OPERATIONS AND SUPPLY CHAIN MANAGEMENT
Vol. 19, No. 3, 2026, pp. 541 – 559
ISSN 1979-3561 | EISSN 2579-9363

The Agricultural Logistics Networks: Bibliometric Evidence on Knowledge Structure and Thematic Evolution

Tran Trung Chuyen
Faculty of Business Administration - Marketing, Nam Can Tho University, Vietnam
Email: ttchuyen@nctu.edu.vn

Nguyen Tri Khiem
Faculty of Business Administration - Marketing, Nam Can Tho University, Vietnam
Email: ntkhiem@nctu.edu.vn

Phan Tran Xuan Trinh
Faculty of Technology and Engineering, Nam Can Tho University, Vietnam
Email: ptxtrinh@nctu.edu.vn

Tran Thanh Huy
Faculty of Technology and Engineering, Nam Can Tho University, Vietnam
Email: tthuy@nctu.edu.vn

Pham Huynh Thuy An
Faculty of Technology and Engineering, Nam Can Tho University, Vietnam
Email: phtan@nctu.edu.vn

Nguyen Thanh Van
Faculty of Business Administration - Marketing, Nam Can Tho University, Vietnam
Email: ntvan@nctu.edu.vn

Nguyen Thi Thu Tam
Faculty of Business Administration - Marketing, Nam Can Tho University, Vietnam
Email: ntttam@nctu.edu.vn

Le Thi Thanh Thuy
Faculty of Business Administration - Marketing, Nam Can Tho University, Vietnam
Email: thoaptx@fe.edu.vn

ABSTRACT

This study presents a quantitative overview of agricultural logistics, a sector that is vital to global food security yet constrained by fragmentation and the perishable nature of commodities. Drawing on a bibliometric analysis of 316 publications indexed in Scopus from 1989 to 2025 and processed with VOSviewer, the study maps the knowledge structure, identifies leading stakeholders, and traces emerging trends. The results indicate a sharp increase in scholarly output after 2019, signaling rising interest in efficiency optimization, sustainability, and the resilience of agri-food supply chains. China and the United States lead in research volume and collaboration networks. The analysis reveals six principal thematic clusters: infrastructure and system optimization; digitalization and the cold chain; sustainable logistics and biomass valorization; risk governance and the extended supply chain; cost efficiency and waste management; and warehouse automation. While foundational keywords such as "agricultural products" and "logistics" remain prevalent, emerging topics including cold chain logistics, big data, and electronic commerce exhibit increasing citation impact. The study provides a comprehensive landscape that enables scholars to pinpoint knowledge gaps for future inquiry and offers strategic implications for firms and policy makers.

Keywords: *agriculture, agricultural products, logistics network, logistics system, bibliometric analysis*

1. INTRODUCTION

The foundation of global food security and a key force behind economic growth for all countries is agriculture (UNICEF, 2023). There is more demand than ever on agricultural systems to produce and distribute food responsibly and efficiently, as the world's population is expected to approach 10 billion people by 2050 (Department of Economic, 2024). But simply raising output is not enough; there are several obstacles in the way of agricultural products as they travel from farm to meal. Because agricultural products are frequently produced in geographically dispersed, fragmented areas, and are very perishable, their supply networks are naturally susceptible and complex (Rojas-Reyes et al., 2024). According to estimates, a sizable amount of food produced worldwide is lost or squandered after harvest, with logistical inefficiencies playing a key role (Khan et al., 2024).

The idea of a robust and effective agricultural logistics network has become crucial to overcoming these obstacles. According to Raimbekov et al. (2024), this network includes all of the infrastructure, information flows, and activities that go into organizing, carrying out, and managing the transportation and storage of agricultural products from their place of origin to their destination of consumption. In order to promote economic and social sustainability, an efficient logistics network may drastically cut post-harvest losses, slash transportation costs, improve food quality and safety, and increase farmer income (Chuyen & Rajagopal, 2025; Siluthanyi et al., 2024). As a result, during the past 20 years, the amount of scholarly work devoted to agricultural logistics networks has grown significantly, indicating its increasing significance to scholars and professionals.

Cold chain management (Mustafa et al., 2024; Shashi et al., 2021), inventory control for perishable goods (Riazi et al., 2024; Taparia et al., 2020), transportation network design (Wong et al., 2024; Wang et al., 2024), and the use of cutting-edge technologies like the Internet of Things (IoT) and blockchain are just a few of the specific topics that have been covered by this proliferation of research (Darbanian et al., 2024; El Mane et al., 2024; Sri Vigna Hema & Manickavasagan, 2024). Findings within these sub-domains have been compiled in a number of narrative reviews. Han et al. (2021) assessed the current status, research gaps, and future challenges of cold chain logistics, while also comparing the development of the cold chain logistics industry and technology in China with that in developed countries in terms of infrastructure, data management, and national policies. These studies are frequently narrow in scope and depend on the subjective selection and interpretation of literature, even when they provide insightful information about particular aspects of the area.

Even with the increasing number of publications, there is still no thorough, quantitative, and macroscopic picture of the intellectual framework of the field of agricultural logistics network study. There is now a lack of systematic understanding regarding the relationships among various study themes, the development of important concepts throughout time, the most significant contributors (authors, institutions, and countries), and the new research fronts. An important research gap is created by the absence of a comprehensive map of the field. It is difficult for novice researchers to understand the current state of the art, for seasoned academics to spot unexplored fields, and for policymakers to make evidence-based choices in the absence of such an overview. In particular, limited attention has been paid to whether the thematic orientation of agricultural logistics network research has changed systematically over time. Earlier studies tend to address operational issues such as transportation, storage, logistics systems, and cost efficiency, whereas more recent studies increasingly emphasize cold chain logistics, digital technologies, sustainability, and supply chain resilience. Therefore, examining the temporal evolution of research themes is necessary to clarify how the field has moved from basic logistics coordination toward technology-enabled and sustainability-oriented agricultural supply chain management. In addition, the literature has not clearly identified the major finding milestones that have shaped agricultural logistics network research over time. It remains unclear which findings dominated the early stage of the field, which findings consolidated the research domain, and which recent findings are now driving new research frontiers.

This work uses a bibliometric analysis strategy to close this crucial gap, using data taken from the VOSviewer visualization tool and the Scopus database. A scientific field's cumulative body of knowledge can be explored quantitatively and objectively using bibliometric analysis, which also reveals the field's underlying structure and evolutionary tendencies (Donthu et al., 2021). The goal of this research is to present the first thorough scientometric analysis of the field of agricultural logistics networks. The following research questions (RQs) are specifically addressed by our work:

RQ1: How has research on agricultural logistics networks performed over time, and what is the publishing trend?
RQ2: Which authors, countries, and organizations are the most successful and significant in this field of study?
RQ3: What are the main areas of study and how do they relate to one another within the field's intellectual framework?
RQ4: How have research themes in agricultural logistics networks evolved over time, and what emerging developments indicate possible avenues for future study?

This work presents a methodical and visual picture of the research environment by providing answers to these questions. This contribution is helpful for practitioners who want to comprehend the major scientific advancements in controlling and enhancing agricultural supply chains, as well as for scholars looking to position their future work. This paper's remaining sections are organized as follows: The research methodology is presented in Section 2. The findings of the bibliometric analysis are presented in Section 3. Conclusion and recommendations are presented in Section 4.

2. RESEARCH METHODOLOGY

The bibliometric method is a systematic and quantitative approach used to measure, describe, and map the intellectual structure of a research domain through the analysis of publications and citations. This approach enables the identification of emerging themes, research trends, and influential entities such as authors, institutions, and countries (Tetteh et al., 2024; Moosavi et al., 2021; Xu et al., 2020). The core of this method lies in citation and co-citation analysis, which evaluate scholarly influence and reveal clusters of related knowledge. Indicators such as local citation counts, global citation counts, and the PageRank algorithm are applied to assess the prominence and

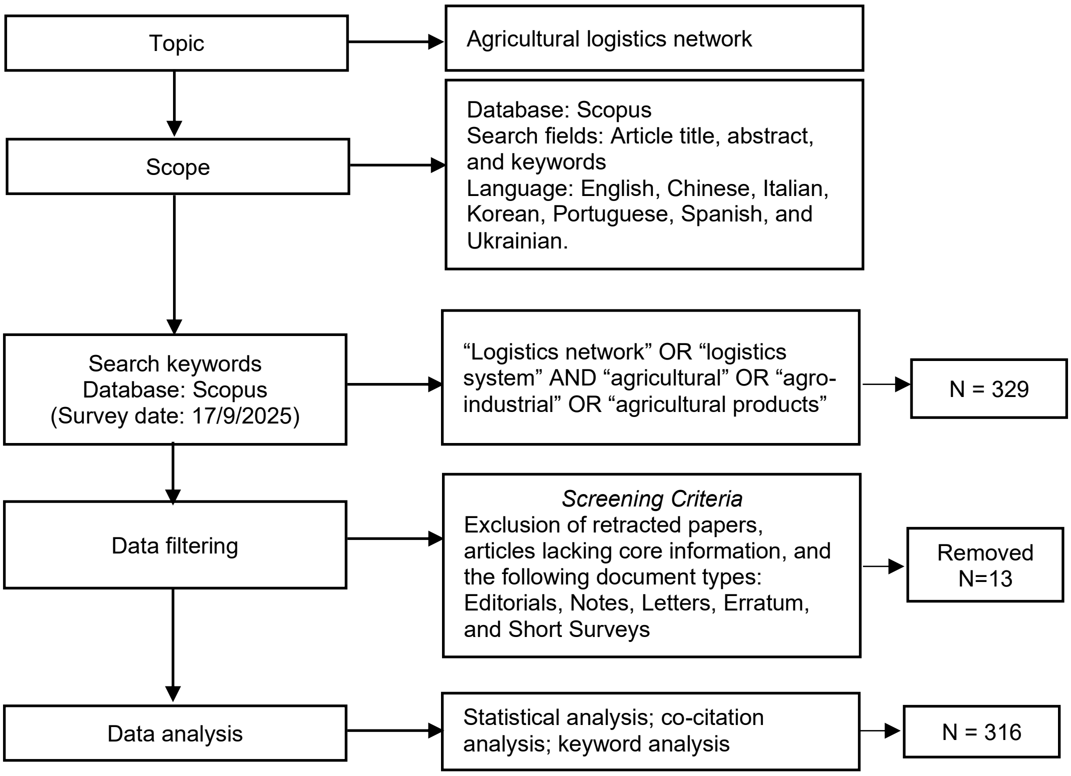

Figure 1 Flow Diagram of the Study Selection Process (*Source: Chuyen & Rajagopal, 2025; Erick et al., 2025)*

credibility of studies within the citation network (Zhang et al., 2023; Zhou et al., 2021). The results are typically visualized through network maps that illustrate structural relationships and collaboration patterns. Specialized tools are employed to construct, filter, and depict networks of keywords, authors, and cited references, ensuring that the analytical process remains transparent and reproducible (Katoch, 2022; Zhang et al., 2023).

The present study on logistics networks for agricultural products utilizes a CSV dataset extracted from the Scopus database, with data collected on September 17, 2025. Scopus is a widely recognized and highly reliable indexing platform, appropriate for evaluating research topics on a global scale rather than limiting the analysis to a single discipline or a few selected journals. Figure 1 illustrates the flowchart of screening and selection procedures applied to identify publications for inclusion in the analysis. The initial search strategy was developed based on keyword approaches used in prior studies by Donthu et al. (2021), Rethlefsen et al. (2021), and Chuyen and Rajagopal (2025) to ensure search optimization. Moreover, titles, abstracts, and keywords serve as the principal marketing elements of an article, determining its visibility and academic impact (Pottier et al., 2024). Therefore, although the title often represents the first opportunity to attract readers' attention, this study extended the search scope within Scopus beyond titles to include abstracts and related keywords in order to capture comprehensive data relevant to the research theme. The query string applied was: "Logistics network" OR "logistics system" AND "agricultural" OR "agro-industrial" OR "agricultural products." Using this search expression, 329 records were retrieved from Scopus, covering the period from 1989 to September 2025. The dataset included various publication types such as journal articles, conference papers, and reviews, written in multiple languages including English, Chinese, Italian, Korean, Portuguese, Spanish, and Ukrainian.

Subsequently, a refinement process was carried out to exclude irrelevant records based on specific criteria. Publications were removed if they had been retracted, lacked essential bibliographic information, or belonged to categories such as editorials, notes, letters, errata, or short surveys. After screening, 316 valid documents remained, comprising journal articles (174 items, 55.1%), books (3 items, 0.95%), book chapters (14 items, 4.4%), conference papers (115 items, 36.4%), and reviews (10 items, 3.2%).

In the next phase, statistical analysis, co-citation analysis, and keyword analysis were conducted to achieve the research objectives. Microsoft Excel and VOSviewer were employed to process and visualize key components, including authorship networks, co-citation relationships, country collaborations, and leading contributors. The integration of statistical tables, maps, and visual figures enabled a comprehensive depiction of the intellectual structure and evolutionary trends within the field. To address the temporal evolution of research themes, this study further interpreted keyword co-occurrence patterns in combination with overlay visualization and bibliographic coupling results.

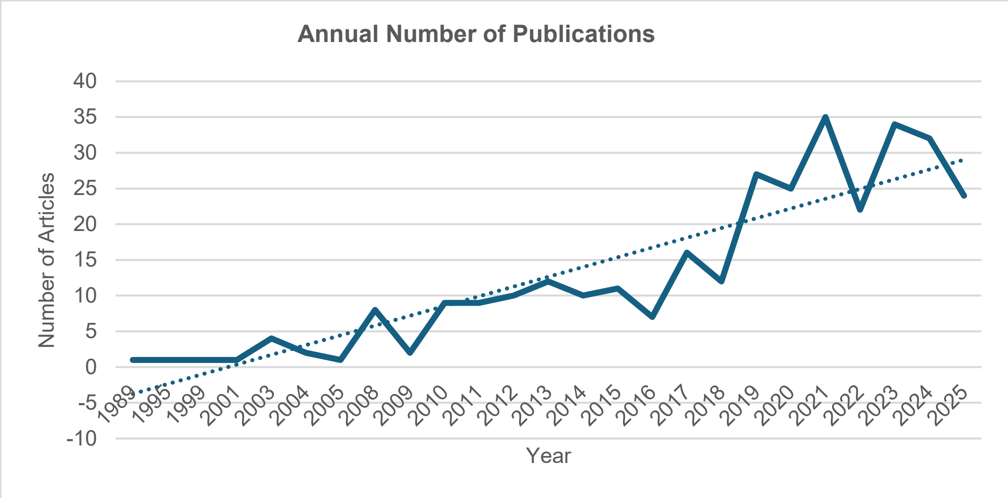

Figure 2 Chart Illustrating the Annual Number of Publications

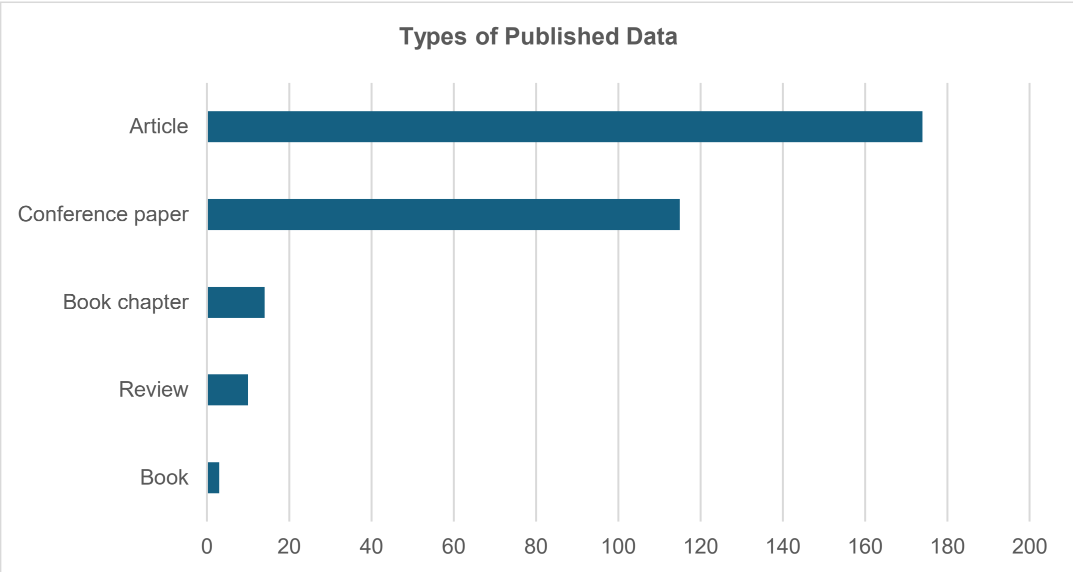

Figure 3 Types of Documents Collected During the Period 1989–2025

Keywords and documents were examined according to their relative position, cluster membership, and average publication year. This procedure enabled the identification of systematic thematic shifts across the field, particularly from conventional logistics system design and cost optimization toward cold chain logistics, digitalization, e-commerce, big data, and sustainability-oriented agricultural supply chains. Finding milestones were identified by combining three sources of evidence: publication growth by period, dominant keyword clusters, and highly cited or recently influential documents. This approach allowed the study to distinguish between mature findings that shaped the knowledge base and emerging findings that indicate new research frontiers.

In addition, future research problems were derived by comparing emerging keyword patterns, thematic clusters, citation evidence, and underexplored issues identified from the bibliometric maps. A topic was considered an important research problem when it showed growing relevance but still lacked sufficient empirical validation, theoretical integration, methodological diversity,or evidence from underrepresented regions.

3. RESEARCH FINDINGS

3.1 Descriptive Statistics

The synthesized results (Figure 2) indicate a gradual increase in the number of publications over time, reflecting the progressive development of the research field. Between 1989 and 2005, only 11 publications were recorded, representing a period of slow growth and the early formation of the discipline. From 2008 onward, the volume of publications rose notably, ranging from 8 to 16 per year during 2008–2018. A significant surge occurred after 2019, reaching a peak of 35 publications in 2021 and totaling 200 during the period from 2019 to 2025. This increase may be associated with advances in scientific research and growing academic interest in the study of agricultural logistics. Nevertheless, after reaching its peak, the publication output slightly declined in 2022 and then stabilized at approximately 32 to 34 items per year during 2023–2024, with 24 publications recorded for 2025. This pattern suggests that the field is in a stage of continued development and warrants further scholarly exploration.

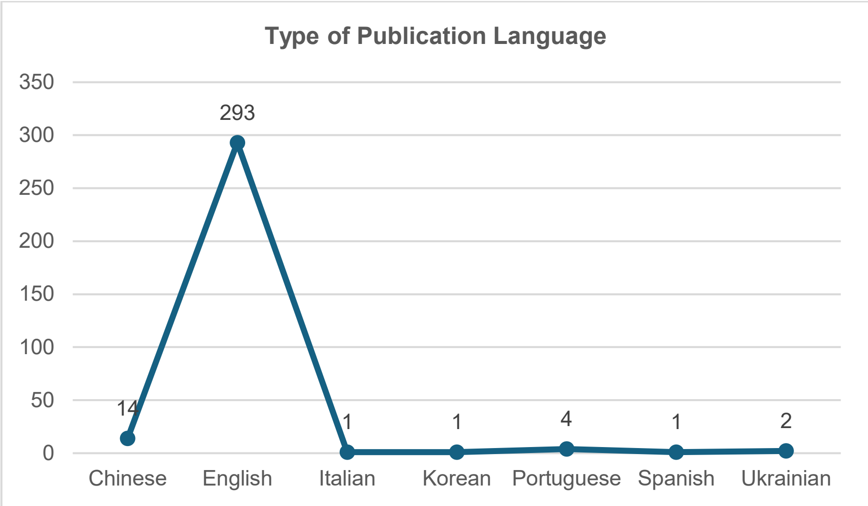

Figure 4 Number of Publications by Language

Figure 3 presents the distribution of publications by type, illustrating both the diversity and the significant scholarly contributions within this field. Among these, journal articles account for the largest share, with 174 items representing 55.1% of the total, indicating that the domain is primarily shaped by formal academic publications. Conference papers rank second with 115 items, corresponding to 36.4%, reflecting the active exchange of knowledge and discussions in professional forums. In contrast, the number of books (3), reviews (10), and book chapters (14) remains relatively modest, suggesting their complementary rather than dominant role. Overall, this distribution highlights the emphasis on rigorous and in-depth research as the foundation for academic development in agricultural logistics.

The compiled results (Figure 4) on the distribution of publications by language reveal the clear predominance of English, with 293 documents, underscoring its central role in international academic research. Chinese ranks second with 14 publications, indicating the strong engagement of the Chinese research community. Other languages, including Portuguese (4), Ukrainian (2), and less common ones such as Italian, Korean, and Spanish (each represented by a single publication), show limited contributions. This distribution highlights the concentration of scholarly communication in dominant languages, particularly English, within the field of agricultural logistics research.

3.2 Co-Authorship Analysis

In the author-level analysis, this study employed the fractional counting method, which allocates proportional contribution scores to each participating entity. For instance, if a publication has four authors, each is assigned one quarter of the total contribution value. The same principle is applied when evaluating institutions or countries, thereby providing a more accurate representation of the degree of involvement of each individual, organization, or keyword. This approach is particularly valuable for studies aiming to assess the balance of contributions or the actual roles of stakeholders. In addition, publications with an excessively large number of authors (up to a maximum of fifteen) were excluded, and the threshold for the minimum number of documents per author was set to one. The results indicate that a total of 925 authors contributed to 316 publications included in the dataset.

In Figure 5a, author groups such as “Shokhansanj, Shabab,” “Ebadian, Mahmood,” and “Townley-Smith, Lawrence” are identified as having strong collaborative relationships and are clustered together. The analysis also highlights several influential researchers within the network, including “Mani, Sudhagar,” “Womac, Alvin Ray,” “Hoque, Mozammei,” and “Naimi, Ladan Jafari.” Figure 5b illustrates the size of each circle corresponding to the strength of author linkages, while the color gradient from blue to yellow represents the average publication year within the period from 2008 to 2016. Recent publications by authors such as “Ebadian, Mahmood,” “Townley-Smith, Lawrence,” and “Lee, David” show relatively high link weights, indicating strong collaboration intensity. Figure 5c depicts the density visualization in which yellow circles represent the clusters with the strongest interconnections among authors within the network. This visualization demonstrates that authors such as “Shokhansanj, Shabab,” “Ebadian, Mahmood,” and “Mani, Sudhagar” have maintained close research collaboration in recent years. Collectively, these visual maps reflect the dynamic and expanding nature of research areas associated with agricultural logistics.

The compiled results presented in Table 1 indicate that the top ten authors have made substantial contributions to the field. The most prolific authors include “Yang, Y.,” “Gebresenbet, G.,” and “Babcock, M. W.” with five publications each, followed by “Qiu, Z.” and “Bosona, T.” with four publications each. Meanwhile, “Xie, R.,” “Sokhansanj, S.,” “Shi, X.,” “Perdana, T.,” and “Olsson, S. O.” each contributed three publications. Regarding source titles, the two most productive journals are IOP Conference Series: Earth and Environmental Science with fourteen publications and Sustainability (Switzerland) with eight publications, both of which play a central role in disseminating research on this topic. In terms of institutional affiliations, Beijing Jiaotong University has the highest number of publications with nine items, followed by Jilin

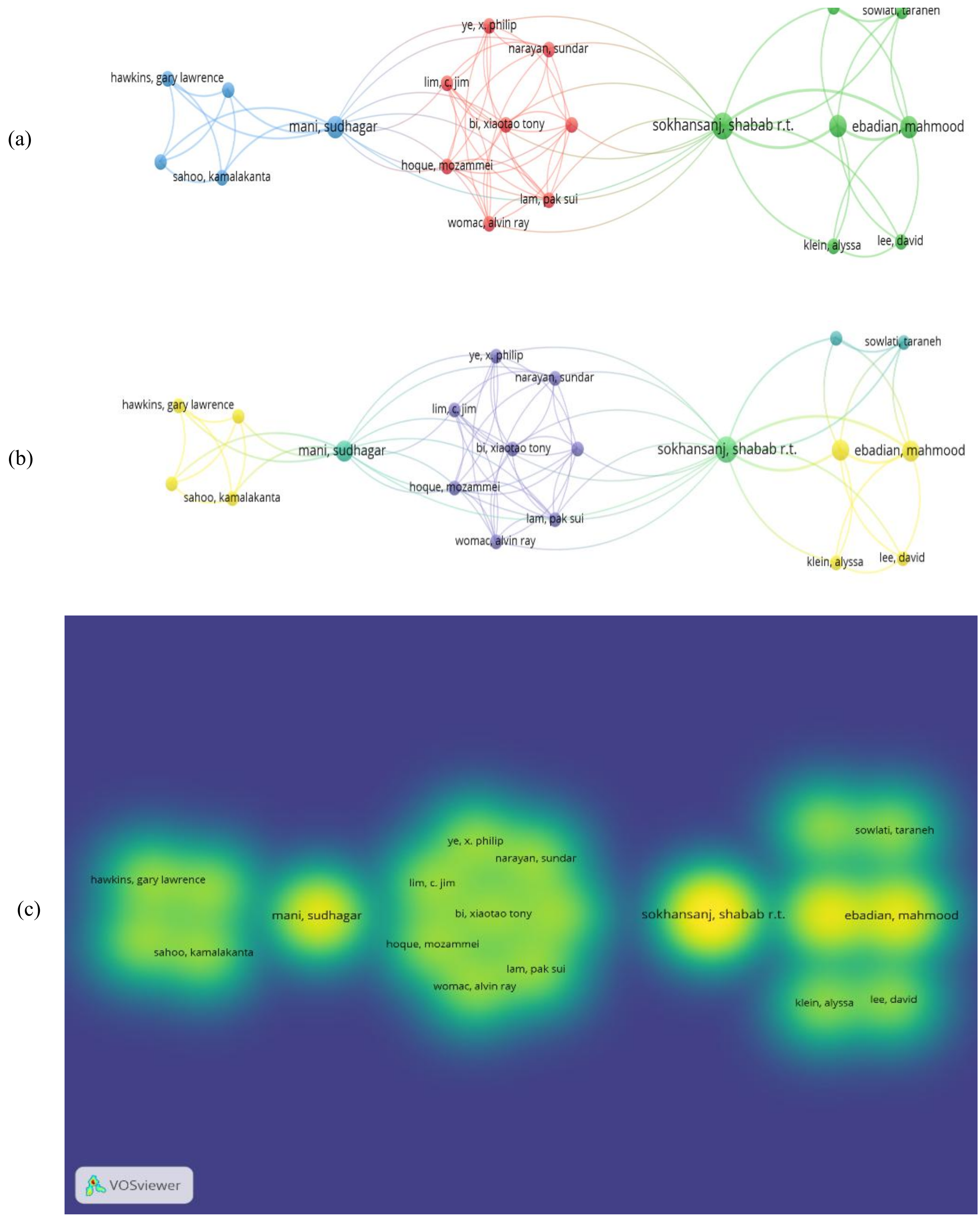

Figure 5 Visualization of Collaboration Among Authors

University and Sveriges lantbruksuniversitet (Swedish University of Agricultural Sciences), each with six publications. Other institutions contributed between four and five publications.

The analysis also shows that the most frequently occurring keywords are “Agricultural Products” (93 occurrences) and “Logistics” (87 occurrences). These findings reveal the broadening scope of the research field and suggest that future studies can build upon the intellectual foundations established by these authors and institutions. Furthermore, the study emphasizes the central importance of the keywords “Agricultural Products” and “Logistics” in guiding in-depth research aimed at addressing challenges within the agricultural logistics sector.

A total of 316 publications related to the research topic were indexed in Scopus during the period from 1989 to 2025. The study established a minimum threshold of one publication per country, resulting in 51 countries meeting

Table 1 The Leading 10 Journals, Source Titles, Affiliations, Authors and Keywords Involved in the Literature on Logistics Networks for Agricultural Products

No.	Name of the Author		Source Title		Affiliations of Publication		The Keywords of the Articles	
	Authors	***Pub. Count***	***Source***	***Pub. Count***	***Affiliations***	***Pub. Count***	***Keywords***	***Pub. Count***
1	Yang, Y.	5	Iop Conference Series Earth and Environmental Science	14	Beijing Jiaotong University	9	Agricultural Products	93
2	Gebresenbet, G.	5	Sustainability Switzerland	8	Jilin University	6	Logistics	87
3	Babcock, M.W.	5	ACM International Conference Proceeding Series	6	Sveriges lantbruksuniversitet	6	Agriculture	59
4	Qiu, Z.	4	International Journal of Logistics Systems and Management	5	Kansas State University	5	Logistics System	53
5	Bosona, T.	4	E3s Web of Conferences	5	Southwest Jiaotong University	5	Agricultural Robots	37
6	Xie, R.	3	Applied Mechanics and Materials	5	Guangzhou University	5	Supply Chains	36
7	Sokhansanj, S.	3	Proceedings of the 8th International Conference of Chinese Logistics and Transportation Professionals Logistics the Emerging Frontiers of Transportation and Development in China	4	Universidade de São Paulo	4	Cold Chain Logistics	36
8	Shi, X.	3	International Journal of Supply Chain Management	4	National University of Life and Environmental Sciences of Ukraine	4	Optimization	26
9	Perdana, T.	3	Acta Agriculturae Scandinavica Section B Soil and Plant Science	4	Jiangsu University	4	Fresh Agricultural Products	26
10	Olsson, S.O.	3	Transportation Quarterly	3	Jiangxi University of Finance and Economics	4	Logistics Network	22

this criterion. Figure 6 illustrates the formation of eight collaborative clusters comprising 75 connections, with a total link strength of 47.00. These clusters clarify the cooperative relationships among countries based on the co-authorship of publications, document weights, and the average publication year, within the defined minimum threshold. The results presented in Figure 6a show that China holds the strongest collaboration links, followed by the United States, the Russian Federation, Ukraine, and Brazil. In Figure 6b, the circle size represents the link strength of each country, while the color gradient from blue to yellow indicates the average publication year during the period 2016–2024. The findings suggest that earlier publications exhibit strong collaboration patterns, particularly between China and the United States. Figure 6c displays the density visualization, where yellow circles represent clusters with the most intensive connections within the network. This indicates that countries such as China, the United States, and the Russian Federation have maintained close cooperation in recent years.

The increasing contributions from these nations have not only strengthened international linkages but also enhanced the overall effectiveness of collaborative research. The analysis further reveals that researchers are extending beyond geographical boundaries, fostering partnerships with a broader range of countries, thereby improving research potential and creating greater opportunities for future international collaboration.

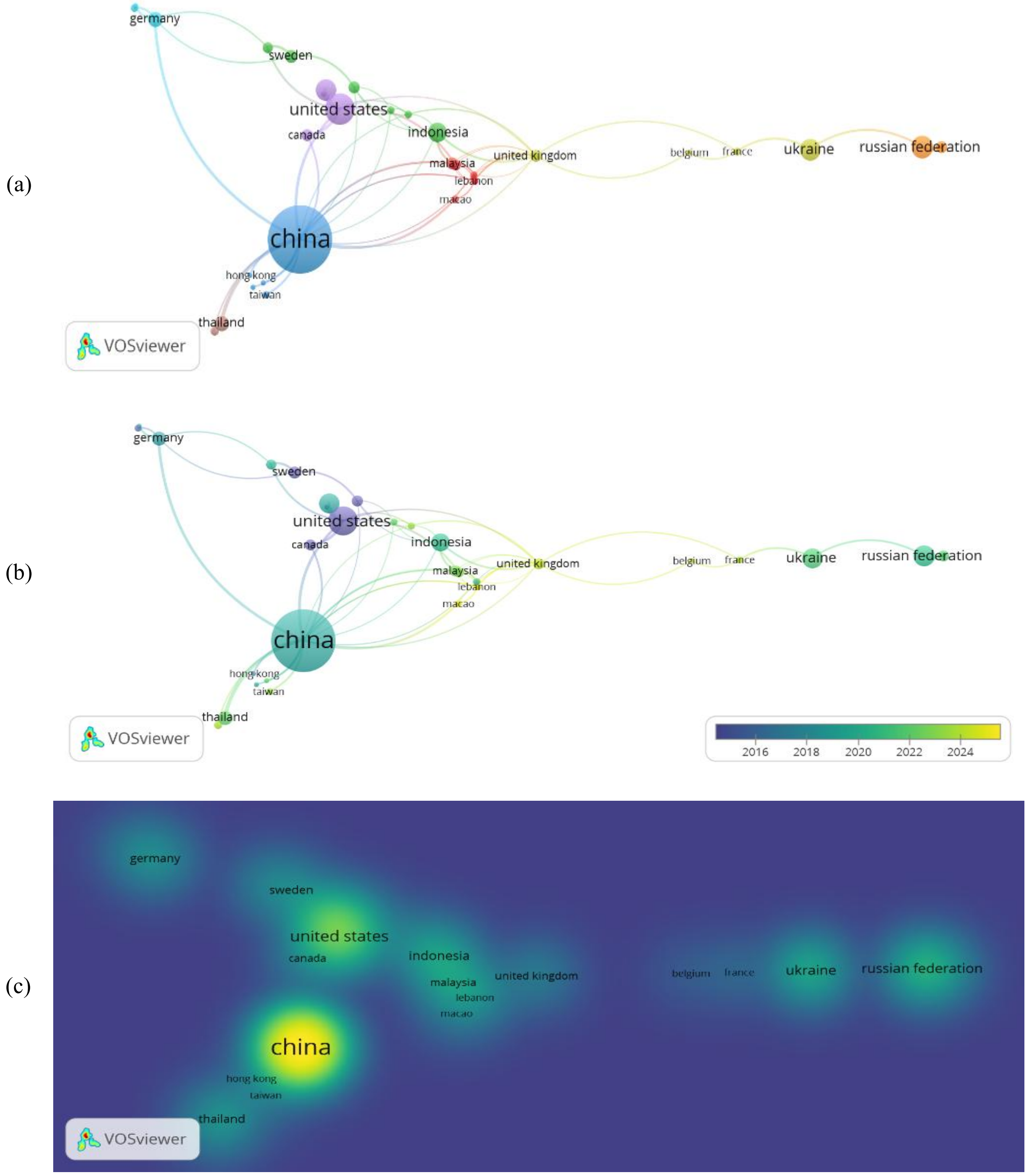

Figure 6 Collaboration Network Among Countries

The analysis of research contributions from the ten leading countries (Table 2) reveals a considerable disparity in both publication output and academic impact. China ranks first with 159 publications and 692 citations, demonstrating a robust research ecosystem with a total link strength of 18.00. The United States occupies the second position with 34 publications and 781 citations, reflecting substantial research productivity. Notably, countries such as the Russian Federation, Ukraine, and Brazil, despite having fewer publications (18, 17, and 16 respectively), achieved significant citation counts (64, 65, and 56 respectively), suggesting concentrated and influential research activity. Indonesia stands out with 14 publications and 176 citations, indicating that the quality and scholarly impact of its research outputs are relatively high. Conversely, the United Kingdom recorded a lower citation rate, with 23 citations across five publications, which may point to the need for stronger international collaboration or improved research visibility. Overall, the data emphasize the dominance of established research centers while also highlighting the potential for emerging countries to strengthen their global influence in the field of agricultural logistics.

3.3 Co-Occurrence Analysis of Keywords

The From the 316 documents collected from the Scopus database, a total of 99 keywords met the minimum occurrence threshold of five. The analysis of these keywords generated six distinct clusters, comprising 1,482 link connections with a total link strength of 564.5. Based on the dominant terms within each cluster, six thematic areas were identified as follows:

Table 2 Ten Leading Countries in Research Contribution

No.	Country	Total Number of Articles	Citations	Total Link Strength
1	China	159	692	18.00
2	United State	34	781	10.00
3	Russian Federation	18	64	4.00
4	Ukraine	17	65	2.00
5	Brazil	16	56	2.00
6	Indonesia	14	176	3.00
7	Thailand	8	58	4.00
8	Germany	7	149	5.00
9	Sweden	6	130	3.00
10	United Kingdom	5	23	5.00

1) **Infrastructure, Energy, and System Optimization in Agricultural Logistics:** This cluster focuses on infrastructure, modeling, and renewable energy applications within agricultural logistics chains. The research orientation involves developing optimization models, such as integer programming, system dynamics, and simulation, to support decision-making in transportation and warehousing while incorporating renewable energy and reverse logistics in rural regions. The central aim is to ensure food security, economic and social efficiency, and environmental sustainability through infrastructure and information system design. The significance of this cluster lies in providing quantitative tools for planning national and regional agricultural transportation and distribution networks.
2) **Digitalization and Cold Chain Development in Agricultural Logistics Networks:** This cluster connects artificial intelligence, big data, the Internet of Things, electronic commerce, and cold chain systems for fresh agricultural products. The research direction involves designing smart logistics networks and cold storage systems to optimize customer service and real-time information management. Key areas of focus include algorithmic applications, such as genetic algorithms, performance evaluation, and the integration of supply chain management from product design to marketing. The findings highlight the potential of digital technologies to improve product quality, reduce post-harvest losses, and standardize agricultural supply chain management in the digital environment.
3) **Biomass Valorization and Cost–Emission Optimization in Agricultural Transport:** This cluster centers on biomass, crop residues, grains, and bioenergy logistics chains. The research emphasis is on simulation and cost–benefit analysis, optimizing logistics costs, and reducing greenhouse gas emissions across the supply chain. Key aspects include designing collection and processing networks, ensuring quality control, and conducting sensitivity analyses to support investment decisions. The overall significance lies in converting agricultural by-products into renewable energy inputs, reducing transportation and processing costs, and improving system sustainability.
4) **Extended Agricultural Supply Chains: Automation, Market Integration, and Risk Management:** This cluster encompasses agribusiness enterprises, agricultural robotics, electronic commerce, international trade integration, and risk assessment. The research direction focuses on configuring transnational agricultural supply chains by integrating competitiveness, investment, and spatial factors while advancing automation in production and logistics. The emphasis is on socioeconomic effects, logistics system location decisions, and governance mechanisms for managing risks in open markets. The findings underline the role of technology and institutional frameworks in enhancing the competitiveness of agricultural supply chains.
5) **Input Cost Efficiency and Waste Management in Agricultural Logistics:** This cluster highlights strategies for cost reduction and operational optimization related to fertilizers, tractors, and waste management. The research orientation includes total cost measurement, operational standardization of vehicle and equipment fleets, and the design of circular economy solutions for waste treatment. Key areas of focus involve comparing logistics alternatives, conducting trade-off analyses, and developing cost-reduction strategies based on economies of scale. The significance lies in improving profit margins, reducing environmental impacts, and stabilizing input supply chains for agribusinesses.
6) **Warehouse Automation and Logistics System Design for Agriculture:** This cluster brings together agricultural machinery, robotics, and warehousing, emphasizing internal supply chain automation. The research direction involves restructuring logistics systems at the levels of farms, production clusters, and distribution centers, with particular focus on warehouse design, material flow, and operational standardization. The main emphasis lies in equipment productivity, reliability, and scalability across seasonal cycles. The contribution of this cluster is the reduction of logistical bottlenecks, improvement of product turnover speed, and enhancement of market responsiveness.

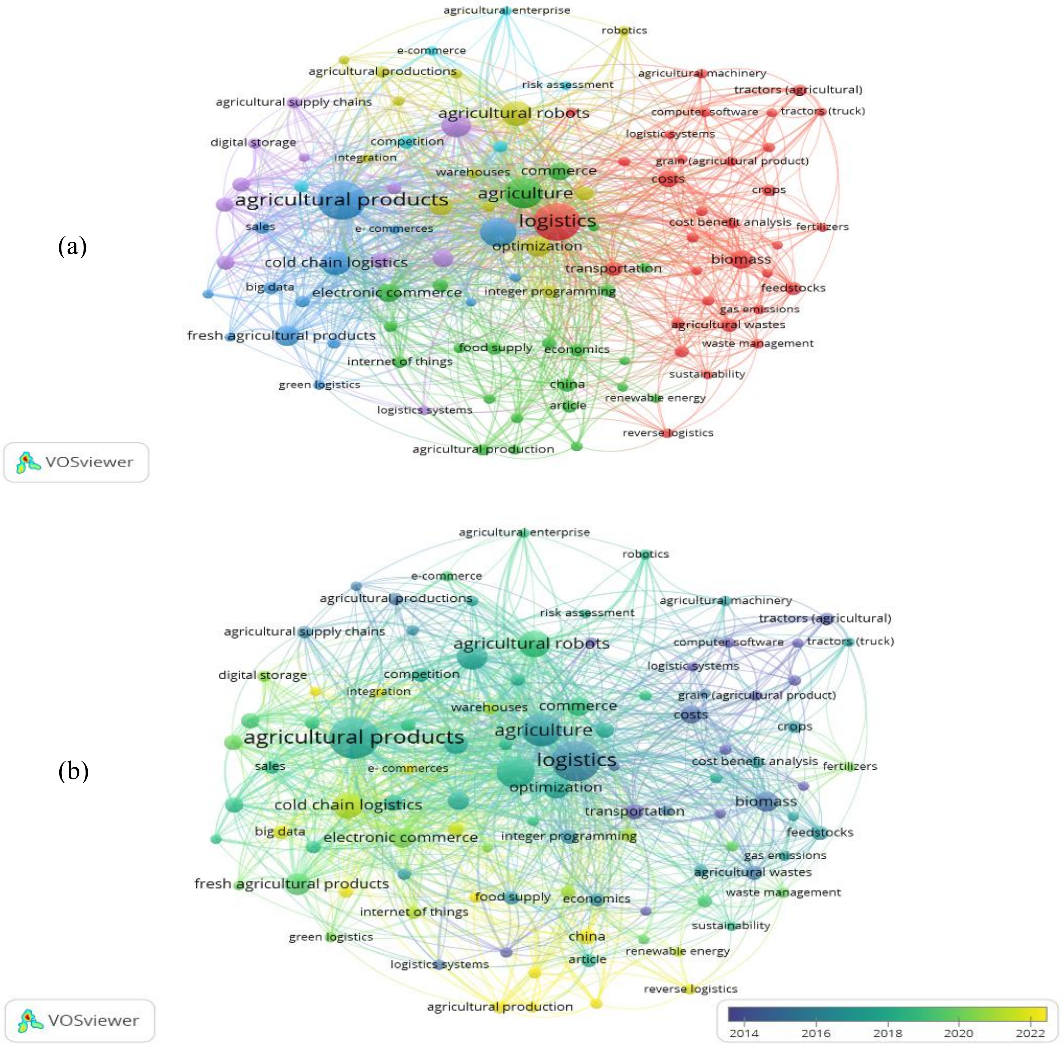

Figure 7 Keyword Co-occurrence Network Visualization

The co-occurrence analysis also indicates that the field covers different product categories, including fresh agricultural products, grains and crops, biomass and crop residues, agricultural inputs, and broader agri-food supply chains. This product diversity implies that logistics network decisions should not be interpreted uniformly, because each product group involves different priorities in terms of cost, time, storage, quality, waste, emissions, and risk.

Figure 7 illustrates the frequency of keyword occurrences through circles of varying sizes, where larger circles represent keywords appearing more frequently in the dataset. In Figure 7a, blue-colored keywords such as "Agricultural Products" have the highest link strength (87.00), while red-colored keywords such as "Logistics" show a slightly lower link strength (80.00). These keywords are also associated with others like "logistics system," "agriculture," and "cold chain logistics," indicating frequent co-occurrence and strong relationships within the research network. Figure 7b presents the association between keyword weights and their average citation scores. The color scale represents citation intensity, with dark blue indicating the lowest values and yellow representing the highest. The analysis reveals an intriguing pattern: frequently occurring keywords with strong connections such as "Agricultural Products," "Logistics," and "Agriculture" tend to have lower average citation scores, while less frequent keywords such as "Cold chain logistics," "Big data," and "E-commerce" achieve higher average citation scores. Therefore, the frequency of keyword occurrence does not necessarily correspond to higher citation impact, and the reverse is also true. The co-occurrence results also reveal that the field is not only thematically diverse but also methodologically diverse. Terms related to optimization, simulation, genetic algorithms, performance evaluation, big data, IoT, and automation suggest that agricultural logistics network research has gradually shifted from conventional planning models toward data-driven and intelligent modeling approaches.

3.4 Analysis of Citations and References

Citation Analysis: The concept of citation refers to the relationship between two documents in which one document references another. In VOSviewer, such relationships are treated as undirected links, meaning that no distinction is made between document A citing document B or document B citing document A (van Eck & Waltman, 2023).

For data processing purposes, the minimum citation threshold was set at five citations out of the total 316 documents. The results show that 93 documents met this criterion and were included in the subsequent analysis.

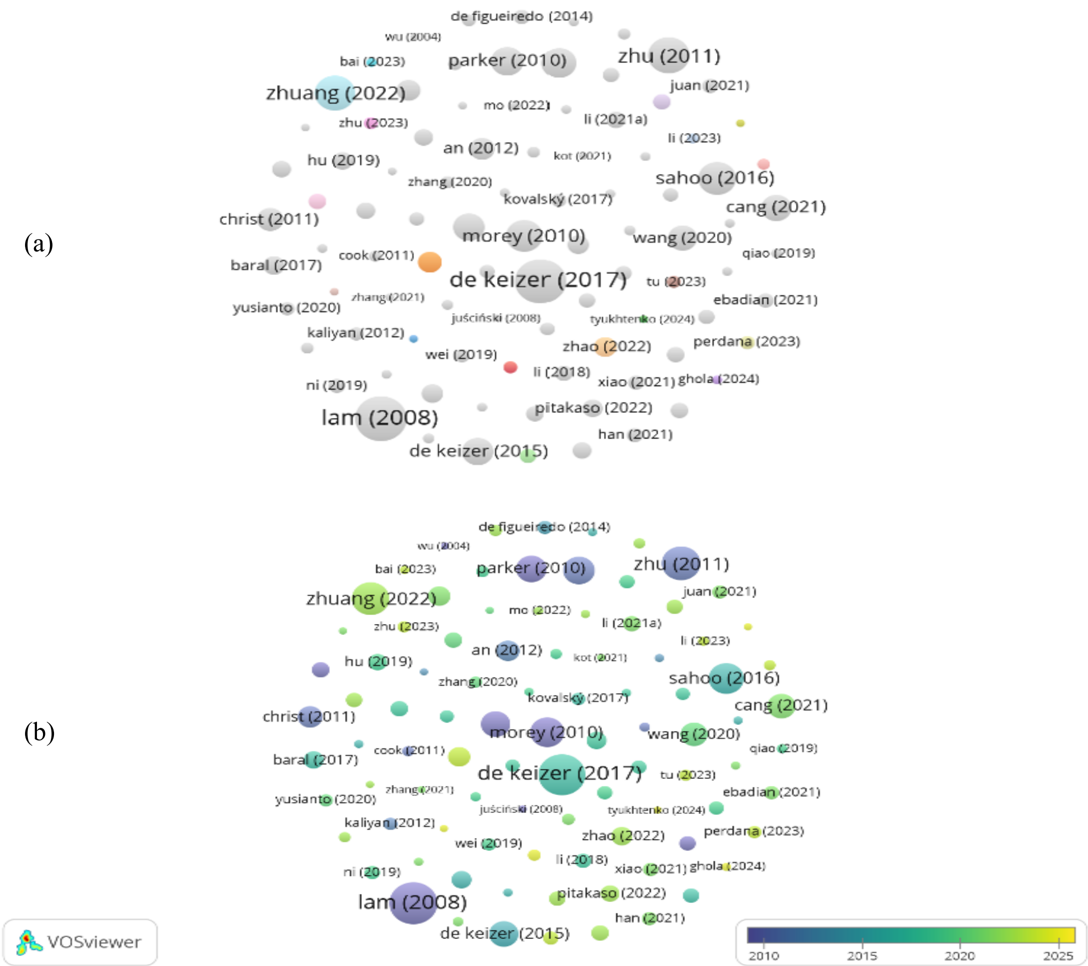

Figure 8 Diagram of Citation Analysis Visualization

Figure 8 provides a visualization of the citation relationships among the documents, where proximity between nodes indicates stronger relationships. In Figure 8a, each circle represents an individual document, with different colors distinguishing them. The circle size corresponds to the number of citations received, where larger circles represent higher citation counts. For example, the works of Lam (2008) with 149 citations, de Keizer (2017) with 141 citations, Zhu (2011) with 96 citations, and Sahoo (2016) with 84 citations are represented by light brown nodes. Additionally, the study by Zhuang (2022), shown in powder blue, is a relatively recent publication but already has 90 citations, suggesting that the author's research topic has attracted considerable scholarly attention. These highly cited and recently influential documents represent key finding milestones in the field. Earlier influential studies contributed to the consolidation of logistics system design and optimization, whereas recent studies indicate a shift toward digital, resilient, and sustainability-oriented agricultural logistics.

In Figure 8b, the average citation levels of documents are represented through a color scale ranging from blue (lower average citations) to yellow (higher average citations). The visualization indicates that although studies such as those by Zhou (2024), Ghola (2024), and Kong (2024) have relatively modest total citation counts, their average citation scores are high. Conversely, earlier studies such as those by Lam (2008), Morey (2010), and Hansson (2004) exhibit high total citation counts but lower average citation values, possibly due to the effect of publication age or diminishing topical relevance, which may have reduced their relative influence in recent years.

Co-Citation Analysis: Co-citation mapping is a bibliometric technique used to explore the intellectual structure of a research domain by identifying relationships among authors or documents that are cited together (Mas-Tur *et al.,* 2021; Subeesh, 2023). The results are typically visualized as a network map in which nodes represent authors or sources, and the connecting lines indicate the frequency with which they are cited concurrently. The distance between nodes reflects the degree of intellectual similarity, allowing the identification of thematic clusters, research schools, and highly influential authors within the field.

For this study, the unit of analysis was defined as the "source," with a minimum citation threshold of two. Out of a total of 242 sources, 59 met this criterion. The results reveal nine clusters as shown in Figure 9. Among these, *Biomass and Bioenergy* (represented in light yellow) has the highest citation count with twelve citations, showing strong connections with other sources such as *Review of Agricultural Economics*, *Applied Energy*, and *Ecological Indicators*. The second most prominent cluster, shown in turquoise, is led by the *International Journal of Production*

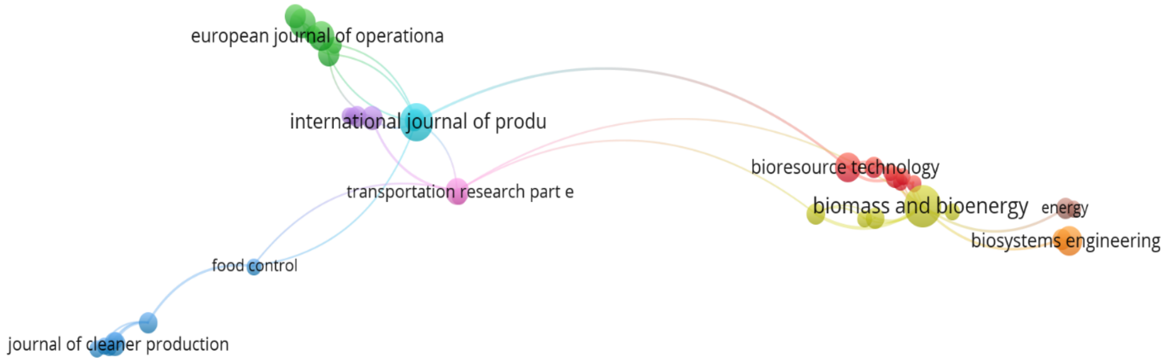

Figure 9 Co-citation Network Analysis Using Sources as the Analytical Unit

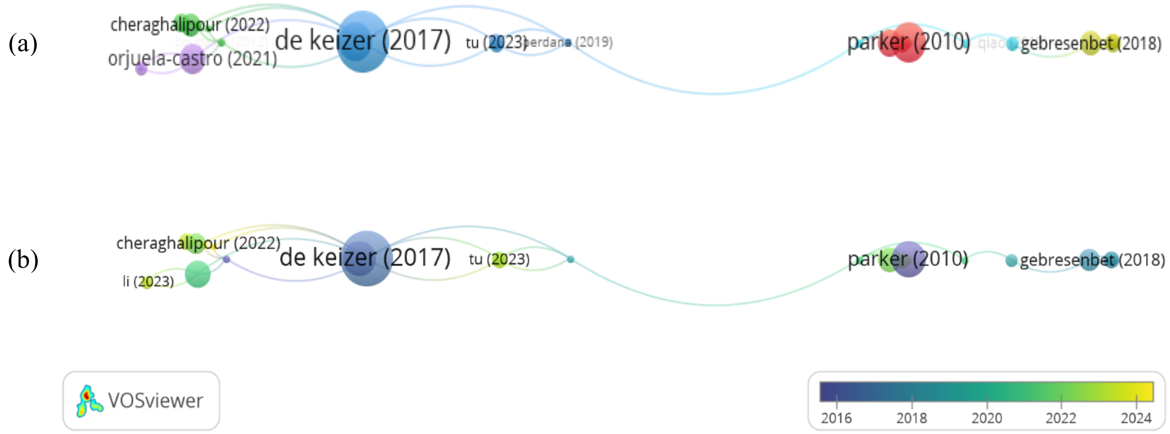

Figure 10 Bibliographic Coupling Analysis (Unit of Analysis: Documents)

Economics, which has ten citations and is closely linked with *International Transactions in Operational Research* and *Transportation Journal*. Additionally, other clusters represented in green include sources such as *Production and Operations Management*, *European Journal of Operational Research*, and *International Journal of Logistics Management*, indicating their significant roles in shaping the intellectual landscape of agricultural logistics research.

3.5 Bibliographic Coupling Analysis

Bibliographic coupling analysis is a technique used to determine the relationship between two documents that share one or more common references, thereby reflecting the degree of thematic similarity between them. A higher coupling strength indicates a closer intellectual connection between the publications (van Eck & Waltman, 2023). In this analysis, the unit of measurement was defined as "documents," with a minimum citation threshold of two. As a result, 168 documents out of the total 316 met this criterion and were grouped into six clusters.

The bibliographic coupling results reveal two prominent knowledge poles. In Figure 10a, the blue cluster is centered around the work of de Keizer (2017), which has 141 citations and is strongly linked to de Keizer (2015) with 59 citations. This cluster also connects with Pedana (2019), Ren (2022), and Tu (2023), representing a foundational research stream that demonstrates both intellectual influence and bridging capacity. On the opposite side, the red cluster is anchored by Parker (2010) with 61 citations, forming strong links with Zhao (2022) with 30 citations, as well as Zhu (2023), Zhang (2021a), and Hu (2023), suggesting a parallel methodological and application-oriented trajectory. The peripheral clusters include the purple cluster led by Orjuela-Castro (2021) with 34 citations and the yellow cluster centered on Gebresenbet (2018) with 22 citations, both reflecting more specialized thematic directions.

In Figure 10b, the color gradient from blue to yellow represents the average citation value, where blue indicates lower averages and yellow denotes higher ones. Recent studies such as Perdana (2023) with 14 citations, Khazaeli (2024) with 3 citations, and Bolivar (2025) with 2 citations show relatively low total citations but high average citation values, highlighting emerging research frontiers. In contrast, documents with high total citations such as de Keizer (2015), de Keizer (2017), and Parker (2010) exhibit lower average citation scores, which is characteristic of mature and well-established knowledge cores.

3.6 Finding Milestones Over Time

The evolution of agricultural logistics network research is better understood through three continuous periods rather than short disconnected phases (Table 3). The first period, 1989–2007, represents the formative stage, when publications were sparse and mainly addressed agricultural goods transport, route coordination, grain transport costs, and biomass-related logistics properties.

Table 3 Major Finding Milestones in Agricultural Logistics Network Research

Period	Evidence from Publication Trend	Representative Papers	Main Research Themes
1989–2007	11 papers; sparse and discontinuous publications	Gebresenbet & Ljungberg (2001); Hansson & Fredriksson (2004); Babcock *et al.* (2003)	Agricultural transport coordination, route optimization, grain transport cost, biomass physical properties
2008–2018	106 papers; stable expansion, 8–16 papers/year	Lam *et al.* (2008); Zhu & Yao (2011); Ebadian *et al.* (2011); Sahoo *et al.* (2016); de Keizer *et al.* (2015, 2017)	Biomass supply logistics, MILP, simulation, GIS, perishable product quality decay, network design
2019–2025	199 papers; sustained high output after 2019	Hu *et al.* (2019); Huang *et al.* (2020); Orjuela-Castro *et al.* (2021); Li & Xiao (2021); Zhuang *et al.* (2022); Bolívar *et al.* (2025)	Cold chain, e-commerce, data mining, livestock waste logistics, seasonal perishable food, digital and resilient logistics

Table 4 Emerging Trends and Important Research Problems for Future Studies

Emerging Trend	Important Research Problem	Suggested Future Research Direction
Digital logistics	How do big data, IoT, blockchain, and e-commerce improve agricultural logistics performance?	Test effects on cost, delivery reliability, traceability, quality preservation, and post-harvest loss reduction.
Cold chain logistics	How can cold chain systems be made affordable and scalable for smallholder-based supply chains?	Develop low-cost cold chain models for farmers, cooperatives, and small agribusinesses in developing economies.
Sustainable and circular logistics	How can digital logistics support waste reduction, biomass valorization, and circular economy?	Examine the integration of IoT, big data, traceability, waste management, and circular logistics models.
Resilience and risk governance	How can agricultural logistics resilience be measured under disruption conditions?	Build quantitative models for climate risk, market volatility, disease outbreaks, and transportation disruptions.
Automation and intelligent logistics	How feasible are robotics and warehouse automation in fragmented agricultural supply chains?	Study affordability, scalability, labor impact, and adoption barriers in rural logistics systems.
Geographical diversification	How do institutional and infrastructural conditions shape agricultural logistics in underrepresented regions?	Conduct comparative studies in Southeast Asia, Africa, South America, and other agriculture-dependent regions.

For example, Gebresenbet and Ljungberg (2001) examined coordination and route optimization of agricultural goods transport to reduce environmental impacts, while Babcock *et al.* (2003) analyzed the effect of railroad abandonment on wheat transportation and handling costs. The second period, 2008–2018, marks the consolidation of model-based logistics network research. Key papers during this period developed MILP, simulation, GIS-based models, and hybrid optimization approaches for biomass supply chains and perishable product logistics. The third period, 2019–2025, reflects accelerated diversification toward cold chain logistics, e-commerce, data mining, Internet-enabled logistics, livestock waste management, seasonal perishable food supply chains, and sustainability-oriented network design.

3.7 Emerging Trends and Unexplored Research Agenda

The results indicate that the most important emerging trends in agricultural logistics network research are concentrated in five directions. First, digitalization is becoming a central trend, particularly through big data, IoT-enabled logistics, e-commerce, blockchain, and real-time information systems. Second, cold chain logistics is gaining increasing importance because of its role in preserving the quality of fresh agricultural products, reducing post-harvest losses, and improving food safety. Third, sustainability-oriented logistics is emerging through studies on biomass valorization, circular economy, emission reduction, and waste management. Fourth, resilience and risk governance have become more visible as agricultural supply chains face disruptions, market volatility, and climate-related uncertainty. Fifth, automation and intelligent logistics systems, including agricultural robotics and warehouse automation, are becoming new research frontiers.

However, these emerging trends also point to several research problems that remain insufficiently addressed. First, future studies should provide stronger empirical evidence on how digital logistics technologies, such as big data, IoT, blockchain, and e-commerce platforms, improve agricultural logistics performance in terms of cost reduction, delivery reliability, traceability, and post-harvest loss reduction. Second, affordable and scalable cold chain logistics models for developing economies require further investigation, particularly for smallholder farmers, cooperatives, and small agribusinesses facing financial, infrastructural, and technical constraints. Third, the connection between digital logistics

Table 5 Evolution of Methods and Models Based on Representative Papers

Period	Representative Papers	Methods/Models Used	Product/Logistics Context	Main Variables/Parameters	Objective/Function
1989-2007	Gebresenbet & Ljungberg (2001); Hansson & Fredriksson (2004); Babcock *et al.* (2003)	Route coordination; route optimization; transport cost analysis; early system analysis	Agricultural goods transport; grain/wheat transport; early biomass and rural logistics	Routes; goods flows; empty haulage; rail access; handling cost; transport mode; basic infrastructure	Improve transport coordination; reduce environmental impact; assess transport and handling costs; establish early logistics planning foundations
2008-2018	Lam *et al.* (2008); Zhu & Yao (2011); Ebadian *et al.* (2011); Sahoo *et al.* (2016); de Keizer *et al.* (2015, 2017)	MILP; multi-commodity network flow; simulation; GIS-based assessment; hybrid optimization-simulation; quality decay models	Biomass feedstocks; crop residues; cotton stalk biomass; perishable and fresh agricultural products; regional logistics networks	Facility/warehouse location; feedstock type; monthly flows; storage and processing capacity; harvest windows; residue availability; transport time; temperature; quality decay	Minimize logistics cost; optimize biomass collection and processing; improve supply reliability; select plant locations; design cost-efficient networks under quality requirements
2019-2025	Hu *et al.* (2019); Huang *et al.* (2020); Orjuela-Castro *et al.* (2021); Li & Xiao (2021); Zhuang *et al.* (2022); Bolivar *et al.* (2025)	Multi-objective and multi-period network design; data mining; genetic algorithm; Internet-enabled cold chain; strategic and tactical-operational MILP	Cold chain logistics; agricultural e-commerce; livestock waste logistics; seasonal perishable food; small-scale farmer supply chains	Seasonality; demand and supply uncertainty; product losses; logistics cost; delivery timeliness; customer satisfaction; cold chain facilities; nutrient flows; shelf life; price-quality sensitivity	Configure resilient and product-specific networks; reduce fresh product losses; optimize cost and service; control environmental impacts; integrate quality, traceability, and sustainability

and the circular economy remains underdeveloped. Although digitalization, waste management, biomass valorization, and emission reduction have been studied separately, more research is needed to explain how IoT, big data, and traceability systems can support waste reduction, biomass utilization, and circular logistics. Fourth, resilience measurement in agricultural logistics networks is still limited. Future studies should develop quantitative models to assess responses to climate change, market volatility, disease outbreaks, geopolitical risks, and transportation disruptions. Fifth, automation and intelligent logistics in rural contexts require deeper analysis, especially regarding affordability, scalability, labor impacts, and suitability for fragmented supply chains. Finally, future research should expand beyond China and the United States to underrepresented regions such as Southeast Asia, Africa, and South America.

3.8 Evolution of Methods and Models in Agricultural Logistics Network Research

Table 5 shows a clear methodological evolution in agricultural logistics network research across three continuous periods. During 1989–2007, studies mainly focused on basic logistics planning, including route coordination, transport cost analysis, and early system analysis. The product context was relatively narrow, mainly covering agricultural goods transport, grain or wheat transport, and early biomass-related logistics. The main variables were also simple, such as routes, goods flows, empty haulage, rail access, handling cost, transport mode, and basic infrastructure. In the 2008–2018 period, the field became more model-driven, with greater use of MILP, multi-commodity network flow models, simulation, GIS-based assessment, hybrid optimization-simulation, and quality decay models. Research during this stage expanded to biomass feedstocks, crop residues, cotton stalk biomass, perishable products, and regional logistics networks, with more complex variables such as facility location, storage capacity, monthly flows, harvest windows, temperature, transport time, and quality decay. From 2019 to 2025, the models became more advanced and application-oriented, incorporating multi-objective and multi-period network design, data mining, genetic algorithms, Internet-enabled cold chain systems, and strategic and tactical-operational MILP. This period reflects a shift toward resilient, product-specific, traceable, and sustainability-oriented logistics networks, especially for cold chain products, e-commerce, livestock waste, seasonal perishable food, and smallholder supply chains.

3.9 Agricultural Product Types and Decision Factors in Logistics Network Design

The synthesis in Table 6 shows that agricultural logistics network studies differ substantially according to product type, modeling approach, decision variables, and objective functions. Early studies mainly examined agricultural goods and grain transport, with a focus on route coordination, transport mode selection, handling costs, and basic infrastructure. Later studies became more product-specific and model-oriented, especially in biomass, crop residues, and perishable product logistics. These studies commonly applied MILP, GIS-based optimization,

Table 6 Product Types, Models, Variables, Parameters, and Objective Functions in Representative Papers

Paper	Product Type	Model/Method	Decision Variables	Parameters	Objective Function/ Main Outcome
Gebresenbet & Ljungberg (2001)	Agricultural goods and inputs	Route optimization; transport coordination	Transport routes; coordination of goods flows	Empty haulage; transport demand; environmental burden	Reduce environmental impact and improve transport efficiency
Babcock *et al.* (2003)	Wheat/grain	Transport cost analysis	Transport mode; handling alternatives	Rail abandonment; highway damage; handling cost	Estimate transport and handling cost impacts
Zhu & Yao (2011)	Multiple biomass feedstocks	MILP; multi-commodity network flow	Warehouse locations; biomass harvested, purchased, stored, processed; monthly transport flows	Feedstock type; seasonality; storage capacity; harvesting team size	Minimize logistics system cost and design biomass-to-bioenergy network
de Keizer *et al.* (2015)	Perishable products	MILP and simulation	Facility location; flow allocation; process allocation	Supply uncertainty; processing time; transport time; quality requirements	Minimize cost while satisfying product quality constraints
Sahoo *et al.* (2016)	Cotton stalk/crop residues	GIS-based site optimization	Plant site; biomass collection areas; supply routes	Residue yield; soil erosion; soil conditioning index; delivered cost	Identify sustainable biomass supply and optimal plant location
de Keizer *et al.* (2017)	Fresh agricultural products	Logistics network design with quality decay	Network structure; storage and transport decisions	Temperature; lead time; heterogeneous quality decay	Optimize network design considering product quality degradation
Hu *et al.* (2019)	Livestock waste	Logistics network management	Waste movement; timing and location of nutrient flows	Nutrient release; soil content; hydrology; spatial layout	Control nutrient pollution and reduce environmental damage
Huang *et al.* (2020)	Fresh agricultural products	Internet-enabled cold chain emergency management	Cold chain emergency response mode; logistics coordination	Information timeliness; loss rate; e-commerce platform; cold chain facilities	Improve real-time response and reduce fresh product losses
Li & Xiao (2021)	Agricultural e-commerce products	Data mining and genetic algorithm	Distribution mode; delivery arrangement	Logistics cost; delivery timeliness; customer satisfaction	Reduce logistics cost and improve customer satisfaction
Bolívar *et al.* (2025)	Perishable products; small-scale farmers	MILP network design	Facility choice; inventory-location; refrigerated/non-refrigerated storage	Shelf life; quality decay; humidity; temperature; price-quality sensitivity	Design agri-food network considering perishability and smallholder conditions

simulation, and quality decay models to address facility location, flow allocation, storage capacity, harvest windows, transport time, and delivered cost. More recent studies further expanded the scope toward fresh products, livestock waste, agricultural e-commerce, seasonal perishable food, and smallholder-based supply chains. The objective functions also became more complex, moving from cost minimization and transport efficiency toward multi-objective goals such as reducing product losses, improving delivery timeliness, controlling environmental impacts, preserving quality, and enhancing traceability. Overall, Table 6 confirms that agricultural logistics network design cannot be treated as a single generic problem. Different product groups require different models, variables, parameters, and decision objectives, suggesting the need for more product-specific and multi-objective research in future studies.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

This study aimed to provide a comprehensive bibliometric overview of the research landscape on agricultural logistics networks from 1989 to 2025, employing VOSviewer software to visualize its intellectual structure. Based on an analysis of 316 publications extracted from the Scopus database, the study yielded several important findings that effectively addressed the research questions.

First, regarding publication trends (RQ1), the field has experienced remarkable growth, with a significant surge beginning in 2019, reflecting the increasing scholarly interest in this area. English has emerged as the dominant language, serving as the primary medium of scientific communication in the field. Second, concerning influential contributors (RQ2), the analysis of collaboration networks indicates that China and the United States are the two leading countries, functioning as central research hubs. Institutions such as Beijing Jiaotong University have distinguished themselves as key contributors in terms of publication output. Author collaboration networks have also formed distinct research clusters, thereby advancing the development of collective knowledge.

Third, in terms of intellectual structure (RQ3), the field is characterized by six major thematic clusters: (1) infrastructure, energy, and system optimization; (2) digitalization and cold chain development; (3) biomass valorization and sustainable logistics; (4) extended supply chains and risk management; (5) input cost efficiency and waste management; and (6) warehouse automation. These themes reveal a multidimensional perspective ranging from fundamental infrastructure issues to advanced technological applications.

Finally, regarding emerging trends (RQ4), the analysis demonstrates a clear shift in research focus. Although foundational keywords such as "Agricultural Products" and "Logistics" appear most frequently, emerging topics including "Cold chain logistics," "Big data," and "E-commerce," while less common, exhibit substantially higher average citation scores. The bibliographic coupling analysis further confirms that recent studies (after 2022) are establishing new and impactful research frontiers. This suggests that the future direction of the field will be closely associated with digital technologies, cold chain logistics, and electronic commerce. The thematic evolution of the field is systematic. Earlier research mainly addressed logistics infrastructure, transportation, storage, and cost efficiency, whereas later research increasingly focuses on digitalization, cold chain systems, e-commerce, big data, circular economy, and supply chain resilience. This confirms that the research questions in the field have gradually shifted from operational efficiency toward intelligent, sustainable, and resilient agricultural logistics networks. Overall, the findings show that the field has developed through four major milestones: the recognition of agricultural logistics as an integrated system; the consolidation of optimization and decision-support models; the expansion toward cold chain logistics, sustainability, and resilience; and the recent emergence of digital, traceable, automated, and intelligent agricultural logistics networks. These milestones clarify how the most important findings have changed over time and provide a stronger basis for future research directions.

The emerging trends of the field are mainly associated with digital logistics, cold chain development, sustainable and circular logistics, resilience-oriented supply chains, and intelligent automation. Nevertheless, several issues remain insufficiently explored, including empirical validation of digital logistics impacts, affordable cold chain models for developing economies, integration between digitalization and circular economy, smallholder adoption of smart logistics, and broader evidence from underrepresented regions. These gaps provide a clearer agenda for future research on agricultural logistics networks.

The review of methods and models further shows a clear methodological transition. Earlier studies mainly relied on descriptive logistics planning, transport models, and basic system analysis, whereas later studies increasingly adopted optimization models, simulation, system dynamics, genetic algorithms, cost-benefit analysis, risk assessment, and performance evaluation models. More recent research is moving toward data-driven and technology-enabled models supported by big data analytics, IoT, blockchain, e-commerce platforms, robotics, and warehouse automation. This indicates that emerging technologies are reshaping agricultural logistics network modeling from static and cost-oriented approaches toward dynamic, multi-objective, real-time, and resilience-oriented decision-making.

The analysis also shows that agricultural products in the literature are not homogeneous. Research has addressed fresh agricultural products, grains and crops, biomass and crop residues, agricultural inputs, and broader agri-food supply chains. The main decision factors incorporated into logistics network studies include cost, time, storage, product quality, post-harvest loss, waste, emissions, traceability, risk, resilience, and infrastructure capacity. However, future research should move beyond general agricultural logistics and develop product-specific, multi-objective models that reflect the different logistics requirements of fresh, bulk, biomass, and input-related agricultural products.

From a theoretical standpoint, this study represents an initial effort to construct a quantitative and comprehensive map of agricultural logistics network research, enabling scholars to position their work and identify existing knowledge gaps. From a practical perspective, identifying technological and sustainability trends offers strategic insights for policymakers and businesses to develop agricultural supply chains that are more efficient and resilient. Nonetheless, the study has certain limitations, as it relies solely on data from the Scopus database and may be influenced by the chosen keyword selection strategy.

4.2 Recommendations

Based on the conclusions drawn from this study, several recommendations are proposed for future research and for practical applications.

For future research: It is essential to focus on cross-cluster integration. Scholars should aim to connect the thematic clusters identified in this study. For example, further research could explore the intersection between Cluster 2 (Digitalization and Cold Chain Development) and Cluster 5 (Waste Management) through the application of IoT and Big Data to minimize post-harvest losses and optimize circular economy models. In addition, greater attention should be given to emerging topics. More empirical investigations, including case studies and surveys, are needed to validate and deepen understanding of highly influential themes such as blockchain, artificial intelligence, and agricultural robotics. Such studies can help transform theoretical insights into practical applications. Furthermore, there is a need to broaden the geographical scope of research. The analysis shows that most studies are concentrated in China and the United States. Future work should address logistical challenges specific to other regions such as Southeast Asia, Africa, and South America, where agriculture plays a vital economic role but remains underexplored in academic literature. Finally, integrating multiple methodological approaches is recommended. Subsequent bibliometric studies may combine data from additional databases, such as Web of Science, and incorporate qualitative methods, including expert interviews, to achieve a more comprehensive and in-depth understanding of the field.

Besides, future research should prioritize six important research problems: measuring the performance impact of digital logistics technologies; designing affordable cold chain models for smallholder-based supply chains; integrating digital logistics with circular economy and biomass valorization; developing resilience measurement models for agricultural logistics networks; assessing the feasibility of automation and robotics in rural logistics systems; and expanding empirical evidence from underrepresented agricultural regions. Future studies should also compare the explanatory and predictive power of different logistics network models, including optimization, simulation, system dynamics, machine learning, big data analytics, and hybrid decision-support models. This would help clarify which modeling approaches are most suitable for different agricultural products, regions, infrastructure conditions, and supply chain structures. Future studies should also classify agricultural products more explicitly and examine whether logistics network models differ across fresh products, grains, biomass, crop residues, agricultural inputs, and processed agri-food products. This would make future research more useful for decision makers because the relative importance of cost, time, waste, quality, emissions, and resilience varies substantially across product groups.

For practical applications: Enhancing the competitiveness of agricultural logistics supply chains requires simultaneous advancement in digital transformation, sustainable logistics investment, and international collaboration in research and technology transfer. First, the emergence of technology-related topics highlights the need for enterprises to prioritize digitalization, IoT, and big data analytics in order to improve transparency, operational efficiency, and traceability across the supply chain. Additionally, the prominence of clusters related to biomass utilization, emission reduction, and the circular economy underscores the urgency of developing green logistics. Therefore, regulatory bodies should introduce incentive mechanisms such as green credit programs and tax benefits to support businesses in transitioning toward environmentally sustainable logistics models. Finally, given the growing formation of global collaboration networks, governments and international organizations should facilitate partnerships between leading research centers and developing nations to strengthen research cooperation and technology transfer, thereby contributing to global food security and sustainable development.

ACKNOWLEDGEMENTS

We gratefully thank all individuals who shared thoughtful comments and offered technical assistance throughout this project. We are especially indebted to the reviewers for their constructive suggestions, which substantially strengthened the manuscript. During preparation, the authors used OpenAI's ChatGPT to help improve clarity, grammar, and readability; afterward, the authors carefully reviewed, edited, and validated the text to ensure accuracy and relevance. The final content of this publication is entirely the authors' responsibility.

CONFLICTS OF INTEREST

The authors affirm that there is no conflict of interest.

REFERENCES

Babcock, M., Bunch, J., Sanderson, J., & Witt, J. (2003). Impact of short line railroad abandonment on highway damage costs: a Kansas case study. *Transportation Research Forum*. *57*(4): 105-121.

Bolívar, J., Cantillo, V., & Miranda, P. (2025). Agri–food supply chain design for perishable products: application to small-scale farmers. *Operational Research*, *25*(2). https://doi.org/10.1007/s12351-024-00878-x

Chuyen, T., & Rajagopal, P. (2025). Logistics Network for Agricultural Products: A Comprehensive Literature Review and Future Directions. *Operations and Supply Chain Management: An International Journal*, *18*(3), 320-342. http://doi.org/10.31387/oscm0620476

Darbanian, F., Brandtner, P., Falatouri, T., & Nasseri, M. (2024). Data Analytics in Supply Chain Management: A State-of-the-Art Literature Review. *Operations and Supply Chain Management: An International Journal*, 1–31. https://doi.org/10.31387/oscm0560411

De Keizer, M., Akkerman, R., Grunow, M., Bloemhof, J. M., Haijema, R., & Van Der Vorst, J. G. (2017). Logistics network design for perishable products with heterogeneous quality decay. *European Journal of Operational Research*, *262*(2), 535–549. https://doi.org/10.1016/j.ejor.2017.03.049

De Keizer, M., Haijema, R., Bloemhof, J. M., & Van Der Vorst, J. G. (2015). Hybrid optimization and simulation to design a logistics network for distributing perishable products. *Computers & Industrial Engineering*, 88, 26–38. https://doi.org/10.1016/j.cie.2015.06.017

Department of Economic. (2024). *World Population Prospects 2024: Summary of Results*. Stylus Publishing, LLC.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, 133, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Ebadian, M., Sowlati, T., Sokhansanj, S., Stumborg, M., & Townley-Smith, L. (2011). A new simulation model for multi-agricultural biomass logistics system in bioenergy production. *Biosystems Engineering*, *110*(3), 280–290. https://doi.org/10.1016/j.biosystemseng.2011.08.008

El Mane, A., Tatane, K., & Chihab, Y. (2024). Transforming agricultural supply chains: Leveraging blockchain-enabled java smart contracts and IoT integration. *ICT Express*, *10*(3), 650-672. https://doi.org/10.1016/j.icte.2024.03.007

Erick, S. B., Mbwambo, J. S., & Salanga, R. J. (2025). Adoption of climate-smart agricultural practices among smallholder leafy vegetable agripreneurs in semi-arid regions. A bibliometric review. *Social Sciences & Humanities Open*, 11. https://doi.org/10.1016/j.ssaho.2025.101428

Gebresenbet, G., & Ljungberg, D. (2001). IT—Information Technology and the Human Interface. *Journal of Agricultural Engineering Research*, 80(4), 329–342. https://doi.org/10.1006/jaer.2001.0746

Han, J. W., Zuo, M., Zhu, W. Y., Zuo, J. H., Lü, E. L., & Yang, X. T. (2021). A comprehensive review of cold chain logistics for fresh agricultural products: Current status, challenges, and future trends. *Trends in Food Science & Technology*, *109*, 536-551. https://doi.org/10.1016/j.tifs. 2021.01.066

Hansson, P., & Fredriksson, H. (2004). Use of summer harvested common reed (Phragmites australis) as nutrient source for organic crop production in Sweden. *Agriculture Ecosystems & Environment*, *102*(3), 365–375. https://doi.org/10.1016/j.agee.2003.08.005

Hu, Y., Sampat, A. M., Ruiz-Mercado, G. J., & Zavala, V. M. (2019). Logistics Network management of livestock waste for spatiotemporal control of nutrient pollution in water bodies. *ACS Sustainable Chemistry & Engineering*, 7(22), 18359–18374. https://doi.org/10.1021/acssuschemeng.9b03 920

Huang, X., Xie, R., & Huang, L. (2020). Real-time emergency management mode of cold chain logistics for agricultural products under the background of "Internet+." *Journal of Intelligent & Fuzzy Systems*, *38*(6), 7461–7473. https://doi.org/10.3233/jifs-179819

Katoch, R. (2022). IoT research in supply chain management and logistics: A bibliometric analysis using vosviewer software. *Materials Today: Proceedings*, 56, 2505-2515. https://doi.org/10.1016/j.matpr.2021.08.272

Khan, A. A., Siddiqui, Y., Siddique, K. H., Bobo, J. A., & Ali, A. (2024). Minimizing postharvest food losses: a vital strategy to alleviate food insecurity and malnutrition in developing nations: a review. *Discover Food*, *4*(1), 145. https://doi.org/10.1007/s44187-024-00129-0

Lam, P. S., Sokhansanj, S., Bi, X., Lim, C. J., Naimi, L. J., Hoque, M., ... & Ye, X. P. (2008). Bulk density of wet and dry wheat straw and switchgrass particles. *Applied Engineering in Agriculture*, *24*(3), 351-358. https://doi.org/10.13031/2013.24490

Li, Q., & Xiao, R. (2021). The use of data mining technology in agricultural e-commerce under the background of 6G Internet of things communication. *International Journal of Systems Assurance Engineering and Management*, *12*(4), 813–823. https://doi.org/10.1007/s13198-021-01108-9

Mas-Tur, A., Roig-Tierno, N., Sarin, S., Haon, C., Sego, T., Belkhouja, M., ... & Merigó, J. M. (2021). Co-citation, bibliographic coupling and leading authors, institutions and countries in the 50 years of Technological Forecasting and Social Change. *Technological Forecasting and Social Change*, 165. https://doi.org/10.1016/j.techfore.2020.120487

Moosavi, J., Naeni, L. M., Fathollahi-Fard, A. M., & Fiore, U. (2021). Blockchain in supply chain management: a review, bibliometric, and network analysis. *Environmental Science and Pollution Research,* 1-15. https://doi.org/10.1007/s11356-021-13094-3\

Mustafa, M. F. M. S., Navaranjan, N., & Demirovic, A. (2024). Food cold chain logistics and management: A review of current development and emerging trends. *Journal of Agriculture and Food Research*, 18. https://doi.org/10.1016/j.jafr.2024.101343

Orjuela-Castro, J. A., Orejuela-Cabrera, J. P., & Adarme-Jaimes, W. (2021). Logistics network configuration for seasonal perishable food supply chains. *Journal of Industrial Engineering and Management*, 14(2), 135. https://doi.org/10.3926/jiem.3161

Pottier, P., Lagisz, M., Burke, S., Drobniak, S. M., Downing, P. A., Macartney, E. L., ... & Nakagawa, S. (2024). Title, abstract and keywords: a practical guide to maximize the visibility and impact of academic papers. *Proceedings B*, 291(2027). https://doi.org/10.1098/rspb.2024.1222

Raimbekov, Z., Syzdykbayeva, B., Rakhmetulina, A., Rakhmetulina, Z., Abylaikhanova, T., Doltes, L., & Kinasheva, Z. (2024). Designing and improving the efficiency of placement of logistics infrastructure for storage, distribution and trade of agri-food products. *Journal of Industrial Engineering and Management*, *17*(3), 777-808. https://doi.org/10.3926/jiem.6081

Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., & Koffel, J. B. (2021). PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. *Systematic Reviews*, 10(1), 39. https://doi.org/10.1186/s13643-020-015 42-z

Riazi, H., Doroodian, M., & Afshar-Nadjafi, B. (2024). Improving the sales process of profitable perishable goods: an inventory control strategy in a planned economy. *International Journal of Retail & Distribution Management*, 52(6), 721-735. https://doi.org/10.1108/ IJRDM-07-2023-0453

Rojas-Reyes, J. J., Rivera-Cadavid, L., & Peña-Orozco, D. L. (2024). Disruptions in the food supply chain: A literature review. *Heliyon*, *10*(14). https://doi.org/10.1016/j.heliyon.2024.e34730

Sahoo, K., Hawkins, G., Yao, X., Samples, K., & Mani, S. (2016). GIS-based biomass assessment and supply logistics system for a sustainable biorefinery: A case study with cotton stalks in the Southeastern US. *Applied Energy*, 182, 260–273. https://doi.org/10.1016/j.apenergy.2016.08.114

Shashi, Centobelli, P., Cerchione, R., & Ertz, M. (2021). Food cold chain management: what we know and what we deserve. *Supply Chain Management: An International Journal, 26*(1), 102-135. https://doi.org/10.1108/SCM-12-2019-0452

Siluthanyi, M., Pradhan, A., & Yahia, Z. (2024). Scenario Analysis for Supply chain management of milled grain products in South Africa: A System Dynamics approach. *Operations and Supply Chain Management: An International Journal*, 142–163. https://doi.org/10.31387/oscm0560419

Sri Vigna Hema, V., & Manickavasagan, A. (2024). Blockchain implementation for food safety in supply chain: A review. *Comprehensive Reviews in Food Science and Food Safety*, *23*(5). https://doi.org/10.1111/1541-4337.70002

Subeesh, V. K. (2023). Bibliometric review and co-citation analysis of documents published in the derivative market: A study based on the Scopus database. *International Journal of Advanced Research*, 11(4), 1178–1190. https://doi.org/10.21474/ijar01/16676

Taparia, R., Janardhanan, S., & Gupta, R. (2020). Inventory control for nonperishable and perishable goods based on model predictive control. *International Journal of Systems Science: Operations & Logistics*, 7(4), 361-373. https://doi.org/10.1080/23302674.2019.1600766

Tetteh, F. K., Kwateng, K. O., & Mensah, J. (2024). Green logistics practices: A bibliometric and systematic methodological review and future research opportunities. *Journal of Cleaner Production*, 476. https://doi.org/10.1016/j.jclepro.2024.1437 35

UNICEF. (2023). *The state of food security and nutrition in the world 2023*. https://doi.org/10.4060/cc3017en

van Eck, N. J., & Waltman, L. (2023). *Manual for VOSviewer version 1.6.20 (VOSviewer manual)*. Universiteit Leiden

Wang, Y., Yang, S., Wang, X. V., & Wang, L. (2024). Research on truck-drone collaborative route planning for rural logistics delivery services. *Scientific Reports*, 14(1), 31815. https://doi.org/10.1038/s41598-024-83149-1

Wong, W. P., Anwar, M. F., & Soh, K. L. (2024). Transportation 4.0 in supply chain management: State-of-the-art and future directions towards 5.0 in the transportation sector. *Operations*

Management Research, 17(2), 683-710. https://doi.org/10.1007/s12063-024-00471-7

Xu, S., Zhang, X., Feng, L., & Yang, W. (2020). Disruption risks in supply chain management: a literature review based on bibliometric analysis. *International Journal of Production Research*, 58(11), 3508-3526. https://doi.org/10.1080/00207543.2020.1717011

Yu, Q., Zhang, M., & Mujumdar, A. S. (2024). Blockchain-based fresh food quality traceability and dynamic monitoring: Research progress and application perspectives. *Computers and Electronics in Agriculture*, 224. https://doi.org/10.1016/j.compag.2024.109191

Zhang, A., Duong, L., Seuring, S., & Hartley, J. L. (2023). Circular supply chain management: a bibliometric analysis-based literature review. *The International Journal of Logistics Management,* 34(3), 847-872. https://doi.org/10. 1108/IJLM-04-2022-0199

Zhou, X., Wei, X., Lin, J., Tian, X., Lev, B., & Wang, S. (2021). Supply chain management under carbon taxes: A review and bibliometric analysis. *Omega*, 98. https://doi.org/10.1016/j.omega.2020.102295

Zhu, X., & Yao, Q. (2011). Logistics system design for biomass-to-bioenergy industry with multiple types of feedstocks. *Bioresource Technology*, 102(23), 10936–10945. https://doi.org/10.1016/j.biortech.2011.08.121

Zhuang, D., Abbas, J., Al-Sulaiti, K., Fahlevi, M., Aljuaid, M., & Saniuk, S. (2022). Land-use and food security in energy transition: Role of food supply. *Frontiers in Sustainable Food Systems*, 6. https://doi.org/10.3389/fsufs.2022.105 3031

Tran Trung Chuyen is a lecturer at the Faculty of Business Administration - Marketing, Nam Can Tho University. His teaching focuses on economics, business administration, logistics, and supply chain management. He is currently a PhD candidate in the field of Transportation and Logistics at the Malaysia University of Science and Technology (MUST).

Nguyen Tri Khiem is currently a lecturer at the Faculty of Business Administration - Marketing, Nam Can Tho University. His teaching and academic interests focus on economics, business administration, and agricultural economics. With his professional background in these fields, Nguyen Tri Khiem contributes to the training of students in business and management disciplines, particularly in areas related to economic analysis, enterprise management, and the application of economic knowledge to agricultural development.

Phan Tran Xuan Trinh is currently a lecturer at the Faculty of Technology and Engineering, Nam Can Tho University. She has academic and teaching expertise in the fields of human resource management, operations management, logistics, and supply chain management. Her teaching focuses on equipping students with fundamental and applied knowledge related to organizational management, operational efficiency, logistics systems, and supply chain coordination in modern business contexts.

Tran Thanh Huy is currently a lecturer at the Faculty of Technology and Engineering, Nam Can Tho University. He has academic and teaching expertise in the fields of food technology, industrial management, logistics, supply chain management, and business administration. His teaching focuses on equipping students with fundamental and applied knowledge related to food production, industrial operations, logistics systems, supply chain coordination, and modern business management.

Pham Huynh Thuy An is a lecturer in the Faculty of Technology and Engineering, Nam Can Tho University, specializing in Food Technology. She currently holds the position of Deputy Head of the Department of Food Technology, contributing to teaching, research, and academic development in the field of food technology.

Nguyen Thanh Van is currently a lecturer at the Faculty of Business Administration - Marketing, Nam Can Tho University. She has academic and teaching expertise in the fields of management, marketing, sustainable development, and e-commerce. Her teaching focuses on equipping students with fundamental and applied knowledge related to business management, marketing strategies, sustainable business practices, digital commerce, and modern business development.

Nguyen Thi Thu Tam is an Assistant to the Faculty of Business Administration - Marketing at Nam Can Tho University. She is involved in academic administration, research activities, and the development of training programs. Her research interests include digital marketing, consumer behavior, entrepreneurship, and sustainable business development.

Le Thi Thanh Thuy is a lecturer at the Faculty of Business Administration - Marketing, Nam Can Tho University. Her teaching and research interests focus on business administration, human resource management, and logistics within the Mekong Delta region. She is currently a PhD candidate in Business Administration at Nam Can Tho University.