Environment-Resilience Agriculture System: Enhancing Resilience to Environmental Change

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ABSTRACT

*This systematic literature review examines the impact of resilient agricultural systems on the environment using bibliometric analysis via VOS viewer, analyzing 212 scholarly papers from the Web of Science and Scopus (2000–2023). Key findings include: (i) a steady rise in publications, which is expected to continue; (ii) the USA leads in research output, followed by England, Australia, and Italy; (iii) Wageningen University & Research is the most productive institution; (iv) *Science of the Total Environment* is the top journal; and (v) frequent keywords include "agriculture," "resilience," "climate change," "sustainability," and "food security." The study highlights research trends and hotspots, emphasizing the growing focus on climate adaptation, biodiversity, and ecosystem resilience. As the first comprehensive bibliometric analysis in this field, it provides valuable insights for sustainable agriculture and resource management, offering a unique contribution to understanding the environmental impacts of resilient agricultural systems.*

Keywords: Resilient, Agricultural systems, Environment, Bibliometric analysis, VOS viewer

JEL classification codes: C19, F69, Q18, F64

1. INTRODUCTION

Environment-resilient agriculture is described as “agriculture that reduces poverty and hunger in the face of environmental change while improving the resources on which it relies for future generations” (Akpan & Zikos, 2023). Phylogeny activities have altered the environment in recent eras, particularly with the onset of industrialization. Environmental change is not a new phenomenon; it has been occurring for hundreds of millions of years. According to the Intergovernmental Panel on Climate Change (IPCC), global warming might reach 1.5 degrees Celsius between 2030 and 2052 if current trends continue, and human activities are

responsible for the approximately 1.0°C degree Celsius rise above pre-industrial levels (Akamani, 2021).

Therefore, a study by Guo et al. (2021) examining urban land use and anthropogenic heat emissions in Beijing found that the presence of the Fifth Ring Road leads to a reduction in snow accumulation by 17% to 22%. This variation is influenced by factors such as aerosol number concentration and particle size. Moreover, in Somalia, 478,000 children are currently at risk of dying from severe acute malnutrition and nearly 20% of Somalia's population has been displaced due to conflict and drought. Additionally, more than half of all children under five are malnourished.

Environmental changes, driven by both natural factors (e.g., shifts in Earth's orbit, volcanic eruptions, ocean current changes) and human activities (e.g., industrialization, deforestation, nitrogenous fertilizers), are exacerbating food insecurity. Climate-related economic losses in agriculture and livestock reached over $80 billion from 2003 to 2013, with Sub-Saharan Africa particularly vulnerable due to its heavy reliance on rain-fed farming. The World Bank predicts that climate impacts on agriculture could push an additional 100 million people into poverty by 2030 (Singh et al., 2021; Bernal et al., 2017).

In Sub-Saharan Africa, disadvantaged households often supplement agricultural income by selling natural resources like shea nuts and moringa, with a focus on empowering women through more efficient processing methods. However, the region is highly vulnerable to environmental changes, particularly shifts in weather and climate (e.g., temperature, precipitation), which threaten agricultural and livestock productivity. To address this, strategies focus on 1) strengthening agricultural systems for vulnerable groups, 2) improving natural resource management, and 3) reducing environmental degradation. These efforts promote crop diversity, off-farm income, and collaboration with public and private sectors to protect ecosystems (Serdeczny et al., 2017).

Environmentally resilient agriculture aims to reduce poverty and hunger amid environmental change while preserving resources for future generations generations (Akpan & Zikos, 2023). For instance, in South Asia, resilient systems enable aquaculture producers to grow nutrient-rich crops like orange sweet potatoes and spinach near ponds. However, severe environmental changes—such as warming, erratic precipitation, floods, droughts, and storms, threaten agricultural systems and could exacerbate malnutrition (Deng et al., 2022).

Despite economic diversification into sectors like manufacturing and services, agriculture remains vital to many developing countries, including Ghana. It employs over 45% of Ghana's workforce and contributes 21% to GDP. However,

Ghana faces significant climate change impacts due to inadequate adaptive measures, highlighting the need to address environmental and socio-economic challenges (Mockshell & Kamanda, 2018).

In light of this, we aim to gain a comprehensive understanding of the contributions made by academic literature on the relationship between resilient agricultural systems and the environment. We are particularly interested in the following research questions.

RQ1: Are studies on the relationship between resilient agricultural systems and the environment expanding?

RQ2: Who are the key players in this field?

RQ3: Which are the renowned nations, institutions, and journals contributing to the study of resilient agricultural systems and the environment?

RQ4: What are the main themes in the literature on resilient agricultural systems and the environment?

RQ5: Which future research trajectories are possible?

This paper is organized as follows: Section 2 provides background information on earlier research related to resilient agricultural systems and the environment. Section 3 summarizes the methodology employed in this bibliometric analysis. Section 4 reports the significant trends and thematic clusters, along with the study's general findings. Section 5 presents the conclusion. Finally, Section 6 covers the study's scope for future research, implications, and limitations.

2. LITERATURE REVIEW

Bibliometric analyses have received increased interest over the last decade. Because of the development of new software programs, transdisciplinary techniques, and the capacity to handle large databases, this method has grown in popularity (Khan et al., 2022). Furthermore, this approach enables objective data analysis and the discovery of numerous patterns in a specific research field as well as journal performance, themes, authorship, co-citations, and references (Ellili, 2022). This study focuses on resilient agricultural system research because of increased awareness of natural resource depletion and environmental changes.

Resilient agricultural systems have gained attention from policymakers and experts amid growing environmental concerns. Studies highlight the importance of financial and technical support for farmers' climate adaptation, alongside social and psychological factors (Deng et al., 2022). However, a meta-analysis by Vermeulen et al. (2018) found that current adaptation efforts have limited success

in enhancing resilience or governance, emphasizing the need for comprehensive, long-term planning and increased support to improve climate adaptation effectiveness.

Rojas-Downing et al. (2017) analyzed climate change's impact on livestock, highlighting challenges like feed scarcity, water shortages, diseases, and heat stress, while noting livestock's contribution to climate change through land use, feed production, and emissions. They emphasize diversification of livestock and crop-livestock systems as key adaptation strategies. Effective climate adaptation in animal husbandry requires integrated approaches, including breeding, nutrition, housing, health improvements, and enhancing animal comfort and performance.

According to the aforementioned literature, recent research on resilient agricultural systems and environmental change primarily uses traditional review techniques (scoping reviews), and the bibliometric approach is uncommon, particularly with visualization analysis (Vickers, 2017; Wang et al., 2018).

3. MATERIALS AND METHODS

3.1. Bibliometric Analysis

A bibliometric review offers an objective, quantitative approach to analyzing scientific performance and mapping research fields, reducing bias compared to methods such as systematic reviews (Donthu et al., 2021; Lim, 2022). It provides unique theoretical and practical insights, complementing other review types. This method was applied to study the performance, influence, and mapping of research in environmentally resilient agricultural systems.

Researchers have conducted bibliometric reviews to explore the concept of Environment-resilient agriculture systems, which focus on how agricultural systems manage disturbances like shocks, stressors, and trends (Urruty et al., 2016). These systems integrate biophysical, technological, and social elements, influenced by external (e.g., market changes) and internal factors (e.g., pests) (Walker et al., 2006). Environmental shocks can deplete smallholders' resources, but strategies like multi-cropping enhance resilience by diversifying crops, improving income, nutrition, and climate adaptation (Bernal et al., 2017).

3.2. Data Collection

This study's objective is to identify the broad trends in research on how resilient agriculture systems affect the environment globally. Consequently, bibliometric analysis is used to conduct a quantitative examination. The review of several schools of scientific knowledge has been prompted recently by bibliometric technique. Many scientists, particularly those in management, finance, and economics, have used it in this way (Belmonte-Ureña et al., 2020; Chen & Yang,

2021; Sitenko & Yessengeldin, 2019). The keyword "impact of resilience agricultural systems on the environment" was chosen based on the primary literature study on this subject.

The study utilized the Web of Science and Scopus databases for bibliometric analysis due to their extensive coverage and reliability. Web of Science was chosen for its high-quality, indexed articles spanning 2000 to 2023, making it a trusted source for academic research (Ye et al., 2020; Rey-Martí et al., 2016). Scopus was selected for its comprehensive collection of peer-reviewed publications in the humanities and social sciences (Fink, 2019; Melander & Arvidsson, 2022). Initial research revealed 214 articles from Web of Science and 254 from Scopus, providing essential bibliographic data (e.g., authors, citations, journals) to achieve the study's objectives.

The study followed the PRISMA framework to select articles on resilient agricultural systems and the environment. Initially, a total of 468 records were identified from Web of Science and Scopus (2000–2023). During screening, 193 non-journal articles (e.g., reviews, book chapters, conference papers) and 10 non-English articles were excluded. In the eligibility phase, 63 duplicates were removed using RStudio, leaving 212 articles for bibliometric analysis.

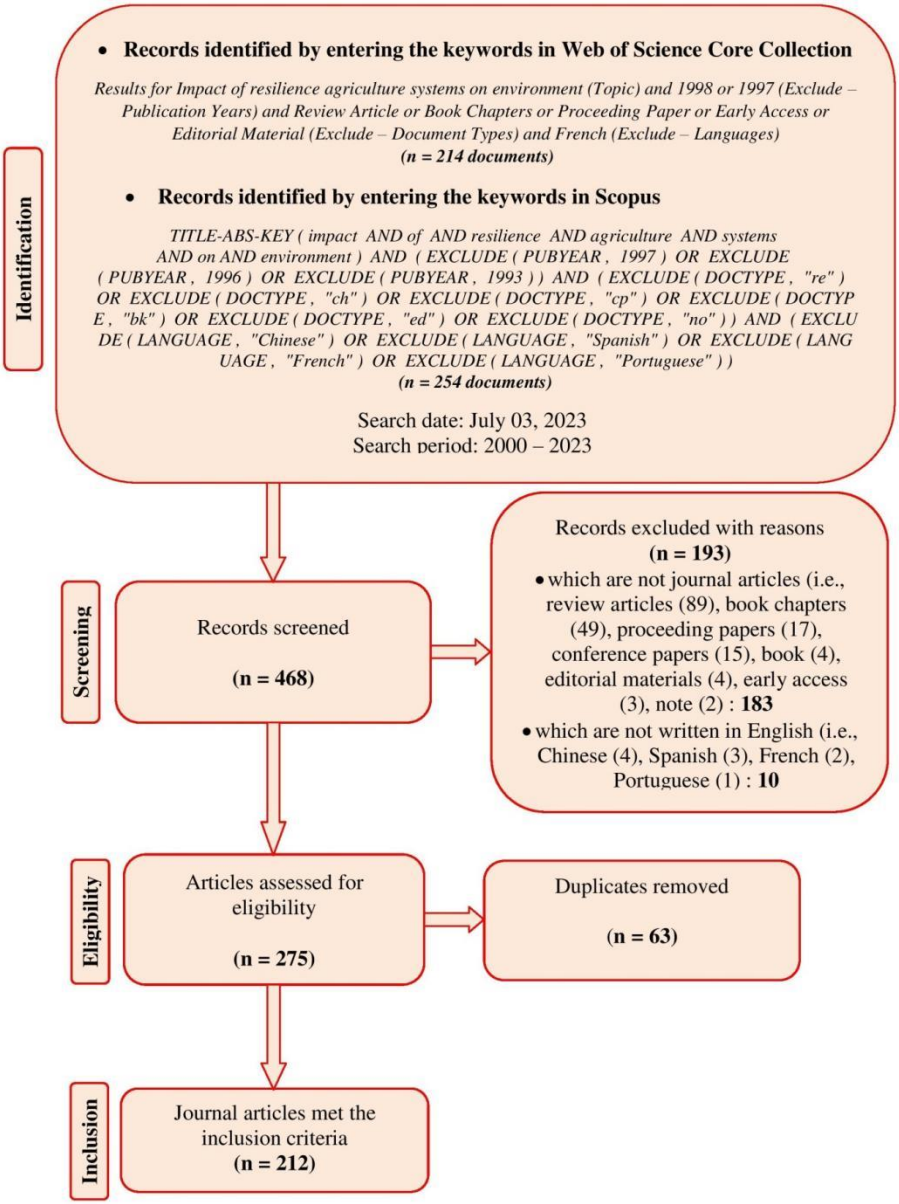
3.3. Selecting Tools p

The study employs bibliometric analysis to explore the relationship between resilient agricultural systems and the environment. This quantitative method evaluates research interest, trends, and contributions across fields, identifying key authors, publications, and hot topics (Prashar, 2020; Yu et al., 2021). It provides an objective assessment of literature, using tools like VOS viewer (version 1.6.19) and Microsoft Excel for data visualization and analysis (Wang & Kim, 2023). This approach helps uncover insights into how resilient agricultural systems impact the environment.

3.4. Analysis of Articles

For bibliometric analysis using VOS viewer, we focused on three key elements: author co-citation, keyword clustering, and literature co-citation (Prashar, 2020). First, we analyzed publications, authors, institutions, and countries to identify trends, major contributors, and leading regions. Second, we examined top journals and co-cited works through cluster analysis. Finally, keyword clustering was used to highlight current and emerging research trends in resilient agricultural systems and their relationship environment.

Figure 1: Documents Selection Flowchart (PRISMA)



Source(s): VOS viewer (version 1.6.19).

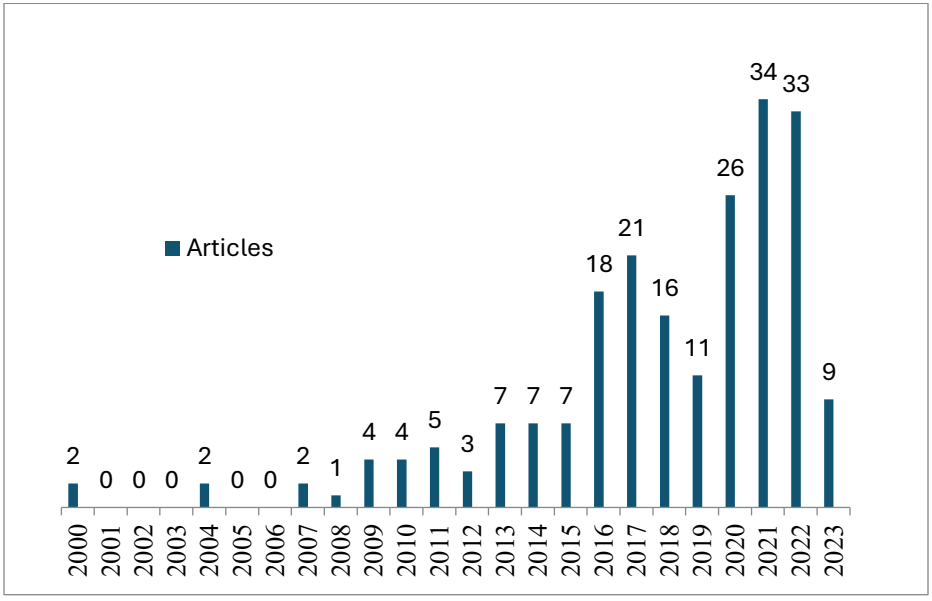
4. RESULTS & DISCUSSION

4.1. Are studies on the relationship between resilient agriculture systems and the environment expanding? (RQ1)

Figure 2 illustrates a bibliometric analysis of publications from 2000 to 2023, revealing fluctuations in the annual number of articles published. The data shows periodic peaks and plateaus, indicating varying research interest and output over time. While no clear upward or downward trend is evident, the analysis suggests that the field has evolved, with some years experiencing notably higher publication rates than others.

The data show fluctuating publication volumes from 2000 to 2023, with some years (e.g., 2001–2003, 2005–2006) having no publications. Notable peaks occurred in 2017 (21 articles), 2018 (16 articles), and 2021 (34 articles), indicating heightened research activity or interest. Periods of stability, such as 2013–2015 (7 articles annually), were also observed. Overall, the trend suggests growth in the field, with increased publications in recent years reflecting expanding knowledge and rising interest in the subject.

Figure 2: **Development of Annual Publications**



Source(s): Authors own creation.

4.2. Who are the most cited authors? (RQ2)

Table 1 summarizes the top 20 most-cited authors and their contributions across disciplines such as environmental science, agriculture, livestock, and health. Their highly cited works demonstrate significant recognition and influence, advancing scientific knowledge and shaping discourse in their respective fields. These studies serve as essential references for academics, policymakers, and practitioners, addressing critical challenges and driving progress.

In particular, the top five most-cited authors (Table 1)—representing diverse countries such as the United Kingdom, Canada, Spain, and the Netherlands—have produced globally accessible research that underscores the international impact of their contributions.

Table 1: Top 20 Most Cited Authors

R	Author(s)	Country	Journal	TC
1	Challinor et al., 2007	UK	Climate Change	369
2	Falloon & Betts, 2010	UK	Science of the Total Environment	291
3	Chagnon et al., 2015	Canada	Environmental Science and Pollution Research	271
4	Bernués et al., 2011	Spain	Livestock Science	244
5	Meuwissen et al., 2019	Netherlands	Agricultural Systems	210
6	Soussana et al., 2019	France	Soil and Tillage Research	163
7	Aspinall & Pearson, 2000	USA	Journal of Environment Management	160
8	De Roest, Ferrari, & Knickel, 2018	Italy	Journal of Rural Studies	131
9	Gerber, Mottet, Opio, Falcucci, & Teillard, 2015	Italy	Meat Science	130
10	McKey et al., 2010	France	Proceeding of the National Academy of Sciences	129
11	Meinke et al., 2009	Netherlands	Current Opinion on Environmental Sustainability	114
12	Wu & Hu, 2020	China	Ecological Indicators	112
13	Hansen et al., 2019	USA	Agricultural Systems	111
14	Waha et al., 2017	Germany	Regional Environmental Change	96
15	Hochman et al., 2013	Australia	European Journal of Agronomy	94
16	Thornton & Herrero, 2014	Kenya	Global Food Security	84
17	Thorburn, Wilkinson, & Silburn, 2013	Australia	Agriculture, Ecosystems & Environment	83
18	Rist et al., 2014	Sweden	Ecosphere	81

19	Kjellstrom & McMichael, 2013	Sweden	Global Health Action	80
20	Cowie et al., 2011	Australia	Land Degradation & Development	77

Note: R: Rank , **TC:** Total citations

Source(s): VOS viewer (version 1.6.19).

4.3. Which country is most enthusiastic about this field of study? (RQ3)

Table 2 provides insight into the research productivity of various countries based on co-authorship in scholarly work. It presents statistics on the top 20 countries, evaluated using several metrics, including the number of articles, links, total link strength (TLS), and total citations (TC).

Table 2: Top 20 Most Productive Countries based on Co-Authorship

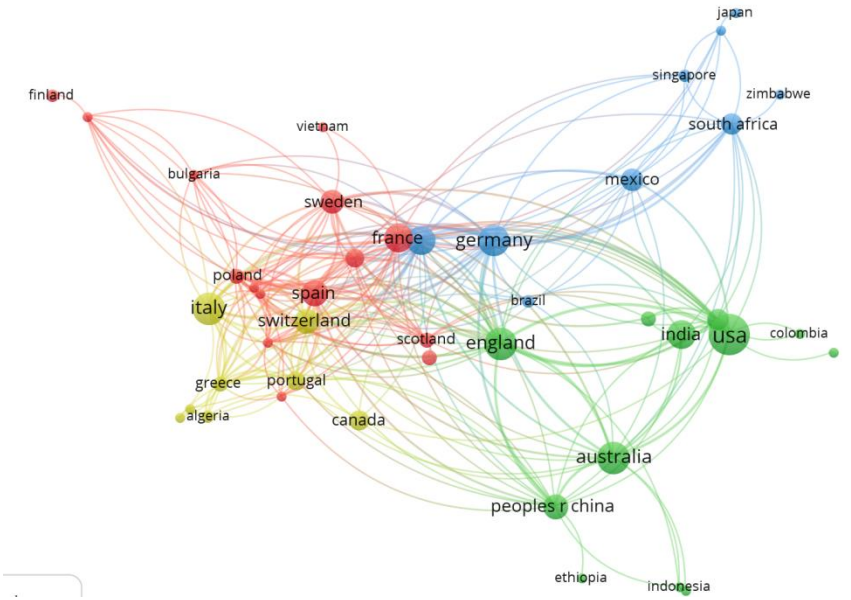
R	Country	Cluster	NoA	Links	TLS	TC
1	USA	2	29	18	33	801
2	England	2	19	24	57	778
3	Australia	2	18	18	31	867
4	Italy	4	18	19	36	648
5	Germany	3	17	27	58	704
6	France	1	15	27	43	976
7	India	2	14	9	15	182
8	Netherlands	3	14	27	57	931
9	Spain	1	12	22	46	659
10	China	2	11	20	27	260
11	Switzerland	4	11	24	48	561
12	Sweden	1	10	21	38	577
13	Mexico	3	9	14	16	241
14	Kenya	2	8	13	22	676
15	South Africa	3	8	15	18	252
16	Canada	4	7	6	7	435
17	Belgium	1	6	22	34	322
18	Portugal	4	6	15	20	180
19	Austria	2	4	5	7	375
20	Greece	4	4	20	29	35

Note: R: Rank, **NoA:** Number of Article, **TLS:** Total link strength, **TC:** Total citations

Source(s): VOS viewer (version 1.6.19).

Co-authorship plays a vital role in scientific collaboration, allowing researchers to combine resources and expertise to conduct impactful research. These indicators help identify countries that actively engage in collaborative research efforts and have made significant contributions to the global scientific community.

Figure 3: **Network Visualization of Most Productive Countries based on Co-authorship**



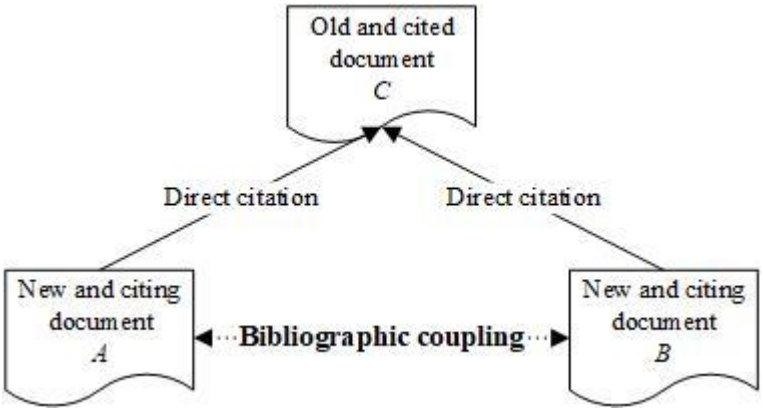
Source(s): VOS viewer (version 1.6.19).

Figure 3 illustrates the collaborative network among 44 countries, divided into four clusters, with 265 links and a total link strength of 414. Each node represents a country, with its size indicating publication volume and links showing international collaboration. Clusters, marked by color, highlight research groups in the same field, while the strength of each link reflects the intensity of collaboration. Only countries with at least two publications were included, showcasing global research partnerships.

4.4. Which are the top institutions (based on bibliographic coupling) in the field of research? (RQ3)

Bibliographic coupling, introduced by Kessler (1963), refers to the connection between two documents that cite the same source. While some studies use the term "bibliometric coupling," the term "bibliographic coupling" is more widely accepted today (Ma et al., 2022). For example, in Figure 4, if documents A and B both cite document C, they are bibliographically coupled, indicating a thematic link between them.

Figure 4: Concept of Bibliographic Coupling Adapted



Institutions play a vital role in advancing research and knowledge dissemination. Table 3 presents the top 20 most productive institutions ranked using bibliographic coupling, evaluated by three metrics: number of articles (NoA), total citations (TC), and citations per document (CpD). These indicators reflect an institution's productivity and influence, highlighting its contribution to research collaboration and impact.

Source(s): Ma et al. (2022)

Table 3: Top 20 Most Productive Institutions based on Bibliographic Coupling

Rank	Institution	Country	NoA	TC	CpD
1	Wageningen University & Research	Netherlands	10	489	48.90
2	Chinese Academy of Science	China	4	43	10.75
3	University of Oxford	UK	4	87	21.75
4	National Institute for Agricultural Research	France	3	365	121.67
5	Manaaki Whenua Landcare Research	New Zealand	3	22	7.33
6	National University of Singapore	Singapore	3	94	31.33
7	The Ohio State University	USA	3	250	83.33
8	The Polish Academy of Science	Poland	3	238	79.33
9	Stockholm University	Sweden	3	100	33.33
10	The University of Canterbury	New Zealand	3	37	12.33
11	The Consortium of International Agricultural Research	France	2	326	163
12	Agricultural Research Centre for International Development	France	2	326	163.00
13	Cornell University	USA	2	78	39.00

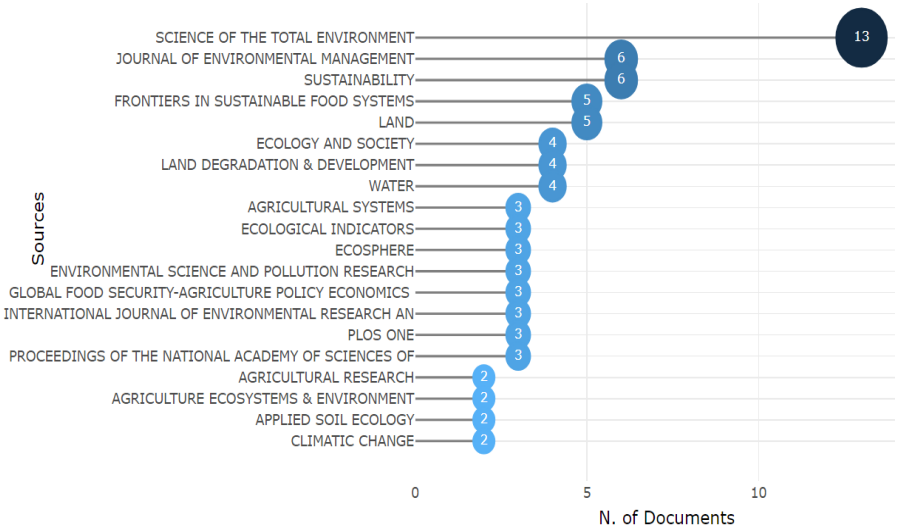
14	International Institute for Applied Systems Analysis	Austria	2	326	163.00
15	The International Food Policy Research Institute	USA	2	111	55.50
16	Katholieke University of Leuven	Belgium	2	215	107.50
17	KTH Royal Institute of Technology	Sweden	2	88	44.00
18	Newcastle University	UK	2	19	9.5
19	North-West University	South Africa	2	96	48
20	Stanford University	USA	2	40	20

Note: NoA: Number of articles, **TC:** Total citations, **CpD:** Citation per document
Source(s): VOS viewer (version 1.6.19).

4.5. Which are the top journals in the field of research? (RQ3)

Figure 5 highlights the top 20 productive journals in environmental research and sustainability. Leading the list is Science of the Total Environment, followed by Journal of Environmental Management and Sustainability, which focuses on environmentally friendly practices. Other notable journals include Frontiers in Sustainable Food Systems, Land, and Ecology and Society, each specializing in distinct areas of environmental research. This figure provides valuable insights into key journals shaping environmental discourse and serves as a resource for further academic exploration.

Figure 5: Top 20 Most Productive Journals



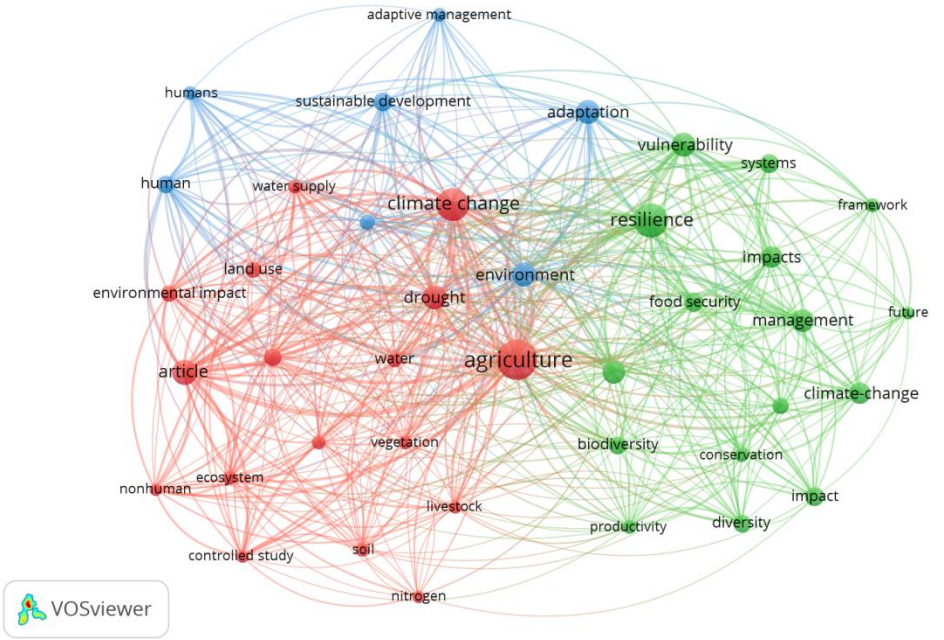
Source(s): Biblioshiny & VOS viewer (version 1.6.19)

4.6. What are the main motifs in the literature on resilient agricultural systems and the environment? (RQ4)

4.6.1. Keywords Co-occurrence

Keyword co-occurrence analysis in Figure 6 highlights current research trends, with 40 out of 2,292 keywords meeting the threshold of eight occurrences. Node size reflects frequency, and connecting arcs depict keyword relationships. The most prominent nodes are "agriculture," followed by "resilience," "climate change," "adaptation," "drought," and "article," indicating their significance and influence in the research network.

Figure 6: Network Visualization of Keywords Co-occurrence



Source(s): VOS viewer (version 1.6.19).

This study focuses on agriculture, resilience, and climate change, exploring challenges, adaptations, and management strategies for sustainable development. Table 4 lists the 20 most common keywords, with "agriculture" being the most prominent, followed by "resilience" and "climate change," underscoring the importance of addressing environmental impacts and promoting sustainable practices

Table 4: Top 20 Frequent Keywords

Rank	Keyword	Cluster	Occurrences	Links	Total Link Strength
1	Agriculture	1	76	39	333
2	Resilience	2	54	35	195
3	Climate change	1	49	38	241
4	Article	1	30	31	193
5	Adaptation	3	27	32	114
6	Drought	1	27	33	140
7	Environment	3	27	38	154
8	Vulnerability	2	26	32	125
9	Sustainability	2	25	34	97
10	Management	2	23	29	81
11	Impacts	2	22	23	61
12	Climate change	2	21	20	65
13	Systems	2	18	19	50
14	Food security	2	17	29	65
15	Impact	2	16	20	37
16	Sustainable development	3	16	25	80
17	Biodiversity	2	14	28	55
18	Diversity	2	14	22	46
19	Ecosystem resilience	1	14	30	91
20	Human	3	14	25	99

Source(s): VOS viewer (version 1.6.19).

4.6.2 Cluster analysis of co-occurrence of keywords

Figure 6 presents a keyword co-occurrence analysis with three distinct clusters (red, green, and blue), each representing interconnected terms. These clusters reveal patterns where terms within the same group frequently appear together, highlighting underlying themes. This visualization aids in text mining, information retrieval, and social network analysis, providing insights into dataset trends and supporting further research.

Table 5, representing Cluster 1 (Red in Figure 6), focuses on ‘Climate Change and Agricultural Impacts’. It highlights the relationship between agriculture and climate change, emphasizing challenges like drought and water scarcity. Key terms such as ‘agriculture’ dominate, reflecting its central role in addressing climate-related issues. The cluster underscores the need for sustainable land and

water management to mitigate climate change's effects on agriculture and ecosystems.

Table 5: Cluster 1 (Red)

Rank	Keyword	Occurrences	Links	Total Link Strength
1	Agriculture	76	39	333
2	Climate change	49	38	241
3	Article	30	31	193
4	Drought	27	33	140
5	Ecosystem resilience	14	30	91
6	Land use	13	23	63
7	Environmental impact	12	27	82
8	Water	11	27	59
9	Soil	10	25	48
10	Vegetation	10	25	45
11	Water supply	10	28	79
12	Crop production	9	22	39
13	Ecosystem	9	24	59
14	Controlled study	8	23	62
15	Livestock	8	28	53
16	Nitrogen	8	16	23
17	Nonhuman	8	22	62

Source(s): VOS viewer (version 1.6.19).

Table 6 represents Cluster 2 (green in Figure 6), which we labeled as '*Building Resilient and Sustainable Systems*'". It explores the interconnected ideas of sustainability, vulnerability, and resilience. This cluster focuses on the vital importance of comprehending and addressing the effects of climate change, examining management options, and promoting resilience in various systems. The aim is to understand the complex relationships between these components and their implications for our future, with an emphasis on food security, biodiversity, and ecosystem services.

The term *"resilience"* refers to a system, community, or person's capacity to tolerate and bounce back from shocks, disruptions, or stresses. In the context of this study, resilience is defined as the ability of various systems to adapt and flourish in the face of challenges brought on by climate change. Another frequently used keyword is *"vulnerability"* which refers to a person's susceptibility to danger, risks, or undesirable effects. Vulnerability focuses on identifying and comprehending the elements that make particular populations, groups, or systems more vulnerable to the harmful effects of climate change. It entails locating and assessing social, economic, and

environmental weaknesses in order to create plans for lowering risks and boosting resilience.

Table 6: Cluster 2 (Green)

Rank	Keyword	Occurrences	Links	Total Link Strength
1	Resilience	54	35	195
2	Vulnerability	26	32	125
3	Sustainability	25	34	97
4	Management	23	29	81
5	Impacts	22	23	61
6	Climate change	21	20	65
7	Systems	18	19	50
8	Food security	17	29	65
9	Impact	16	20	37
10	Biodiversity	14	28	55
11	Diversity	14	22	46
12	Ecosystem services	13	23	50
13	Conservation	10	20	36
14	Productivity	10	27	46
15	Framework	9	17	32
16	Future	8	17	27

Source(s): VOS viewer (version 1.6.19).

Table 7, representing Cluster 3 (Blue in Figure 6), focuses on "Adaptation and Sustainable Development in the Human Environment." Key themes include adaptation, the environment, and sustainable development, with “Adaptation” and “Environment” being the most frequent keywords (27 occurrences each). Other significant terms, such as “Sustainable development,” “Human,” and “Economics,” highlight their relevance in addressing environmental challenges. The presence of “Humans” and “Adaptive management” suggests a focus on implementing adaptable solutions to promote sustainable development and tackle environmental issues.

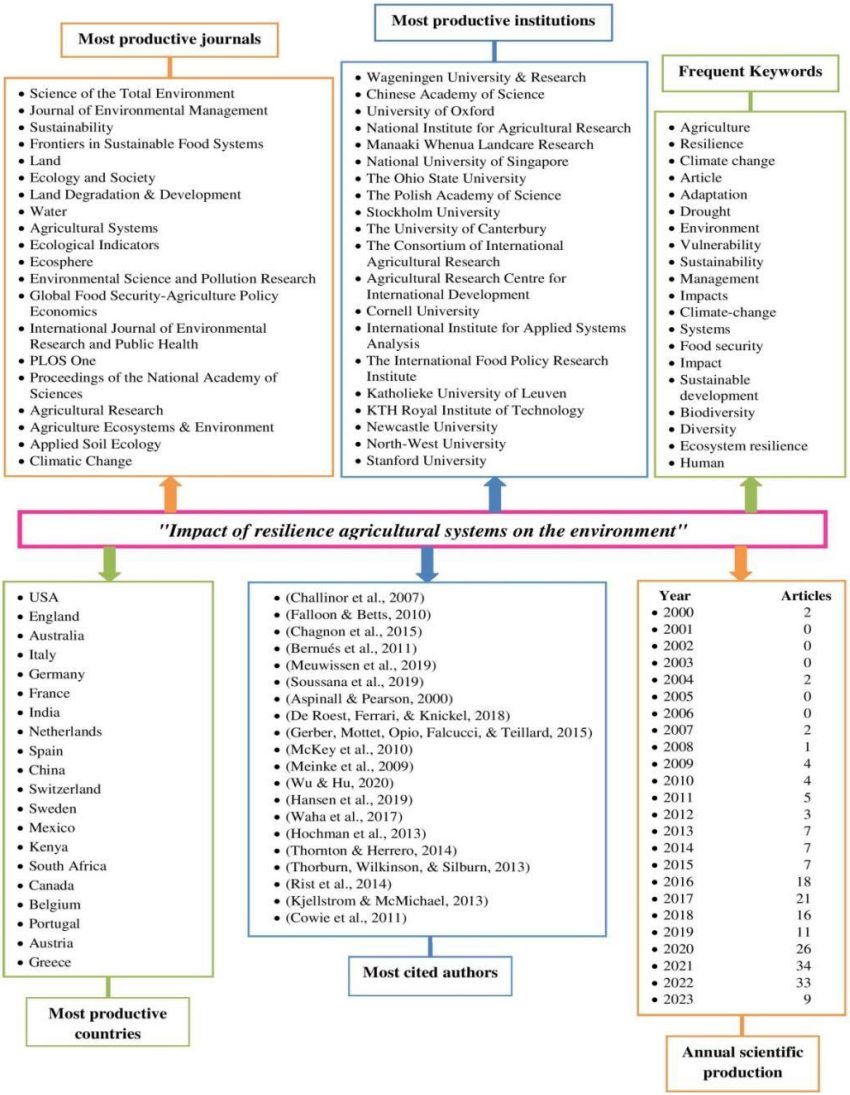
Table 7: Cluster 3 (Blue)

Rank	Keyword	Occurrences	Links	Total Link Strength
1	Adaptation	27	32	114
2	Environment	27	38	154
3	Sustainable development	16	25	80
4	Human	14	25	99
5	Economics	11	30	73
6	Humans	10	20	69
7	Adaptive management	9	18	41

Source(s): VOS viewer (version 1.6.19).

5. CONCLUSION AND POLICY RECOMMENDATIONS

Figure 7: Science Mapping of Impact Resilience Agricultural Systems on the Environment



Source(s): VOS viewer (version 1.6.19)

This study analyzes 212 articles using VOS viewer to explore the link between resilient agricultural systems and the environment. Key findings include limited literature existing from 2000 to 2008, but publications surged, peaking at 34 in 2021, reflecting growing academic interest. Challinor et al. (2007) is the most cited author, with 369 citations. The USA leads in research output, followed by the UK, Australia, Italy, and Germany, showing global engagement. The top journals are Science of the Total Environment and Journal of Environmental Management.

Research focuses on themes like "agriculture," "resilience," "climate change," "adaptation," "sustainability," "food security," and "biodiversity."

6. FUTURE RESEARCH DIRECTIONS, CONTRIBUTIONS, AND LIMITATIONS

6.1. What are the potential future directions for research? (RQ5)

Future research on resilient agricultural systems should explore the long-term impacts on biodiversity and soil health to assess benefits and drawbacks. Additionally, the integration of advanced technologies like remote sensing and precision agriculture should be examined to enhance efficiency and innovation. Moreover, the socioeconomic implications, including adoption barriers and policy interventions, need to be addressed to ensure effective implementation. Last but not least, the impacts of climate change and extreme weather should be studied, focusing on mitigation and adaptation strategies. Addressing these areas will advance knowledge and provide evidence-based recommendations for balancing environmental preservation with agricultural productivity.

6.2. Contributions

Our study significantly advances the mapping and visualization of the relationship between resilient agricultural systems and the environment. By conducting comprehensive bibliometric analysis from 2000 to 2023, we fill a critical gap in prior research, offering a systematic and thorough evaluation of this relationship for the first time. This contribution strengthens academic understanding and provides a foundational framework for future studies in this field.

6.3. Limitations

However, this bibliometric analysis has some limitations despite its important contributions. Depending on the database used, the number of relevant articles may vary. We only selected the literature from the Web of Science and Scopus databases. However, more articles on the subject of interest could be identified by using additional databases. The selection of additional databases for a bibliometric

review in this field may be considered in future research, such as ScienceDirect, Dimensions, JSTOR, ProQuest, and Google Scholar.

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