Exploring research on sustainable performance in agriculture: A bibliometric perspective

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Abstract. This study presents a bibliometric analysis of research on sustainable performance in agriculture, based on 112 peer-reviewed articles published between 2007 and July 2025 in the Web of Science. Drawing on VOSviewer and Scimago Graphica, the analysis examines publication trends, countries, keyword co-occurrence, and future research directions. The results reveal steady growth in publication output since 2017, with citation activity peaking in 2024. China, the Netherlands, the United Kingdom, and Italy emerge as the top contributing countries. Keyword co-occurrence analysis uncovers four major thematic clusters: institutional frameworks, systems-based assessment tools, farm-level environmental strategies, and community-driven sustainability practices. The appearance of recent keywords such as industry 4.0, multi-criteria decision-making, and sustainable productivity signals a shift toward digital and data-informed approaches. Future research should build on these findings by integrating advanced technologies, broadening regional participation, and developing context-sensitive assessment models to further advance sustainable agricultural systems.

1 Introduction

In recent decades, the concept of sustainable performance has garnered increasing attention within the context of agricultural systems. Sustainable performance integrates environmental, economic, and social dimensions to ensure the long-term viability and resilience of food production, supply chains, and rural livelihoods [1]. Agriculture is increasingly confronted with challenges such as climate change, land degradation, and global food insecurity [2, 3]. Consequently, enhancing sustainable performance outcomes has become an urgent priority for both researchers and policymakers [4].

This growing interest has sparked a surge of interdisciplinary research on sustainable performance in agriculture [5]. These research encompasses a wide range of themes, including resource-efficient farming practices, sustainability assessment metrics, environmentally responsible agribusiness strategies, and rural development policies [6, 7]. However, despite the proliferation of research, the field still lacks a comprehensive and systematic overview. In particular, there is limited knowledge regarding the evolution of the

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field over time in terms of research focus, future research directions, knowledge structure, and geographical and institutional contributions. To address this gap, this study conducts a systematic bibliometric analysis of 112 peer-reviewed articles indexed in the Web of Science between 2007 and July 2025. Specifically, the study seeks to answer the following research questions, which are summarized in Table 1.

Table 1. Research questions.

RQ	Research Question
RQ1	What are the emerging trends in publication and citation in sustainable performance in agriculture from 2007 to July 2025?
RQ2	What are the most productive countries contributing to the field of sustainable performance in agriculture?
RQ3	What are the most frequent keywords, and what do these keywords reflect about the evolution of research on sustainable performance in agriculture?
RQ4	What are the key future research directions in the field of sustainable performance in agriculture?

The structure of the remaining sections is as follows. Section 2 describes the research methods and data sources. Section 3 presents the visualization results. Section 4 provides the conclusions. Section 5 highlights the study's contributions. and Section 6 discusses limitations and future research.

2 Research methods and data source

2.1 Research methods

This study employs a bibliometric analysis to systematically investigate the development process, keyword structure, and research trends in the field of sustainable performance research in agriculture [8]. Bibliometric analysis facilitates the quantitative evaluation of academic publications by uncovering intellectual patterns through network-based visualizations [9, 10]. It is particularly effective in identifying influential publications, mapping co-authorship structures, and detecting recurring keywords within a research field [11]. Two specialized tools, VOSviewer and Scimago Graphica, were employed in the analysis [12, 13]. Moreover, the literature selection process was designed to ensure methodological rigor and transparency by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework [14, 15].

2.2 Data source

The bibliometric dataset employed in this study was extracted from the Web of Science [16]. The database's multidisciplinary coverage, particularly in the fields of agriculture, environmental science, and sustainability studies, makes it a suitable and credible source for bibliometric research in the field of sustainable performance in agriculture [17, 18].

Literature was retrieved from the Web of Science database during the data acquisition phase using the search terms "agriculture" and "sustainab* performance". Following the application of all filtering criteria, the final dataset consisted of 112 publications, covering the period from 2007 to July 2025. Figure 1 provides a detailed overview of the screening and selection process in accordance with the PRISMA framework.

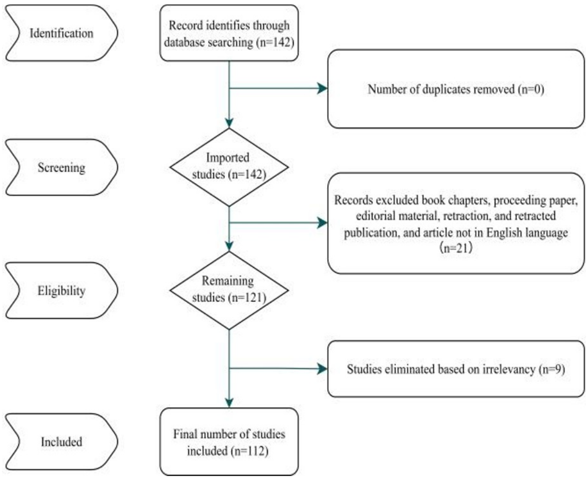

Fig. 1. PRISMA workflow showing the data acquisition process.

3 Results

3.1 Descriptive analysis

Figure 2 illustrates the annual distribution of publications and citations related to sustainable performance in agriculture from 2007 to July 2025. Research activity remained limited before 2016 but began to increase steadily from 2017, with a marked rise after 2019 and a peak of 17 publications in 2021. This upward trajectory may reflect growing global attention to agricultural sustainability and the emergence of performance-related policy frameworks. Citation counts followed a similar trend, reaching a peak in 2024. Although the 2025 data reflect only the first half of the year, both publication and citation levels remain relatively high, indicating sustained scholarly interest and ongoing citation momentum.

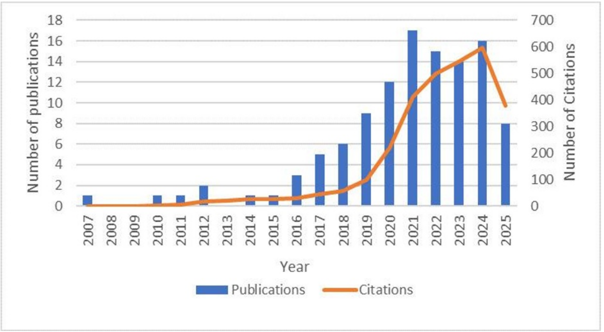

Fig. 2. Annual distribution of publications and citations (2007–July 2025).

Figure 3 illustrates the international collaboration network in the field of sustainable performance in agriculture. China emerges as the most productive country, contributing 15 publications, followed by the Netherlands (11), the United Kingdom (10), and Italy (10). These countries form the core of a dense global collaboration network, primarily concentrated in Europe and East Asia. This leading position likely reflects the presence of strong research infrastructures, long-standing national commitments to sustainability agendas, and active funding mechanisms in support of agricultural innovation.

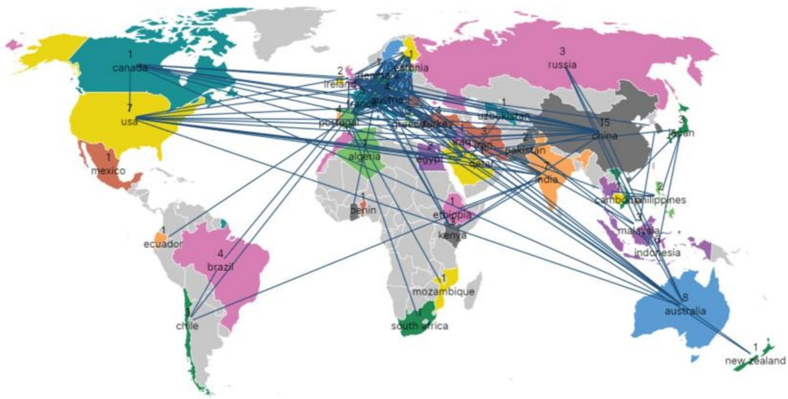

Fig. 3. International distribution of articles and co-authorship networks.

3.2 Analysis co-occurrence

In this study, a total of 640 keywords were extracted from the selected literature dataset. A minimum occurrence threshold of four was applied in order to enhance the clarity and relevance of the network visualization. This criterion was selected to strike a balance between network comprehensiveness and analytical interpretability, ensuring that only keywords with substantial topical relevance were retained. Based on this threshold, 70 keywords met the inclusion criteria and were included in the co-occurrence analysis. The resulting network comprises four distinct clusters, 923 interconnections, and a total link strength of 1,428, highlighting the structural relationships among frequently used terms.

The cluster analysis offers insights into the major research directions and thematic groupings within the field of sustainable performance in agriculture [19]. As shown in Fig. 4, the four keyword clusters represent distinct conceptual areas, each reflecting a specific research orientation. In the visualization, node size indicates keyword frequency, while different colours distinguish thematic clusters, thereby facilitating interpretation of the field's intellectual structure [20].

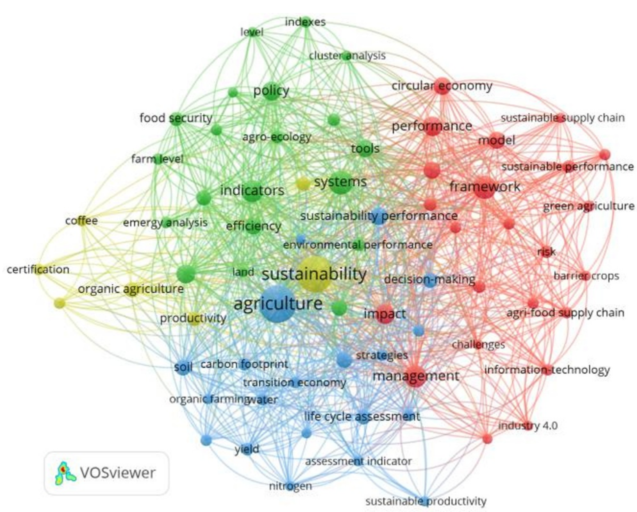

Fig. 4. Keyword co-occurrence network.

Table 2. Co-occurrence of keywords with VOSviewer.

Cluster	Items	Top 5 Keywords	Occurrences	Links	Total links strength	Topic
1 (red)	23	framework	17	43	96	Policy frameworks and performance management in sustainable agriculture
		management	16	48	99	
		impact	13	37	61	
		performance	13	36	64	
		circular economy	11	32	53	
2 (green)	20	systems	18	44	93	Sustainability assessment and system-level governance mechanisms
		indicators	16	46	92	
		policy	12	28	49	
		sustainability assessment	12	42	67	
		efficiency	10	27	40	
3 (blue)	20	agriculture	39	64	194	Sustainability and emission-oriented decision-making in farming
		sustainability performance	11	29	43	
		carbon emission	9	35	49	
		soil	9	37	52	
		decision-making	8	28	41	
4 (yellow)	7	sustainability	37	62	150	Organic agriculture, farmer cooperation, and sustainability standards
		organic agriculture	8	29	48	
		farmers cooperatives	7	30	39	
		productivity	7	22	30	
		safa guidelines	5	13	19	

Cluster 1, highlighted in red, comprises 23 keywords, including framework, management, performance, circular economy, and impact. This cluster reflects a strong emphasis on institutional and managerial approaches to agricultural sustainability. It underscores the role of strategic frameworks and performance models, which are often associated with circular economy principles, in shaping sustainable agricultural systems and supply chains. Cluster 2, shown in green, includes 20 keywords such as systems, indicators, policy, assessment, and efficiency. This cluster represents a systems-based approach that emphasizes sustainability assessment tools, policy mechanisms, and performance indicators for evaluating agricultural outcomes. It reflects efforts to quantify and guide sustainable practices through the use of structured evaluation frameworks. Cluster 3, displayed in blue, comprises 20 keywords, with key terms including agriculture, carbon emission, soil, decision-making, and sustainability performance. This cluster centers on farm-level practices and environmental outcomes, with a focus on the ecological and technical dimensions of sustainable agriculture, such as emissions reduction, soil management, and field-level decision-making. Cluster 4, represented in yellow, includes 7 keywords such as organic agriculture, farmers cooperatives, productivity, and Sustainability Assessment of Food and Agriculture systems (SAFA) guidelines. This cluster highlights community-based and smallholder-oriented sustainability practices. It particularly emphasizes approaches grounded in organic farming, local cooperation, and alignment with global sustainability frameworks such as the Food and

Agriculture Organization of the United Nations (FAO)'s SAFA guidelines. The details are shown in Table 2.

Figure 5 presents the overlay visualization of keyword co-occurrence, where node size represents keyword frequency and color indicates the average year of appearance. Central keywords such as sustainability, agriculture, environmental performance, and sustainability assessment appear in blue and green tones, indicating their foundational and sustained relevance within the field. These terms serve as conceptual anchors that connect various thematic directions. In contrast, emerging research trends are reflected in yellow-coloured keywords such as industry 4.0, innovation, multi-criteria decision-making, sustainable productivity, and transition economy, suggesting a recent shift toward digital technologies, performance optimization, and economic transitions in agriculture. The appearance of these topics highlights a progression from broad conceptual discourse to more applied, data-driven approaches to sustainable performance. This shift also signals the growing influence of digitalization and systems thinking in addressing sustainability challenges within agricultural systems.

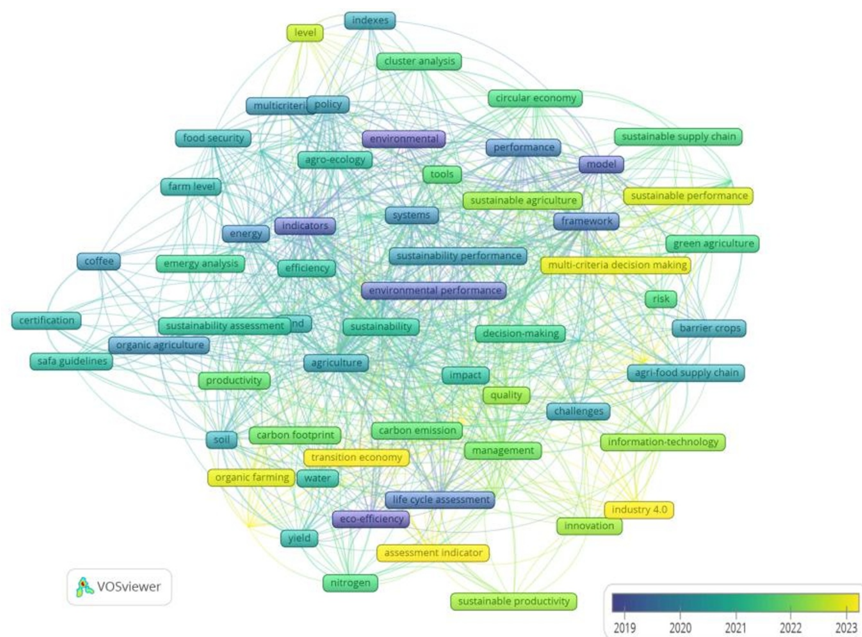

Fig. 5. Keyword co-occurrence overlay.

4 Conclusion

This study findings are summarized below and organized according to the four research questions.

RQ1: What are the emerging trends in publication and citation in sustainable performance in agriculture from 2007 to July 2025? The analysis of publication and citation trends reveals a clear upward trajectory in research on sustainable performance in agriculture, with a steady increase in publications beginning in 2017 and reaching a peak in 2021. Citation counts continued to rise, attaining highest level in 2024, which suggests a time-lagged but growing impact of earlier studies. This pattern reflects a transition from initial conceptual interest to more empirical and performance-oriented research. This shift has been driven by global sustainability agendas, the institutionalization of assessment frameworks, and the growing urgency of climate and food system challenges. The sustained growth in both publication volume and citation frequency indicates that sustainable performance has moved from the margins to become a central and dynamic focus within agricultural research.

RQ2: What are the most productive countries contributing to the field of sustainable performance in agriculture? At the national level, research output is concentrated in countries with established academic infrastructures and policy-driven sustainability agendas, with China and several European nations being the most prominent contributors. These countries also demonstrate strong co-authorship linkages, resulting in dense transnational research networks. Nevertheless, the dominance of Global North countries highlights a global inequality that limits the applicability of findings to developing country contexts. In contrast, contributions from regions facing diverse agricultural challenges, such as Sub-Saharan Africa, Southeast Asia, and Latin America, remain limited. This disparity reflects unequal access to research resources and suggests that widely adopted sustainability evaluation frameworks may fail to account for context-specific agricultural conditions. Bridging this gap through more inclusive knowledge production is essential to ensure the global relevance and practical applicability of sustainable performance research in agriculture.

RQ3: What are the most frequent keywords, and what do these keywords reveal about the evolution of research on sustainable performance in agriculture? The most frequent keywords such as sustainability, agriculture, systems, environmental performance, and assessment suggest that the field has developed around core concerns with measuring and improving sustainable outcomes in agricultural systems. The co-occurrence analysis identifies four major thematic clusters. These clusters collectively illustrate that the field is becoming increasingly multidimensional. However, the analysis also reveals an imbalance among environmental, economic, and social dimensions, with environmental aspects receiving more attention than social and economic ones. This imbalance may limit the comprehensiveness of sustainable agricultural practices. This development involves the integration of policy frameworks, quantitative assessment systems, practical management strategies, and local implementation efforts to advance both the evaluation and the application of sustainable performance in agriculture.

RQ4: What are the key future research directions in the field of sustainable performance in agriculture? Foundational concepts such as sustainability, agriculture, and environmental performance remain central to the field. At the same time, future research agenda centered on the integration of digital tools such as precision agriculture, big data analytics, and decision-support systems into sustainability evaluation frameworks. In addition, addressing the persistent underrepresentation of region-specific studies is essential. Future research should prioritize the development of localized assessment models that are tailored to the specific sustainability challenges faced by diverse agricultural systems, particularly in low- and middle-income countries.

5 Contributions

Theoretically, this study provides a structured overview of the literature on sustainable performance in agriculture, identifying four main topics: institutional and strategic management approaches; systems thinking and policy-oriented assessment tools; technical and ecological aspects of agricultural practices; and community-based sustainability models aligned with global standards. These topics reflect the field's evolution from conceptual exploration to more applied, interdisciplinary, and performance-driven research. In particular, the novelty of this study lies in highlighting the recent shift in research trends from traditional "green" agriculture toward smart and digital sustainable agriculture.

Practically, this study provides a structured reference for guiding future research development and publication strategies in the field of sustainable agricultural performance.

It identifies key contributing regions, and emerging thematic areas, thereby offering a foundation for advancing empirical inquiry and promoting more targeted, context-specific investigations. The increasing prominence of keywords related to digital innovation and performance evaluation further underscores the need to align research agendas with evolving technological capabilities and sustainability policy frameworks. Moreover, the findings can inform agricultural policies and support smallholder farmers in developing regions by promoting inclusive and context-sensitive digital solutions. In practice, these digital technologies can only be applied to a limited extent in smallholder farming—mainly through low-cost mobile tools or cooperative platforms—while high costs and technological dependency remain significant risks.

6 Limitation and future research

This study relied exclusively on keyword data retrieved from the Web of Science database. Although Web of Science is a reputable and widely used source of high-quality academic literature, reliance on a single database may limit the breadth and diversity of the research landscape captured. Moreover, potential keyword bias, limited time coverage, and the lack of triangulation with other methods should also be acknowledged. Future research could enhance the robustness of bibliometric analyses by incorporating data from additional platforms such as Scopus or CNKI, refining search strategies, and combining bibliometric mapping with qualitative approaches.

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