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Mapping the Evolution of Agricultural Economics: A Bibliometric Analysis of the Nexus Between Economic Growth, Environmental Sustainability, and Econometric Modeling

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Abstract

Understanding how agriculture contributes to economic growth while maintaining environmental sustainability has become an essential question in contemporary development research. To examine how this interdisciplinary field has evolved, this study employs a bibliometric analysis of 394 Scopus-indexed articles retrieved on 3 October 2025, reflecting research published from 1975 through 2025, focusing on the intersection of agriculture, economic growth, environmental sustainability, and econometric modeling. Data were analyzed with VOSviewer and CiteSpace to map research trends, collaboration, and methodological patterns. The results indicate a consistent rise in publication activity and citation impact, reflecting the growing scholarly attention to sustainable agricultural economics. Asian countries, particularly China, India, Malaysia, and Indonesia, have emerged as leading contributors, highlighting the region's central role in agricultural transformation and policy-driven research. Econometric approaches such as time series, panel data, and cointegration models dominate methodological trends, underscoring the discipline's increasing reliance on quantitative analysis. However, international and interinstitutional collaboration remains limited, suggesting that greater integration is needed to achieve a more unified global research landscape. The findings provide valuable insights into the intellectual structure and evolution of agricultural economics, offering a foundation for future studies that aim to strengthen methodological diversity and advance sustainable development policies.



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1. Introduction

Agriculture has long been recognized as a fundamental driver of economic growth, food security, and social development [1–3]. In many regions, particularly in Asia, the agricultural sector remains a cornerstone of employment, rural income, and national productivity [4–6]. Beyond its economic contributions, agriculture is also deeply intertwined with environmental sustainability, influencing land use, resource management, and ecological resilience [7–13]. As global concerns about food supply, climate change, and population growth intensify, understanding how agricultural systems contribute to sustainable economic expansion has become increasingly vital [14–17].

Over the past few decades, the relationship between agriculture, economic development, and the environment has grown more complex. While agricultural modernization has enhanced productivity and trade competitiveness, it has also introduced new environmental and social challenges [18–21]. Balancing economic progress with ecological integrity now represents one of the central dilemmas of sustainable development [22, 23]. Within this context, econometric analysis has become an indispensable tool for quantifying and explaining the dynamic interactions among agricultural production, income growth, and environmental outcomes [24–26]. By applying rigorous statistical models, researchers are able to identify causal linkages, long-term relationships, and policy implications that traditional qualitative methods may overlook [27–29].

Despite the expanding body of research connecting these domains, existing studies often remain fragmented. Many investigations have explored the relationship between agricultural output and economic growth, while others have examined environmental sustainability or the methodological application of econometrics. However, few have integrated these strands to provide a holistic understanding of how econometric methods have shaped the scientific discourse linking agriculture, economic growth, and environmental concerns. Moreover, the absence of a comprehensive bibliometric overview limits our ability to evaluate research trends, collaboration networks, and emerging themes within this interdisciplinary field.

Given this gap, a bibliometric approach is well-suited to systematically map and quantify the intellectual landscape of agricultural economics research [30–33]. Bibliometric analysis enables scholars to assess the evolution of knowledge production, identify influential authors and institutions, and explore how

methodological frameworks such as econometrics have been applied to address sustainability-oriented agricultural issues [34]. By combining bibliometric mapping with network visualization, this study offers an evidence-based perspective on how global scholarship in this area has evolved and interacted over time.

Although several bibliometric studies have examined agriculture, environmental sustainability, or econometric modeling separately, there has been limited effort to integrate these strands within a single analytical framework. This study contributes novelty by systematically mapping the intersection of agricultural economics, economic growth, environmental sustainability, and econometric analysis over a fifty-year period (1975–2025). By combining bibliometric and network visualization tools, it provides a new perspective on how econometric approaches have shaped sustainability-oriented agricultural research and policy discourse.

Therefore, the present study aims to analyze the scientific structure, collaboration patterns, and thematic evolution of research at the intersection of agriculture, economic growth, environmental sustainability, and econometric analysis. Through this approach, it seeks to highlight key research trends, influential contributors, and methodological shifts that define the field. The insights derived from this analysis are expected to inform future research directions, support evidence-based policy formulation, and contribute to a more integrated understanding of sustainable agricultural development.

2. Methodology

2.1. Data Source and Search Strategy

This study employs a bibliometric approach to examine the intersection of agriculture, economic growth, environmental sustainability, and econometric modeling. All bibliographic data were retrieved from the Scopus database, which is widely recognized for its comprehensive coverage of peer-reviewed literature in science, economics, and environmental studies. Scopus was selected as the primary data source because it offers broader coverage of peer-reviewed journals in the fields of economics, environmental studies, and agricultural sciences compared to other databases. It also provides comprehensive metadata, including author affiliations, citations, and keywords, which are essential for network-based bibliometric mapping. Although other databases, such as Web of Science (WoS), also provide high-quality records, Scopus was preferred due to its wider disciplinary inclusion, standardized indexing format compatible with bibliometric tools such as VOSviewer and CiteSpace, and higher volume of relevant

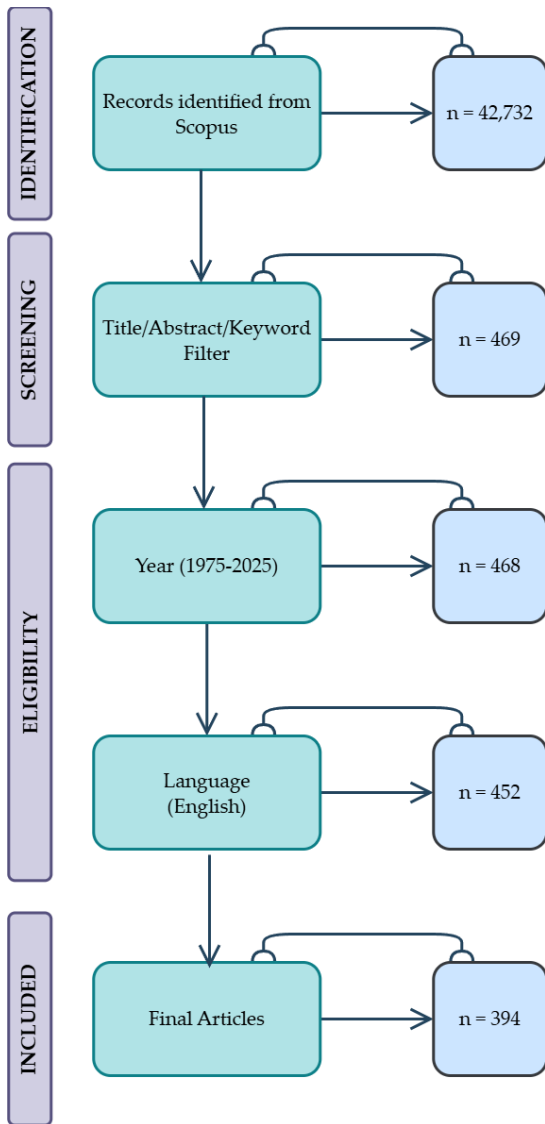


Figure 1. PRISMA flow diagram of the literature selection process.

publications within the study's interdisciplinary scope. The search was conducted using a Boolean query designed to capture publications that explicitly link agricultural research with economic and environmental dimensions. This study was conducted on 3 October 2025 using the following query: ((agriculture OR farming OR agribusiness OR "agricultural sector") AND ("economic growth" OR "economic development" OR "growth economics") AND (environment OR ecology OR "environmental impact" OR sustainability OR "natural resources")) AND (econometrics OR "econometric model" OR "econometric analysis" OR "time series" OR "panel data" OR ARDL OR "autoregressive distributed lag" OR VAR OR "vector autoregression" OR VECM OR "vector error correction model" OR cointegration)).

The query was applied to article titles, abstracts, and keywords, covering publications from 1975 to 2025.

Filters were set to include only documents written in English and categorized as final articles. The initial search yielded 42,732 records across all fields, which were refined to 469 results when limited to the Title-Abstract-Keyword category. After applying temporal, language, and document type filters, a total of 394 records were selected for bibliometric analysis. The data selection and screening process followed the PRISMA guideline, as illustrated in Figure 1, to ensure transparency and reproducibility in data refinement.

2.2. Data Processing and Normalization

The bibliographic data were exported from Scopus in CSV format for further processing. Microsoft Excel was used for preliminary data cleaning, normalization, and organization. This stage involved unifying author and institutional names, standardizing country labels, and identifying duplicate entries. In addition, pivot tables were employed to generate summary statistics and to verify the consistency of metadata prior to network visualization. Because CiteSpace requires Web of Science (WoS) formatting, the Scopus CSV file was converted into the standard WoS template to ensure compatibility for burst and co-citation analysis. This preprocessing stage ensured that all datasets were harmonized and ready for visualization and statistical interpretation.

2.3. Bibliometric and Network Analysis

Bibliometric mapping and visualization were performed using VOSviewer version 1.6.20, while CiteSpace version 6.2.R2 was employed for detecting burst keywords. The analyses were conducted at five distinct levels corresponding to the major dimensions of bibliometric research:

1. Author-level analysis - author co-authorship networks were constructed to identify leading contributors and collaborative structures.
2. Organization-level analysis - institutional networks were analyzed to determine the most productive research organizations and their interconnections.
3. Country-level analysis - international co-authorship patterns were examined to assess the geographic distribution of research and cross-border collaboration.
4. Keyword-level analysis - author keyword co-occurrence mapping was used to uncover thematic structures and identify emerging research clusters.
5. Reference-level analysis - co-citation mapping was applied to reveal the intellectual foundations and methodological frameworks that shape this research domain.

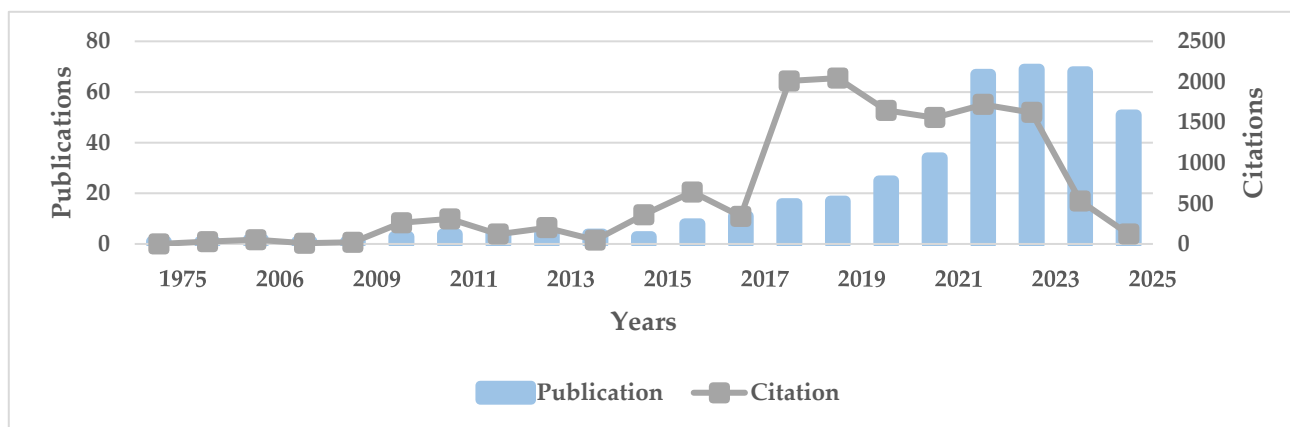


Figure 2. Trends of publications and citations in the field of agriculture, economic growth, and econometric studies.

Table 1. Top five years by publications and citations in the field of agriculture, economic growth, and econometric studies.

Year	Pub.	Cit.	N-Pub	N-Cit	OS
2022	67	1721	0.971	0.841	0.906
2023	69	1621	1.000	0.792	0.896
2021	34	1558	0.485	0.761	0.623
2024	68	529	0.985	0.259	0.622
2019	17	2046	0.235	1.000	0.618

Note: Pub = publications; Cit = citations; N-Pub/Cit = normalized values (max = 1.000); OS = Overall Score (composite index).

Each network was visualized based on Total Link Strength (TLS), which quantifies the degree of association among items in a given category. In VOSviewer, the size of each node represents the frequency of occurrence or citation, while the distance between nodes indicates the strength of their relationship. Clusters were automatically generated by the software’s modularity-based algorithm to represent cohesive research themes or communities.

2.4. Tools and Analytical Framework

The combination of VOSviewer and CiteSpace allowed for a comprehensive representation of both the structural and temporal dimensions of the literature. VOSviewer was particularly effective for mapping static relationships such as co-authorship, organizational ties, and keyword co-occurrence. CiteSpace, on the other hand, provided temporal insights through its burst-detection algorithm, enabling the identification of emerging topics and shifts in intellectual focus.

All analyses were conducted on a Windows-based operating system using standardized visualization parameters for network resolution, clustering, and link normalization. The integrated workflow, comprising Scopus data retrieval, Excel preprocessing, and bibliometric visualization, ensured methodological transparency and replicability across analytical stages.

All key parameter settings used in the bibliometric analysis were reported. In VOSviewer (version 1.6.20), the minimum occurrence threshold was set to one for all

categories, including authors, organizations, countries, keywords, and cited references, allowing a comprehensive mapping of the research domain. The full counting method was applied for normalization. In CiteSpace (version 6.2.R2), the analysis was conducted using a g-index with $k = 15$, time slicing from 1975 to 2025 at one-year intervals, and cosine similarity as the link strength metric. These standardized parameters ensure that the analyses can be replicated accurately and the sensitivity of results can be properly assessed.

3. Results

3.1. Trends in Publications and Citations

The analysis of publication and citation trends provides an overview of the evolution of research connecting agriculture, economic growth, and econometric analysis. A total of 394 final research articles were identified and analyzed from the Scopus database after applying the filtering criteria. As shown in Figure 2, the number of publications has increased significantly in recent years, particularly after 2019. The highest number of articles was recorded in 2023 with 69 publications, followed closely by 2024 with 68 publications. Although 2019 recorded the fewest publications among the top five years, it achieved the highest citation count of 2,046, indicating that earlier studies in this domain had a substantial academic influence.

As summarized in Table 1, both publication and citation counts reveal a consistent upward trend, suggesting a

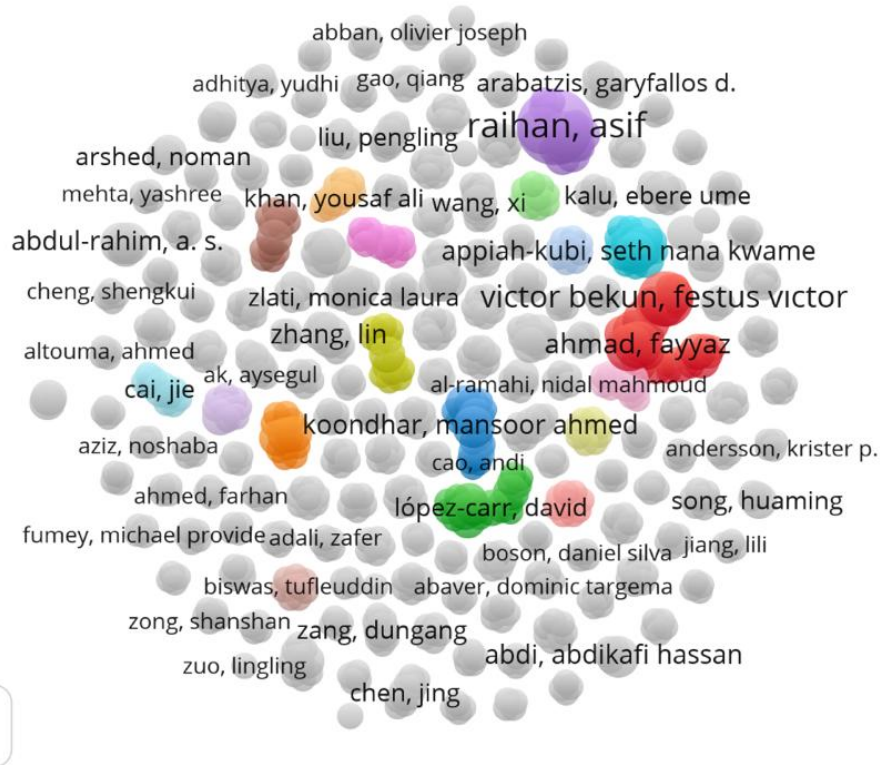


Figure 3. Authors co-authorship network in the field of agriculture, economic growth, and econometric Studies (Items: 1000, Clusters: 169, Links: 2496, TLS: 2601).

Table 2. Leading authors by publications, citations, and total link strength.

Author	Pub.	Cit.	TLS	N-Pub	N-Cit	N-TLS	OS	Cluster
Raihan, Asif	13	1045	27	1.000	1.000	1.000	1.000	5
Bekun, Festus Victor	6	576	13	0.417	0.551	0.481	0.483	1
Ahmad, Fayyaz	4	225	19	0.250	0.215	0.704	0.390	1
Chandio, Abbas Ali	4	225	19	0.250	0.215	0.704	0.390	1
Appiah-Kubi, Seth Nana Kwame	3	59	21	0.167	0.056	0.778	0.334	6

Note: Pub = publications; Cit = citations; N-Doc/Cit = normalized values (max = 1.000); OS = Overall Score (composite index).

growing academic interest in applying econometric techniques to agricultural and economic growth studies. The normalized and composite scores (OS) also highlight that 2022 and 2023 were the most productive and influential years. This reflects the increasing emphasis on sustainability and econometric modeling within the agricultural economics research community.

3.2. Author Collaboration Network

The co-authorship network shown in Figure 3 illustrates the collaborative patterns among scholars active in this research field. The network consists of 1,000 items grouped into 169 clusters, forming 2,496 links with a TLS of 2,601. The high number of clusters and links indicates that research on agriculture and econometric modeling has attracted diverse scholars with interconnected interests, even though the collaboration density remains moderate.

As presented in Table 2, Asif Raihan emerged as the most influential author with 13 publications, 1,045 citations, and the highest TLS value. Other active contributors include Festus Victor Bekun, Fayyaz Ahmad, Abbas Ali Chandio, and Seth Nana Kwame Appiah-Kubi, all of whom have contributed multiple papers with notable citation impacts. The strong performance of these authors indicates that the literature is shaped by a small but active group of researchers whose work often intersects on topics of agricultural economics and environmental sustainability.

3.3. Organizations' Collaboration Network

The institutional collaboration network visualized in Figure 4 demonstrates the connections among universities and research centers contributing to this topic. The network includes 280 institutions, grouped into 23 clusters, with 707 links and a total link strength of 748.

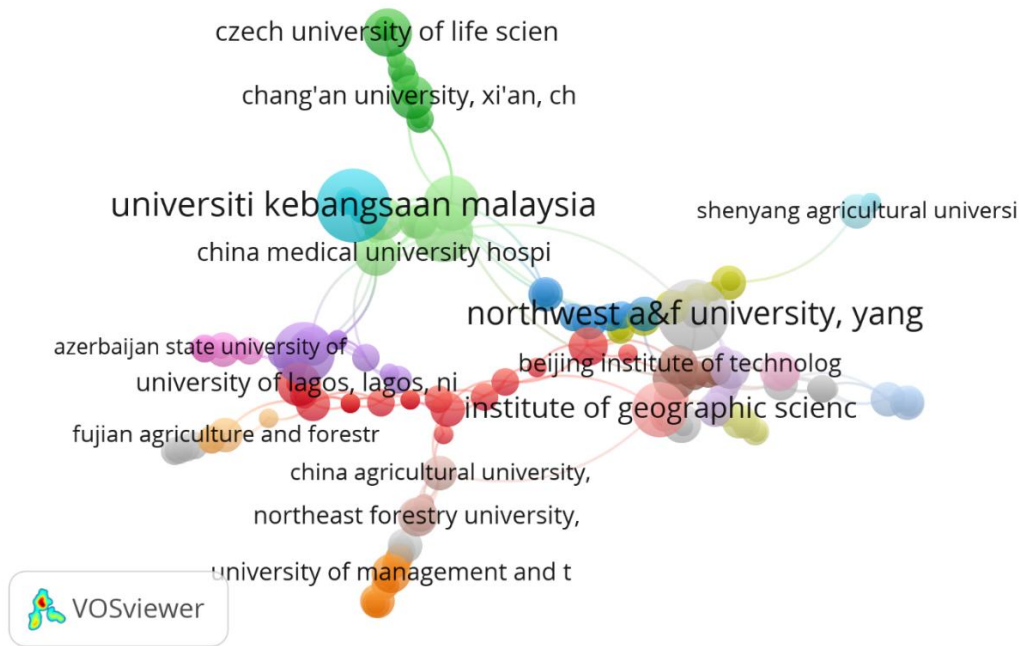


Figure 4. Organizations co-authorship network in the field of agriculture, economic growth, and econometric Studies (Items: 280, Clusters: 23, Links: 707, TLS: 748).

Table 3. Top contributing organizations by publications, citations, and collaboration strength.

Organization	Pub.	Cit.	TLS	N-Pub	N-Cit	N-TLS	OS	Cluster
Universiti Kebangsaan Malaysia	14	1047	10	1.000	0.858	0.357	0.738	6
Northwest A&F University	13	407	25	0.923	0.334	0.893	0.717	23
Lanzhou University	8	659	24	0.538	0.540	0.857	0.645	11
İstanbul Gelişim Üniversitesi	10	718	17	0.692	0.589	0.607	0.629	5
Institute of Geographic Sciences and Natural Resources Research	8	571	18	0.538	0.468	0.643	0.550	10

Note: Pub = publications; Cit = citations; N-Doc/Cit = normalized values (max = 1.000); OS = Overall Score (composite index).

These figures suggest that institutional collaborations exist but are relatively fragmented, with a few universities acting as central nodes in the network.

According to Table 3, Universiti Kebangsaan Malaysia ranks first in both productivity and citation impact, followed by Northwest A&F University, Lanzhou University, İstanbul Gelişim Üniversitesi, and the Institute of Geographic Sciences and Natural Resources Research. The dominance of institutions from Asia reflects the regional relevance of agricultural and econometric studies in addressing environmental and development challenges. Nevertheless, cross-institutional collaboration across continents remains limited, which could represent an opportunity for future interdisciplinary partnerships.

3.4. International Collaboration by Country

The international co-authorship analysis depicted in Figure 5 reveals that research on agriculture, economic growth, and econometric modeling is globally distributed, though concentrated in specific countries.

The network consists of 77 countries organized into 16 clusters, connected by 242 links with a total link strength of 362, indicating moderate levels of international collaboration.

As shown in Table 4, China leads the global contribution with 171 publications and 6,493 citations, far surpassing other countries. Turkey, Pakistan, Malaysia, and the United States follow as secondary contributors with lower publication and citation numbers. The predominance of Asian countries suggests that this field has become particularly relevant in regions where agriculture plays a crucial role in economic development. However, the relatively modest link strength among countries indicates that international research cooperation could be further enhanced to promote knowledge exchange and methodological innovation.

3.5. Author Keyword Co-Occurrence Analysis

Keyword co-occurrence mapping helps identify dominant and emerging themes in this research domain. The network illustrated in Figure 6 comprises 998 keywords

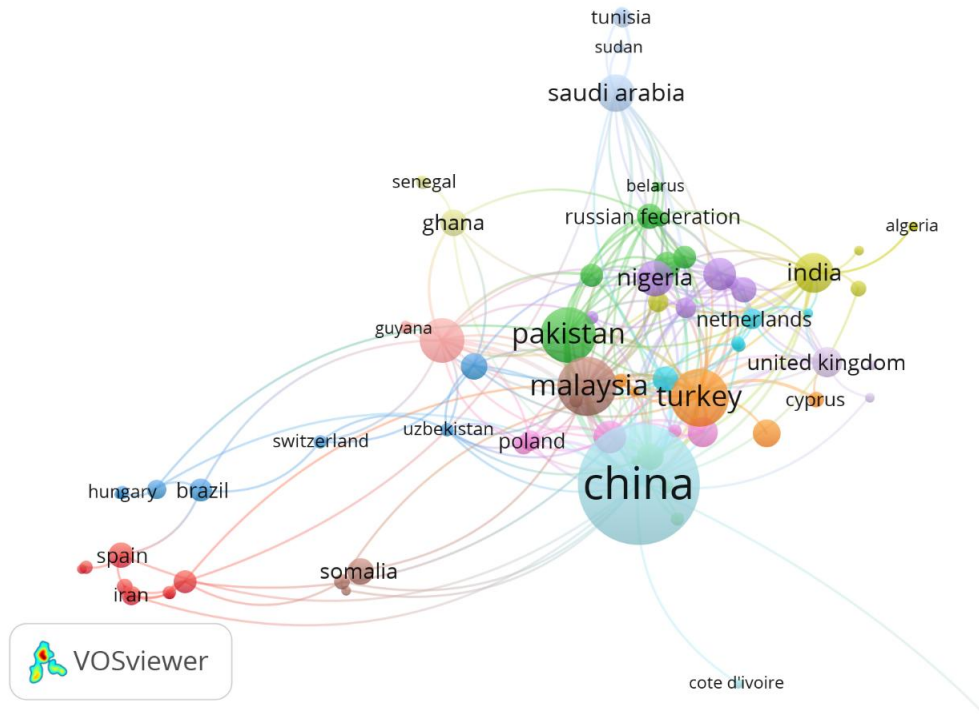


Figure 5. International co-authorship network of countries in the field of agriculture, economic growth, and econometric studies (Items: 77, Cluster: 16, Links: 242, TLS: 362).

Table 4. Top countries by publications, citations, and total link strength.

Country	Pub.	Cit.	TLS	N-Pub	N-Cit	N-TLS	OS	Cluster
China	171	6493	109	1.000	1.000	1.000	1.000	15
Turkey	38	1954	48	0.218	0.301	0.440	0.320	7
Pakistan	35	1503	51	0.200	0.231	0.468	0.300	2
Malaysia	39	1639	41	0.224	0.252	0.376	0.284	8
United States	23	1131	29	0.129	0.174	0.266	0.190	10

Note: Pub = publications; Cit = citations; N-Doc/Cit = normalized values (max = 1.000); OS = Overall Score (composite index).

Table 5. Top 10 author keywords.

Author Keyword	Occurrences	Cluster
Agriculture	170	1
Economic Development	162	11
Economic Growth	137	1
Sustainable Development	93	1
Carbon Dioxide	86	1
Carbon Emission	73	1
Economics	63	1
Sustainability	61	1
Climate Change	58	13
Human	51	10

grouped into 18 clusters, forming 41,642 links with a total link strength of 59,463. The high number of connections reflects the interdisciplinarity of research linking agriculture, economics, and environmental issues.

As presented in Table 5, the most frequent keywords include "agriculture," "economic development," "economic growth," "sustainable development," "carbon dioxide," "carbon emission," "economics," "sustainability," "climate change," and "human." These terms emphasize a growing focus on sustainability and environmental

efficiency within the context of agricultural economics. The prominence of keywords related to carbon and climate change indicates that scholars increasingly integrate econometric tools to study environmental externalities and agricultural productivity.

The keyword burst analysis using CiteSpace, summarized in Table 6, highlights the temporal evolution of influential topics. Terms such as "agricultural robots," "carbon footprint," and "Kuznets curve" emerged strongly after 2019, showing a transition toward technology-driven and sustainability-oriented research themes. Earlier bursts, including "environmental protection" and "time series analysis," reflect methodological and conceptual foundations that supported the later expansion of this interdisciplinary field. The burst detection covered the full period from 1995 to 2025.

3.6. Reference Co-Citation Analysis

The co-citation network presented in Figure 7 reveals the intellectual structure underlying this field of study. The network includes 535 cited references distributed across

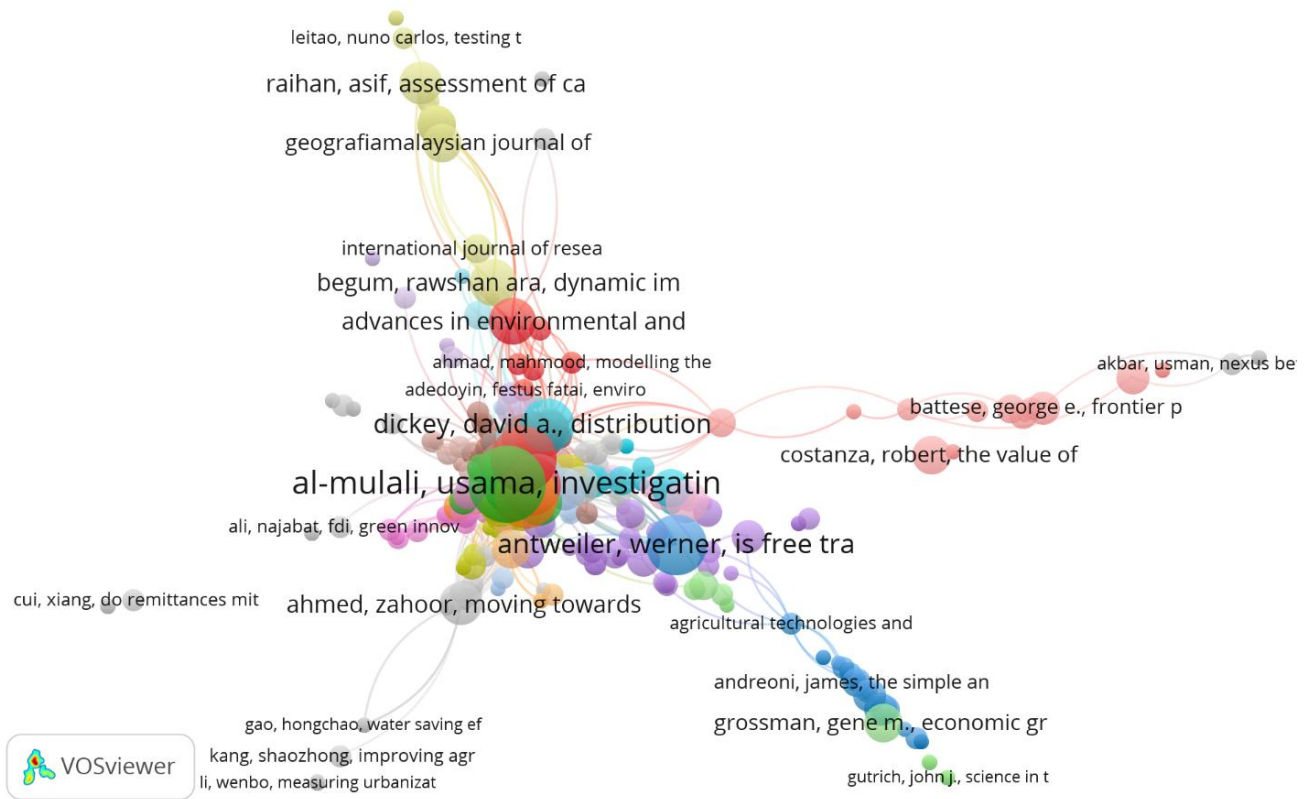


Figure 7. Reference co-citation network in the field of agriculture, economic growth, and econometric studies (Items: 535. Cluster: 29, Links: 2442, TLS: 2643).

Table 7. Top five most co-cited reference.

Author	Title	Year	Citations	Cluster
Al-Mulali, Usama	Investigating The Environmental Kuznets Curve Hypothesis in Vietnam	2015	17	2
Agboola, Mary Oluwatoyin	Does Agricultural Value Added Induce Environmental Degradation? Empirical Evidence from an Agrarian Country	2019	13	1
Sarkodie, Samuel Asumadu	The Relationship between Carbon Dioxide and Agriculture in Ghana: A Comparison of VECM and ARDL Model	2016	12	7
Antweiler, Werner	Is Free Trade Good for The Environment?	2001	11	3
Appiah, Kingsley	Causal Relationship between Agricultural Production and Carbon Dioxide Emissions in Selected Emerging Economies	2018	11	1

This thematic evolution shows that agriculture is no longer treated as a purely productive sector but as a multidimensional component of sustainable development [35]. Many studies have emphasized the importance of environmentally efficient technologies, climate-resilient farming, and the optimization of natural resources for maintaining long-term economic performance. The increasing prominence of terms like sustainability, carbon emission, renewable energy, and eco-efficiency also indicates the integration of agricultural research with global sustainability agendas, particularly the Sustainable Development Goals related to food security, green economy, and responsible resource use [36–38]. Overall, the thematic clusters confirm that contemporary scholarship aims to balance productivity with environmental integrity through evidence-based economic analysis.

4.2. Collaboration and Knowledge Network

The authorship and institutional collaboration networks show that Asia has emerged as a dominant hub of research activity in agriculture, economic growth, and sustainability. Countries such as China, India, Malaysia, and Indonesia have contributed a growing share of publications, driven by strong national agendas in food security, export competitiveness, and rural development. This finding aligns with the broader reality that Asian economies rely heavily on agriculture as both a key pillar of economic growth and a policy priority [5, 39–41].

Despite this regional strength, international collaboration remains relatively fragmented. Many authors and organizations tend to collaborate within national boundaries, while cross-regional cooperation is still limited. The network structure suggests that institutional

funding and local research incentives often favor domestic projects, which may limit the diffusion of knowledge beyond regional contexts. However, the gradual emergence of cross-continental links between Asian and European research groups shows progress toward more globalized collaboration. Several bibliometric studies in related disciplines have also found that international partnerships enhance citation impact and methodological diversity [42–45]. Strengthening such collaborations could therefore accelerate innovation and bridge methodological gaps between regions with different levels of technological and economic capacity [46–49].

4.3. *Methodological Integration in Agricultural Econometrics*

The reference co-citation analysis illustrates how econometric modeling has become a central analytical foundation within agricultural and environmental economics. The frequent use of methods such as ARDL (Autoregressive Distributed Lag, which examines both short-run and long-run relationships between variables), VAR (Vector Autoregression, which captures the dynamic interdependencies among multiple time series), and VECM (Vector Error Correction Model, which models long-run equilibrium relationships while accounting for short-run deviations) demonstrates the discipline's increasing reliance on statistical modeling to test both short-run and long-run causal relationship. This methodological pattern reflects a broader academic effort to quantify interactions among agricultural productivity, environmental constraints, and macroeconomic growth.

Recent studies have applied these econometric techniques to explore diverse topics such as the environmental Kuznets curve hypothesis in agriculture, the efficiency of input use, and the economic impacts of carbon mitigation strategies [50–53]. The dominance of these models suggests a maturation of agricultural economics as a data-driven science that integrates theoretical frameworks with empirical evidence [54]. In this sense, econometrics does not merely serve as a technical tool but also as a conceptual bridge connecting sustainability research with policy evaluation [55]. The co-citation clusters further indicate that highly cited works often combine econometric rigor with discussions of development policy, reflecting the growing convergence between quantitative modeling and sustainability-oriented policy analysis.

4.4. *Policy Implications and Future Research Directions*

The bibliometric evidence points to several implications for policy and academic advancement. From a policy perspective, the regional concentration of research in

Asia underscores the strategic role of agriculture in driving sustainable economic transformation. Governments in this region have invested heavily in research related to productivity enhancement, environmental management, and rural welfare [56–58]. Yet, the limited degree of interregional collaboration suggests that there are still barriers to knowledge exchange and methodological harmonization across different economies. Policies that promote open-access databases, joint funding schemes, and collaborative research programs could help reduce these disparities and foster a more integrated global research landscape.

From an academic perspective, future studies may further advance the field by incorporating emerging methods such as spatial econometrics, system-dynamics modeling, and big-data analytics. These tools could better capture the complex feedback loops among agricultural systems, climate change, and socioeconomic outcomes. Furthermore, integrating satellite-derived data, artificial intelligence, and precision-farming indicators with econometric models could provide new insights into the spatial and temporal variability of agricultural productivity [59–61]. Future research should also place stronger emphasis on the assessment of carbon-neutral agriculture and policy evaluation frameworks aligned with sustainable development.

These findings collectively emphasize that the integration of econometric approaches with sustainability perspectives has reshaped the analytical landscape of agricultural economics. While this integration marks a major step forward, the field continues to face challenges in expanding cross-regional collaboration and methodological diversity. Addressing these challenges will be crucial for advancing a more coherent and globally relevant understanding of sustainable agricultural development. The following section concludes this study by summarizing the key implications of these insights and outlining potential directions for future research.

5. Conclusion

This bibliometric analysis provides a comprehensive overview of the evolution of research linking agriculture, economic growth, environmental sustainability, and econometric modeling from 1975 to 2025. The results highlight a steady increase in publication and citation activity, driven largely by Asian countries such as China, India, Malaysia, and Indonesia. Methodologically, econometric approaches, including time series, panel data, and cointegration models, have become central to this interdisciplinary domain.

The findings underscore the growing integration between agricultural economics and sustainability

research, revealing how econometric tools are increasingly used to evaluate policy impacts and environmental trade-offs. However, institutional and international collaboration remains limited, suggesting that further efforts are needed to build stronger global partnerships and promote methodological innovation across regions.

This study contributes to the literature by mapping the intellectual structure and collaboration patterns in agricultural economics, yet it is limited to Scopus-indexed journal articles. Future research could incorporate additional databases such as Web of Science or Dimensions and apply hybrid methods combining bibliometrics, text mining, and machine learning to capture emerging trends more comprehensively. Strengthening interdisciplinary and cross-regional cooperation will be essential for advancing a unified understanding of sustainable agricultural development.

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