Greening the harvest: A bibliometric review of past and emerging research trends in green supply chain management in agriculture

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Shahreza Shauqi Ismail
Trisakti Institute of Transportation and Logistics, Jakarta, Indonesia.

Nura Abubakar Allumi
School Technology Management and Logistics Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

Yousif Munadhil Ibrahim
Al-Farqadein University, Basra, Iraq. Basra Oil Company, Ministry of Oil Basra, Iraq.

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Abstract

Purpose: The aim of this study is to analyze the evolution of research trends in green supply chain management (GSCM) in agriculture, constructing an intellectual framework to improve the efficiency and environmental sustainability of the supply chain with smart agricultural technologies.
Design/methodology/approach: The review used the bibliometric approach with two science mapping approaches (i.e., co-citation and co-word analysis) were perfomed to analyze 381 articles published in the Web of Science (WoS) database to investigate past and future research direction in GSCM using the VOSviewer software.
Findings: Previous studies mainly focused on CE integration, sustainable agri-food supply chain design, and blockchain in supply chain management, whereas future research is expected to emphasize green logistics, low-carbon supply chains, smart circular systems, and digital innovation in green agri-SCM.
Limitations and Research implications: This study is limited to the WoS database and two bibliometric techniques. Future research should validate the identified themes through additional bibliometric and empirical studies.
Practical Implications: This study provides practical insights for managers, policymakers, and researchers to support the development of sustainable agricultural supply chains through circular economy, green logistics, and digital technologies.
Originality/value: This study provides a comprehensive knowledge map of GSCM in agriculture by identifying past research themes and future research directions through bibliometric analysis.
Keywords: Green Supply Chain, Agri-food Supply Chain, Bibliometric, Past Trend, Future Prediction

Introduction

In line with the growing global environmental challenges and the need for sustainable practices, attention to GSCM in the agricultural sector has increased in recent years. GSCM's main focus is on environmental sustainability aspects, where every step of the supply chain, from design, distribution, and recycling schemes, aims to increase efficiency and reduce the impact of environmental damage. The bibliometric approach can be a solution to map research progress, starting from the past, present, and to identify new trends in the future. This study expands the understanding of the evolution of GSCM (Rejeb et al., 2023; Soegoto et al., 2022).

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The new study says the link between GSCM and digital technology, green finance, and risk management. All of these things are aimed at enriching the direction of research in the future (D'Angelo & Belvedere, 2023; Fahim & Mahadi, 2022). Innovative technologies, such as blockchain, are said to be able to strengthen the transparency and resilience of the supply chain (Chelh & Ababou, 2023). On the other hand, the bibliometric approach shows the results of academic interest since 2013, indicating great potential for innovation of needs through an interdisciplinary approach (Amofa et al., 2023).

Operational efficiency is indeed important to prioritize, but we must not forget that the application of sustainability principles for food security and environmental preservation is no less important (Lwesya & Achanta, 2022). During the COVID-19 pandemic, stakeholders learned valuable lessons to minimize supply chain disruptions and improve sustainable farming practices (Ngetich et al., 2022). Therefore, exploration with the GSCM bibliometric approach serves as a foundation for future research so that agricultural technology, sustainability, and agricultural green supply chains can be integrated simultaneously.

Allaoui et al. (2018) It shows that a multi-purpose decision-making framework can optimize the flow of the agro-food supply chain. This is based on sustainability practice indicators, such as carbon footprint and water footprint. Previous literature also emphasizes that a solid foundation is needed to integrate and implement sustainability, starting from economic and environmental sustainability, and not forgetting that social aspects are no less important, in order to improve the performance of agricultural supply chains over time (Mangla et al., 2018). Moreover, Touboulic and Walker (2015) examine from a theoretical perspective that drives the development of sustainable supply chain thematic research because it offers a promising future direction of research, by designing adaptive strategies that can adapt to the circumstances in the GSCM in order to face challenges in an uncertain environment and market.

Generally, the gap in research distance shows that it should require a cross-disciplinary approach that combines theory and practice in order to balance and align the two in GSCM. Using a bibliometric approach, this study aims to uncover some of the main themes that have not yet been explored and to find out the relationship between past research developments and predicting current trends as strategies for both academics, policymakers, and practitioners. Achieved little by little. Meanwhile, specifically, the purpose of bibliometric analysis is as follows: Knowing the structure of knowledge about GSCM in agriculture has reached a point where, with the help of co-citation analysis, predict future research directions of GSCM in agriculture by using co-word analysis, and this contributes to achieving a more sustainable and inclusive agricultural supply chain.

This paper is organized into sections that include an introduction, a section describing the bibliometric methods used, a section with the results (past and future trends in green supply chain research within the agricultural sector), and a discussion section that discusses the implications, limitations, and future research directions of this research.

Methodology

Bibliometric approach

Bibliometric analysis has recently become a popular way for researchers to review the academic literature in a given field and get an overview of the direction of research development in the past, present, and future (Donthu et al., 2021). Through this analysis, researchers will be able to map the landscape of the academic literature, so that they can identify the direction of development of a study, trending research topics, and gaps in previous research can be comprehensively mapped (Zupic & Čater, 2015). In addition, Tozzi et al. (2023) highlight how bibliometric analysis can identify and show trends that will emerge on several topics in a scientific field, so it is very useful to contribute to the evolution of research in a field. Two types of bibliometric analysis were conducted for this study, which were done together as per the two main objectives that have been formulated.

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Co-citation analysis is used to map the relationships between documents, authors, or journals that are often referred to together, in order to explore the theoretical basis and intellectual development of a field (Shiau et al., 2023). This analysis assesses relevance based on the frequency of joint citations, revealing influential research and thematic groups, although it tends to highlight the most cited works so that new or specific studies are potentially overlooked. In this study, co-citation analysis was conducted using the cited references from the Web of Science database. This analysis identifies publications that are frequently cited together to reveal the main research themes and the intellectual structure of GSCM research in agriculture. The resulting clusters represent groups of studies with similar research interests.

Co-word analysis will provide the evolution and potential direction of the research topic by calculating how often keywords appear in publications (Donthu et al., 2021). In co-word analysis, it will be seen that words that appear together can be related to the same concept. Based on keyword patterns, co-word analysis can be used to identify key themes as suggestions for recent research, as well as to describe how an inter-concept may relate over time, so that it can be useful for predicting future research trends (Callon et al., 1983). Co-word analysis was conducted using author keywords to examine the relationships among frequently used terms. Related keywords were grouped into clusters using VOSviewer to identify emerging research themes and future research directions in GSCM within the agricultural sector.

To support this analysis, VOSviewer is used for its ease of presenting powerful visualizations and its ability to handle large amounts of data. This is very helpful in visually representing bibliometric networks, such as co-citation analysis to explore past research and co-word analysis, to predict future research directions (van Eck & Waltman, 2010). All the convenience of VOSviewer, as well as supporting databases from WoS and supporting large-scale analysis, makes it one of the advantages over other software (van Eck & Waltman, 2014). Through these various conveniences, VOSviewer excels in accommodating various types of bibliometric analysis, as well as the co-citation and co-word analysis used in this study (Donthu et al., 2021; van Eck & Waltman, 2017).

Searching Strategy and Data Collection Procedure

A search of the WoS database was conducted on July 15, 2025, which is considered the most comprehensive and authoritative source of scientific datasets with over 74.8 million records covering 254 disciplines (Singh et al., 2021). It has been used in bibliometric studies to confirm the quality of publications (Fauzi, 2024). This is the main keyword used in this study, which was then expanded using synonyms, related terms, and their variations. From these keywords, the following search strings are used to retrieve metadata from the database: TI=((“green supply chain*" OR "sustainable supply chain*" OR "eco-friend* supply chain*" OR "environment* supply chain*" OR "green logistic*" OR "sustainable logistic*" OR "circular supply chain*" OR "low-carbon supply chain*" OR "closed-loop supply chain*" OR "clean supply chain*") AND (agricultur* OR farm* OR agribusiness* OR "food production" OR "crop production" OR "agricultural sector*" OR "agricultural supply chain*" OR "sustainable agriculture" OR "precision agriculture" OR agro-industr*)). This search string was applied for searching in the fields of titles, abstracts, and keywords.

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Results and Discussion

Descriptive Analysis

Zhu and Liu (2020) highlighted that WoS offers extensive coverage over the years, while Chirici (2012) noting its wide-ranging information across multiple disciplines. Consequently, Zyoud et al. (2017) contends that WoS encompasses the most credible and high-impact scientific research. Based on the search results of the WoS database, 381 documents were found with a total of 11,558 citations, of which 11,263 were from other sources (not the citations themselves). The average citation per document is 30.34, and the H-index value is 57. Publication data from 2007 to July 15, 2025, which shows a significant increase in the number of articles in recent years, as shown in Figure 1. This is certainly relevant with the global attention shown to sustainability, food security, and digitalization issues in the agricultural sector, which is increasing. The increase in this publication reflects the high interest from academics and practitioners in the topic of GSCM. The high number of citations also indicates that this topic is relevant and often used as a reference.

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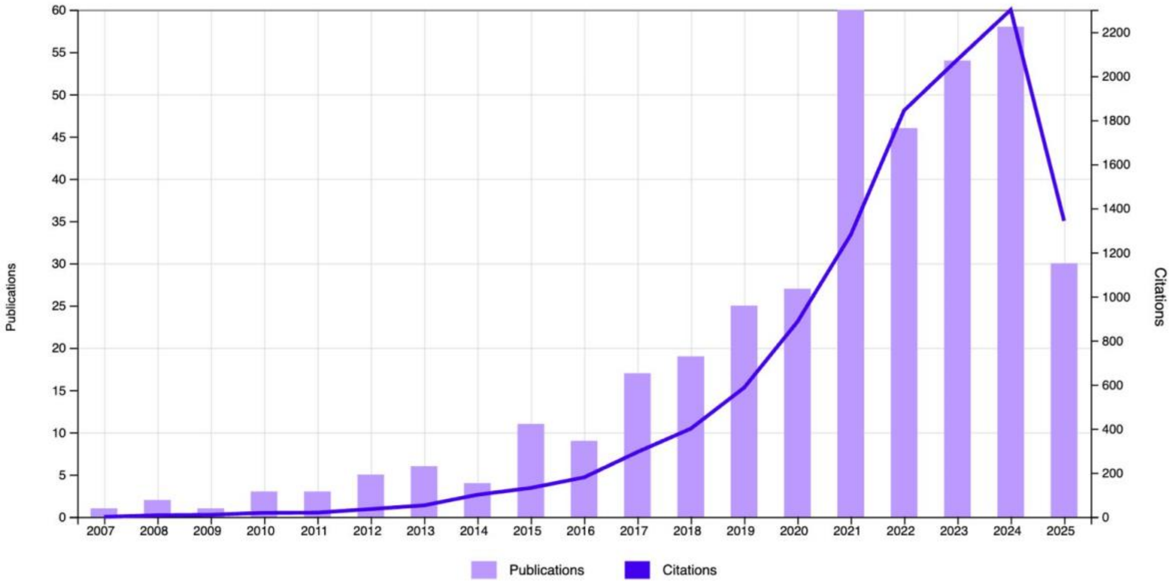

Figure 1. Number of publications and citations on green supply chain agriculture in the WoS database retrieved on 15 July 2025

Co-citation Analysis

Of the 381 main documents in the co-citation analysis, 50 publications with a minimum of nine citations were identified. Determining the right citation threshold is important for accurate mapping of the scientific landscape. Thresholds that are too high can overlook significant research groups, while thresholds that are too low risk result in recurring or less relevant themes (Geng et al., 2020). Therefore, the number nine was chosen to maintain thematic strength while ensuring a clear separation of clusters.

Co-citation analysis is calculated by how much two documents have been cited together. In bibliometric analysis, Total Link Strength (TLS) will represent the strength of a document in terms of how strongly it is connected to the network (Zupic & Čater, 2014). The analysis results identified the top three documents with the highest TLS as Cheraghalipour et al. (2019) at 162, Cheraghalipour et al. (2018) at 148, and Salehi-Amiri et al. (2021) at 138, as summarized in Table 1. The VOSviewer network visualization (Figure 2) reveals four clusters, as identified by thematic interpretations of key articles as listed in Table 2.

Table 1. Top 10 documents with the highest co-citation and total link strength

Ranking	Publication	No. of citations	Total Link Strength
1	Cheraghalipour et al. (2019) : Designing and solving a bi-level model for rice supply chain using the evolutionary algorithms	19	162
2	Cheraghalipour et al. (2018) : A bi-objective optimization for citrus closed-loop supply chain using Pareto-based algorithms	18	148
3	Salehi-Amiri et al. (2021) : Designing a sustainable closed-loop supply chain network for walnut industry	14	138
4	Banasik et al. (2017) : Closing loops in agricultural supply chains using multi-objective optimization: A case study of an industrial mushroom supply chain	16	120
5	Ahumada and Villalobos (2009) : Application of planning models in the agri-food supply chain: A review	17	112
6	Motevalli-Taher et al. (2020) : Wheat sustainable supply chain network design with forecasted demand by simulation	12	107
7	Liao et al. (2020) : Designing a closed-loop supply chain network for citrus fruits crates considering environmental and economic issues	10	101
8	Kamble et al. (2020) : Modeling the blockchain enabled traceability in agriculture supply chain	14	98
9	Saberi et al. (2019) : Blockchain technology and its relationships to sustainable supply chain management	18	98
10	Salehi-Amiri et al. (2022) : Designing a Closed-loop Supply Chain Network Considering Social Factors; A Case Study on Avocado Industry	10	97

Source(s): Created by authors based on VOSviewer and bibliometric metadata

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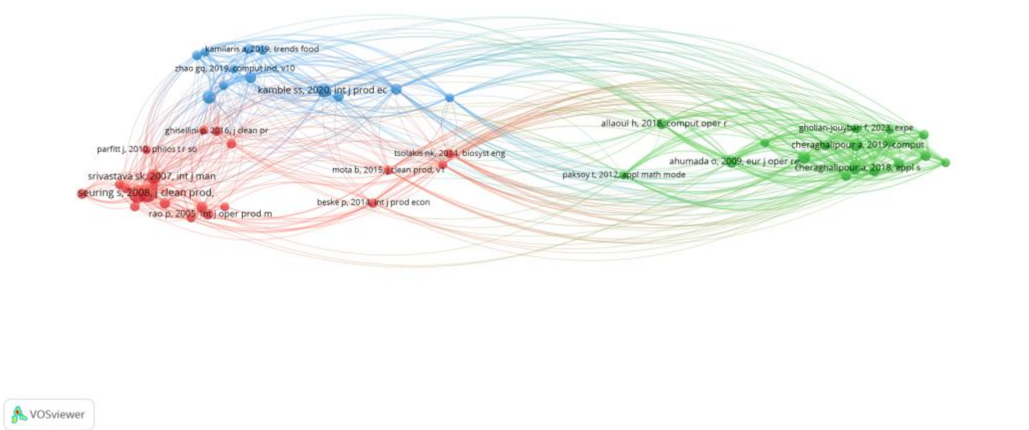

Figure 2
Network visualization of co-citation analysis output
Source(s): Created by authors based on VOSviewer and bibliometric metadata

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Table 2. *Co-citation analysis on the green supply chain in agriculture*

Cluster No and color	Representative publication	Number of publications	Cluster label
1 (Red)	Carter and Rogers (2008), Seuring and Müller (2008), Rao and Holt (2005), Srivastava (2007), Ghisellini et al. (2016), Parfitt et al. (2010), Shukla and Jharkharia (2013), Beske et al. (2014), Genovese et al. (2017), Mota et al. (2015), Touboulic and Walker (2015), Tsolakis et al. (2014), Carter and Liane Easton (2011), Diabat and Govindan (2011), Pagell and Shevchenko (2014)	21	Circular Economy (CE) Integration in Sustainable Supply Chain Management (SSCM)
2 (Green)	Ahumada and Villalobos (2009), Allaoui et al. (2018), Banasik et al. (2017), Farooque et al. (2019), Borodin et al. (2016), Cheraghalipour et al. (2018), Cheraghalipour et al. (2019), Chouhan et al. (2021), Salehi-Amiri et al. (2022), Bai and Sarkis (2020), Gilani and Sahebi (2021)	17	Sustainable and Green Agri-food Supply Chain Design
3 (Blue)	Kshetri (2018), Saberi et al. (2019), Bai and Sarkis (2020), Kamilaris et al. (2019), Zhao et al. (2019), Kamble et al. (2020), Kouhizadeh et al. (2021), Esmaeilian et al. (2020), Mangla et al. (2018)	12	Blockchain Technology in Supply Chain Management

Source(s): Created by authors based on VOSviewer and bibliometric metadata

Cluster 1 (Red): Circular Economy (CE) Integration in Sustainable Supply Chain Management (SSCM)

Comprising 21 publications, this cluster focuses on the CE SSCM and the shift from a linear to a regenerative and resource-efficient model. Preliminary studies have established a theoretical foundation for the integration of environmental, social, and economic dimensions into SSCM (Carter and Rogers, 2008 (Carter & Rogers, 2008; Seuring & Müller, 2008). The essence of CE is that sustainability goals are integrated into operational strategies. It has been demonstrated that green supply chain initiatives lead to enhanced economic performance (Ghisellini et al., 2016; Rao & Holt, 2005; Srivastava, 2007). Parfitt et al. (2010) found the point of food waste critical in the context of food and provided a solution to the problem via surplus redistribution and the use of by-products in accordance with the CE strategy. Agricultural supply chains face challenges such as perishable commodities, seasonality, and logistical complexity, but can still be addressed through a CE-based SSCM approach (Shukla & Jharkharia, 2013).

In addition, there is also evidence that encourages organizational adaptability and innovation (Genovese et al., 2017), as well as the implementation of circular practices such as remanufacturing, recycling of commodities that still have added value, and product service systems (Beske et al., 2014). Mota et al. (2015) and Touboulic and Walker (2015) integrating economic, environmental, and social aspects to demonstrate the holistic nature of CE in SSCM. In contrast, several kinds of resource-based theoretical frameworks for institutional theory have been identified to explain the drivers and barriers to adopting and adapting CE. Tsolakis et al. (2014) and Carter and Liane Easton (2011) have a more systemic parallel view of the evolution of SSCM, where strategies such as local sourcing, modular processing, and utilization of residual waste that can still be used are prioritized. Diabat and Govindan (2011) demonstrate regulatory pressures, stakeholder engagement, and even potential cost efficiencies of implementing CE in SSCM. Gradual improvement is no longer enough; nowadays, the times show that significant innovation and a redesign of the supply chain are indispensable (Pagell & Shevchenko, 2014). CE is a paradigm shift that shifts the relationship between the old economic and environmental systems to sustainable agriculture (Ghisellini et al., 2016).

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Cluster 2 (Green): Sustainable and Green Agri-food Supply Chain Design

The cluster contains 17 publications, with a focus on sustainable and green agri-food supply chain design, highlighting the need for different supply chain designs to address the unique characteristics of agricultural commodities, including perishability, seasonality, and demand fluctuations (Ahumada & Villalobos, 2009). The stochastic model developed is, of course, to improve the resilience of the supply chain, overcome the uncertainty of production variability, which is basically caused by climatic, market, and logistical factors (Borodin et al., 2016). So that with this model combined with metaheuristic algorithms, it can solve complex problems in the supply chain of oranges, rice, and sugarcane (Cheraghalipour et al., 2018, 2019; Chouhan et al., 2021)

Allaoui et al. (2018) proposed a decision-making model that reconciles the competing objectives, such as in the hybrid multi-goal approach used to balance cost efficiency with environmental performance. Farooque et al. (2019), who reviewed circular supply chain management as an integrated approach to achieve economic and environmental objectives throughout the food value chain. In addition to environmental considerations, Salehi-Amiri et al. (2022) the social dimensions of the supply chain design include community welfare and fair labor. The examples of green supply chain designs for pistachios, wheat, and walnuts show the versatility of the sustainable supply chain frameworks (Gilani & Sahebi, 2021).

Cluster 3 (Blue): Blockchain Technology in Supply Chain Management

This cluster, made up of 12 publications, focuses on the role of blockchain technology in supply chain management. Kshetri (2018) said blockchain supports the purpose of supply chains by increasing information exchange, lowering transaction costs, preventing fraud, and strengthening efficiency, social, and environmental accountability. Saberi et al. (2019) found that blockchain supports SSCM through higher data integrity, enables verification of sustainable practices, and increases stakeholder trust. Bai and Sarkis (2020) added with a technology assessment model to evaluate blockchain's contribution to transparency and sustainability, particularly in reducing information asymmetry.

Blockchain applications for agriculture and food are rapidly growing for tracing the origin of products, ensuring food safety, and verifying fair trade (Kamilaris et al., 2019). For example, Zhao et al. (2019) identify applications in reducing product counterfeiting, inefficiencies in logistics, and limited visibility in the supply chain. Kamble et al. (2020) Blockchain is also viewed as an enabler of data-driven agricultural supply chains to align with digital transformation and to enhance sustainable performance and decision-making under uncertainty. The barriers to adoption are high costs, interoperability issues, and resistance to change (Kouhizadeh et al., 2021). Esmaeilian et al. (2020) This requires strong governance and cross-industry collaboration. And top management support, technological readiness, and collaboration networks are also determinants of success, thus confirming that blockchain integration is socio-technical in nature (Mangla et al., 2018).

To provide an overall view of the co-citation findings, Figure 3 illustrates the evolution of the intellectual foundations of GSCM in agriculture. Figure 3 shows that GSCM research in agriculture has evolved from sustainability and circular economy concepts to agricultural supply chain optimization, and more recently toward digital-enabled GSCM through

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technologies such as blockchain, traceability, and transparency. This evolution reflects the growing emphasis on improving supply chain efficiency, resilience, and sustainability.

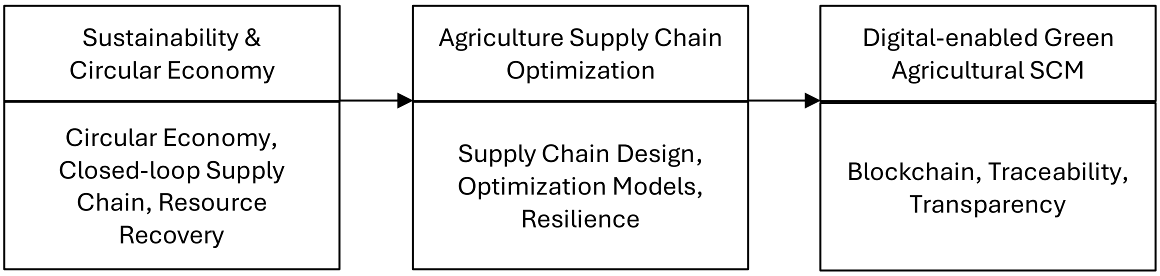

Figure 3. Evolution of the Intellectual Foundation of GSCM in Agriculture
Source(s): Created by authors

Co-word Analysis

Co-word analysis is carried out on the WoS database to determine which keywords appear most frequently in the literature. This refers to Geng et al. (2020) different threshold values being tested to avoid having too many irrelevant clusters or too few, so that new themes are overlooked. Of the total 2,063 keywords, 60 met the threshold of nine occurrences and formed four clusters. This threshold value was chosen after some experimentation, as this value resulted in the strongest network structure that best identifies important research areas while excluding less relevant terms. The top 15 keywords are Management (82), Sustainability (82), Model (52), and Performance (51), as shown in Table 3. Subsequently, Figure 4 presents the network structure of the four clusters, and Table 4 summarizes each cluster with labels, the number of keywords, and representative keywords.

Table 3. Top 15 keywords in the co-word analysis green supply chain in agriculture

Rank	Keyword	Occurrences	Total Link strength
1	Management	82	306
2	Sustainability	82	299
3	Model	52	185
4	Performance	51	187
5	Framework	46	195
6	Sustainable supply chain	43	140
7	Optimization	38	141
8	Impact	35	133
9	Supply chain management	34	140
10	Circular economy	32	139
11	Supply chain	29	92
12	Systems	27	101
13	Design	26	100
14	Agriculture	25	99
15	Green supply chain	24	55

Source(s): Created by authors based on VOSviewer and bibliometric metadata
Note: Sorted based on number of occurrences.

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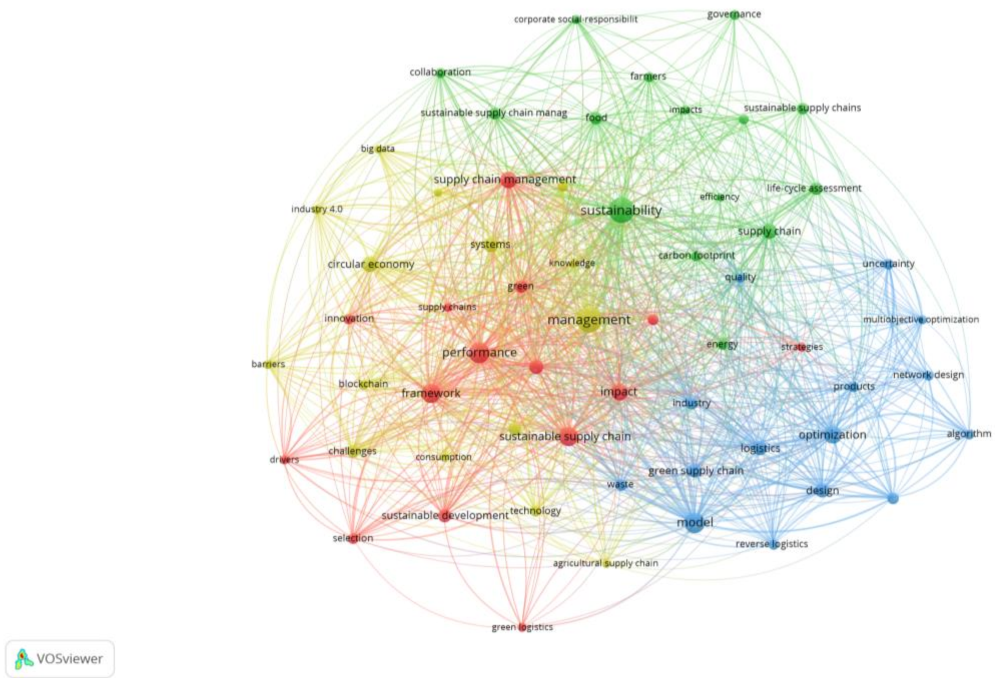

Figure 4. Co-word analysis on green supply chain agriculture
Source(s): Created by authors based on VOSviewer and bibliometric metadata

Table 4. Summary of co-word analysis on green supply chain in agriculture

Cluster No and color	Representative keywords	No. of keywords	Cluster label
1 (red)	Agriculture, drivers, food supply chain, framework, green logistics, impact, innovation, performance, strategies, sustainable development, sustainable supply chain	15	Green Logistics and Sustainable Food Supply Chains
2 (green)	Carbon footprint, collaboration, corporate social-responsibility, efficiency, energy, farmers, food, governance, impacts, life cycle assessment, supply chain, sustainability	15	Integrated Governance and Sustainability Assessment for Low-Carbon Agri-Supply Chains
3 (blue)	Algorithm, closed-loop supply chain, design, green supply chain, industry, model, multiobjective optimization, network design, optimization, quality, reverse logistics, uncertainty, waste	15	Smart Optimization and Circular Supply Chain Systems
4 (yellow)	Agricultural supply chain, barriers, big data, blockchain, challenges, circular economy, consumption, food waste, future, industry 4.0, knowledge, management, system, technology	15	Digital Innovation and Implementation Challenges in Green Agri-SCM

Source(s): Created by authors based on VOSviewer and bibliometric metadata

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Cluster 1 (Red): Green Logistics and Sustainable Food Supply Chains

This cluster of 15 keywords predicted that future research in the supply chain agriculture will concentrate on green logistics and the sustainable food supply chains, which has been a major concern in recent years as global environmental awareness in the agricultural sector has grown. Green logistics encompasses approaches to minimizing the environmental footprint of logistics operations, and sustainable food supply chains are designed to align with ecological boundaries; hence, the adoption of GSCM in agriculture is more pressing to minimize the environmental footprint and maintain sustainable production practices (Arjuna et al., 2022; Endyanti et al., 2021).

The implementation of GSCM has been proven to bring various benefits, ranging from increased operational efficiency to improved environmental performance, which at the same time also increases. Companies that implement more mature GSCM practices are likely to result in better environmental performance (Endyanti et al., 2021). Green procurement, waste reduction, and eco-friendly design have also become solutions in strengthening agricultural logistics performance (Arjuna et al., 2022). On the other hand, GSCM will also improve resource optimization and sustainable profitability. Structured and systematic green logistics will facilitate a more effective distribution of agricultural products, especially in the context of CE principles with reduction, reuse, and recycling (Ni et al., 2019).

Today's technology has also opened new opportunities. As is the case with blockchain, which is highly beneficial in increasing transparency, simplifying supply chain flows, and strengthening the practice of blockchain (Sharabati, 2021). Global trends clearly show the need to align logistics with sustainable production (Habib et al., 2021). In addition to being an efficiency solution, GSCM is also a market strategy to create value-added and strengthen the company's social image (Habib et al., 2021; Yang et al., 2019).

Cluster 2 (Green): Integrated Governance and Sustainability Assessment for Low-Carbon Agri-Supply Chains

The cluster consists of 15 keywords, with a focus on integrated governance and sustainability assessment for low-carbon agri-supply chains. This then shows that the relationship between governance and sustainability assessments in the low-carbon agricultural supply chain is increasingly important as the Earth strives for carbon neutrality. This systemic framework is useful as a direction for agricultural practices to be more efficient, productive, and environmentally friendly in the future. The reason for this transformation lies in GSCM, which seeks to integrate environmental factors into the supply chain, including idea design of product, lifecycle management, and waste reduction, as well as maximizing resource efficiency (Habib et al., 2021; Xu et al., 2022).

GSCM can mitigate high greenhouse gas emissions in the agricultural sector (Arjuna et al., 2022). Therefore, sustainability assessments should include ecological and governance dimensions that emphasize cooperation between producers, suppliers, and consumers (Novitasari et al., 2022). Stakeholders need to maintain discipline towards mechanisms and regulations to remain consistent with GSCM implementation (Cao et al., 2024).

Future research should start thinking about and finding solutions to efforts on how digital technology and green innovation can further improve the GSCM framework (Hou, 2022; Zhang, 2023). GSCM serves as an important strategy to face global environmental challenges, already an environmental advantage, but the Company's reputation and competitiveness will also improve if this GSCM is integrated into an environmental sustainability strategy (Habib et al., 2021; Xu et al., 2022).

Cluster 3 (Blue): Smart Optimization and Circular Supply Chain Systems

Based on the 15 keywords in this cluster, agricultural supply chain research will focus on smart optimization and circular supply chain systems. Intelligent optimization and circular supply chain systems (CSCS) are a significant leap in supply chain management, especially in the agricultural sector. One of the smart optimizations is the application of advanced technologies, such as IoT, blockchain, and big data analytics, to improve the efficiency and sustainability of circular supply chains that focus on resource recycling. Recent studies also present that smart technology improves the robustness and resilience of circular supply chains. They note that good supply chain management can be a solution to environmental problems (Angelis et al., 2018; Sahoo et al., 2022). They noted that good supply chain management can address environmental issues such as the reuse of resources (Angelis et al., 2018). Bressanelli et al. (2018) highlighted that CE will bring economic and environmental benefits without the need for vertical integration, thereby creating more opportunities for farmers.

Smart technology certainly also increases important aspects in building public trust in meeting regulatory standards, namely reliability and transparency (Arena et al., 2019). Saberi et al. (2019) emphasizing that blockchain can address inefficiencies while smoothing the flow of the supply chain to make it more transparent. In addition, the integration of big data with a circular approach will support better decision-making so that operational performance also improves (Giudice et al., 2020). Future research should examine more technology improvements and collaboration between organizations to create more efficient and sustainable agricultural supply chains (Montag et al., 2021).

Cluster 4 (Yellow): Digital Innovation and Implementation Challenges in Green Agri-SCM

A cluster of 15 keywords shows that future research in agricultural supply chains focuses on digital innovation and implementation challenges in green agri-SCM. Digital innovations have proven to be effective in driving environmental sustainability in terms of the agricultural supply chain, as the use of data analytics, IoT, and blockchain will help increase resource efficiency and process transparency that supports GSCM in reducing waste and carbon emissions while improving operational efficiency and further emphasizing the need for engagement with suppliers to achieve greener practices, that can be achieved through digital platforms (Deng et al., 2021; Wang et al., 2024; Zhang, 2023). Kim and Chai (2017) further stress the need for engagement with suppliers to achieve greener practices, which can be enhanced through digital platforms.

Despite the promise and prospects, the adoption of digital innovation faces serious obstacles. Sarin and Srivastava (2024) identifying the limitations of understanding green technology and the high cost of implementation make it a major obstacle in the implementation of GSCM. On the other hand, Shamsuddin (2017) states that while standards like ISO 14000 can be a first step, the process towards sustainability must be gradual due to its complexity. Financial institution support is essential, as access to financing can help farmers invest in the green technologies needed (Xia et al., 2022; Yi et al., 2021). This finding aligns with previous research demonstrating that digital technologies help organizations improve decision-making and performance, thereby facilitating more sustainable supply chain management practices (Adeyemi, 2026). Furthermore, this finding is consistent with previous bibliometric studies emphasizing the increasing role of technological innovation in supporting sustainability research and practice (Santoso & Syukri, 2025).

Future research is on how to leverage new technologies to improve supply chain operations that can support the social and economic aspects of this gradual change. Frameworks should be leveraged to link challenges in implementation and map their social impact (Iqbal et al.,

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2024; Qi et al., 2024). The combination of digital innovation and green practices can help accelerate the transition to more sustainable agriculture around the world.

Implications

Theoretical Implications

This bibliometric study expands the mapping of the theoretical foundations of GSCM in the agricultural sector by combining sustainability practices with robust theoretical frameworks, such as the resource-based view (RBV). Empirical results show that the ability of the environment to process waste into value-added products, the application of green logistics, and the use of closed-loop systems play a role as a strategy for optimizing resources, increasing competitiveness, and also strengthening sustainability (Agyabeng-Mensah et al., 2020). Furthermore, the CE paradigm emphasizes a circulation system that is able to encourage resilience and resource efficiency (Bressanelli et al., 2018; Geissdoerfer et al., 2017). This is also in line with the dynamic concept of sustainability, where organizations are required to be able to respond to environmental uncertainties and disturbances, especially in agriculture, which is prone to climate risks and perishable commodities (Jing et al., 2023; Liu et al., 2024).

Furthermore, this study enriches the perspectives and theories of stakeholders that cross-sectoral policies and collaboration are key factors in the adoption of GSCM. Pressures on regulations, social demands, and imitation practices encourage agribusinesses to integrate eco-friendly practices, so multi-stakeholder engagement is essential in creating sustainable food systems (Touboulic & Walker, 2015). On the other hand, the deployment of digital innovations such as blockchain, IoT, and big data is in line with the technology organization's (TOE) environmental framework, which focuses on technological reliability, management's commitment within the organization (Saberi et al., 2019; Sahoo et al., 2022). Placing GSCM in the context of the Triple Bottom Line (TBL) supports the argument that the next generation of agricultural supply chains must be sustainable and viable both economically and socially viable (Singh & Srivastava, 2022; Wu et al., 2023).

Practical Implications

The development of the GSCM landscape offers an opportunity for academics to expand theoretical frameworks related to the sustainability and resilience of the supply chain. Jing et al. (2023) highlight the need to measure the resilience of agricultural products in green supply chains, as managed environmental sustainability can contribute to stronger supply chain efficiency. Liu (2019) also revealed that leadership characteristics, such as age and education, influence the adoption of GSCM practices, which provides opportunities for further research in sustainability initiatives. Operational efficiency and the outcome of its impact on the environment can be assessed based on a framework, such as the supply chain operations reference model (SCOR) model (Fu et al., 2024).

As for practitioners, the application of GSCM not only has ethical value but also serves as a competitive differentiator. Companies that can take advantage of agricultural supply chain financing schemes can overcome capital constraints that hinder the transition to sustainable practices (Xia et al., 2022). These changes are not only in line with consumers' preference for the assumption of environmentally friendly products, but also have the potential to increase profitability and market position.

The implications for policymakers are that the design of regulatory frameworks, incentive programs, and the design of effective green credit and subsidies policies can encourage investment in green supply chain initiatives (Deng et al., 2021; Wang et al., 2024), and then supported by the role of institutions to create a supportive ecosystem in guiding agricultural practices towards sustainability goals (Wu et al., 2023). Taghikhah et al. (2021) It also notes that this systemic approach can improve biodiversity and soil fertility, and thus requires regulatory support to foster organic farming practices.

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Gaps

One of the key gaps is the need for a decision-making framework that is able to effectively integrate the TBL principle into agricultural operations. Singh and Srivastava (2021) emphasizes the need for tools and schemes that support structured decision-making to manage the interconnectedness of environmental, economic, and social factors in the GSCM, which simultaneously notes the lack of research reviewing the effects of these policies. Another gap is the current understanding of the resilience of agricultural value chains in developing countries. Liu et al. (2024) pointed out that low-carbon agricultural supply chains are subject to supply uncertainty, and risk management related to supply uncertainty is key to the implementation of low-carbon agricultural supply chains, but the literature on risk management in GSCM is still limited, and there is a research gap on the relationship between agricultural supply chains and climate change. Guo (2023) also identifies the complex reciprocal relationships between climate change and agricultural practices and their impacts, and the need for a multidimensional approach to address this condition, including the use of environmentally friendly innovations and technologies. Wang et al. (2023) noted that digital platforms play an important role in sustainable agro-food supply chains, but the current framework is not sufficient to deal with the operational complexity of this transition.

Limitations and Suggestions for Future Research

This research contributes to the study of GSCM in the agricultural sector from a bibliometric analysis perspective. However, it has some limitations as it solely depends on the data of the WoS database, which may not cover all relevant research from other reputable sources and can lead to selection bias and a lack of completeness. The role of public policy, institutional support, and implementation challenges in the rural agriculture sector has not been adequately addressed.

More research on how to empirically test theoretical models is needed, specifically to monitor, longitudinally, the adaptation process for agricultural companies as they adopt sustainable practices, and to supplement quantitative data with a mixed method that incorporates qualitative data to gain greater insights into consumer behavior. Conversely, the investigation of socio-economic aspects will play a key role in the evolution of sustainability discourse in the context of agricultural supply chains, with studies that include indicators of community welfare, labor conditions, and social justice expanding the understanding of the adoption of green supply chains. Further research should evaluate the role of advanced technologies, such as the IoT, in strengthening sustainable practices in the agricultural sector, so as to be able to create new solutions that are aligned with operational efficiency and environmental awareness.

Conclusion

This bibliometric review provides an evolving view of GSCM in the agricultural sector, and based on the co-citation analysis and co-word analysis, it identifies the research trends of past and future in the context of GSCM promotes supply chain optimization, which results in economic efficiency with environmental sustainability in mind. In addition, co-citation

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analysis identified three research themes that reflected past research trends, and co-word analysis identified four themes that guided future research directions for GSCM researchers in the agricultural sector.

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Corresponding Author

Shahreza Shauqi Ismail can be contacted at: ismail.shauqi06@gmail.com

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