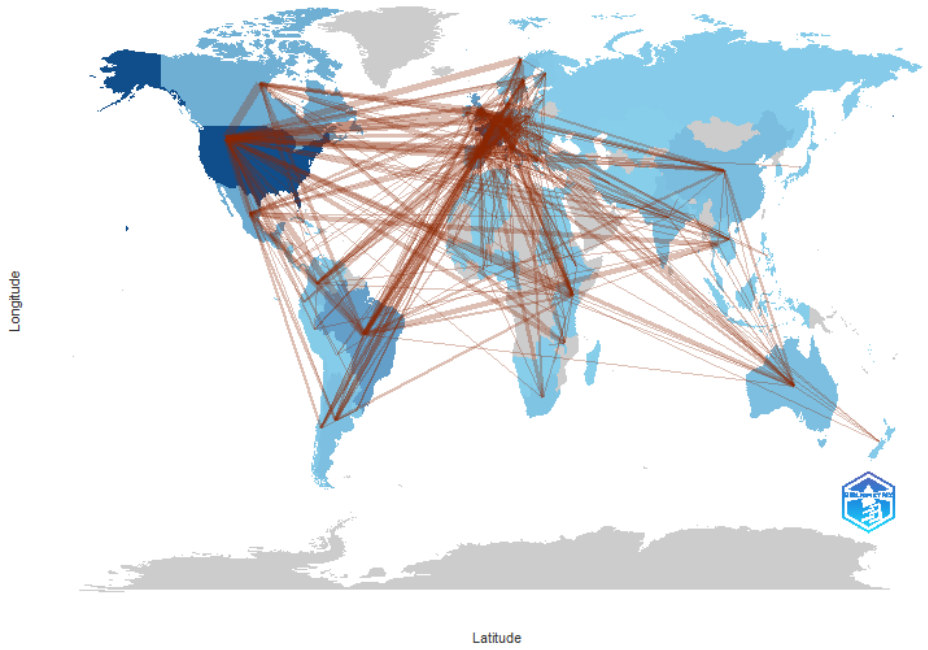


*Figure 11. Collaboration map in publications with agroecology*

## Conclusion

Agroecology is a concept that refers to agricultural practices comprising principles of sustainability such as economic, environmental, and social factors. Although the term "agroecology" emerged in the 1930s, it was only recognized as a scientific discipline until the 1960s. However, with the rise of environmental movements in the 1960s, agroecology was gained importance and evolved into an agricultural practice in the 1980s. In this study, data obtained from 1907 agroecology-related articles indexed in the WoS database between 1987 and 2024 were analyzed using bibliometric analysis methods with various parameters.

The bibliometric analysis results indicate an increase in the number of articles published on agroecology and agroecological practices. Particularly in the last decade, there has been a significant rise in research activity in this field. This increase reflects growing interest among researchers, agricultural stakeholders and agro-environment policymakers on agroecology. It can be stated that this trend underscores the potential of agroecological practices to enhance environmental and economic sustainability in agricultural production.

When examining the number of articles published in specific journals, it was observed that researchers working in the field of agroecology and sustainable agricultural systems tended to concentrate their efforts, especially in journals such as "Agroecology and Sustainable Food Systems," "Sustainability," "Frontiers in Sustainable Food Systems," "Agriculture and Human Values" and "Agronomy for Sustainable Development." These journals were found as significant platforms for agroecology research.

The evaluation of the contributions of universities on agroecology research reveals that several institutions in the United States and Europe hold prominent positions in this field. Affiliations such as Montpellier University, Vermont University, and Calif Berkeley University

were conducted pioneering research in agroecology and agroecological practices, making valuable contributions to the literature.

When the distribution of corresponding authors by country was examined, it was observed that countries such as the United States, France, and Spain are leading in agroecology research. Additionally, these countries were prioritized international collaborations, indicating an increase in global cooperation in the field of agroecology. When the citation counts of prominent researchers' works were examined, it was evident that certain names have significant impacts on the literature of agroecology. Researchers such as Alexander Wezel, Miguel A Altieri, and Stephane Bellon have made substantial contributions to the field of agroecology and agroecological practices, gathering prominent levels of citations.

In conclusion, the increase in the quantity and quality of research conducted in the field of agroecology reflects a growing awareness and scientific interest in the sustainability of agricultural systems. Agroecological practices are likely to continue being important tools for enhancing the environmental and economic sustainability of agricultural production in the future. Particularly, developing solutions based on agroecological principles is crucial for combating climate change, loss of biodiversity, and soil erosion with environmental problems caused using chemical inputs in agricultural production and unsafe food production. Therefore, it can be said that the interest in research and publications in the field of agroecology will persist. The increase in research and applications in agroecology can contribute to making agriculture more sustainable and global food systems more safe, equitable and environmentally friendly.

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