“A bibliometric analysis of research trends on the sustainable development of the agri-food industry and its impact on food security”

AUTHORS	Anar Abbasov Azer Gurbanzade

ARTICLE INFO	Anar Abbasov and Azer Gurbanzade (2025). A bibliometric analysis of research trends on the sustainable development of the agri-food industry and its impact on food security. *Environmental Economics*, *16*(2), 149-161. doi:10.21511/ee.16(2).2025.11
DOI	http://dx.doi.org/10.21511/ee.16(2).2025.11
RELEASED ON	Monday, 09 June 2025
RECEIVED ON	Thursday, 13 March 2025
ACCEPTED ON	Thursday, 29 May 2025

JOURNAL	"Environmental Economics"
ISSN PRINT	1998-6041
ISSN ONLINE	1998-605X
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
51	4	0

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Anar Abbasov (Azerbaijan), **Azer Gurbanzade** (Azerbaijan)

A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS ON THE SUSTAINABLE DEVELOPMENT OF THE AGRI-FOOD INDUSTRY AND ITS IMPACT ON FOOD SECURITY

Abstract

The sustainable development of the agri-food industry has become increasingly critical in the face of rising food insecurity, climate change, and recent global disruptions such as the COVID-19 pandemic and geopolitical conflicts. This study aims to perform a bibliometric analysis of global research concerning the sustainable development of the agri-food industry and its implications for food security across nations. Drawing on 1,704 Scopus-indexed publications from 1993 to the first quarter of 2025, the study identifies four distinct phases of research growth, ranging from an exploratory stage to a recent surge in interdisciplinary and technology-focused studies. Keyword co-occurrence analysis reveals five major thematic clusters: agri-food supply chains, environmental sustainability, public health and nutrition, technological and product innovation, and systemic food security. Thematic evolution demonstrates a clear progression from fragmented early research to integrated, systems-based approaches, with a growing emphasis on digital technologies (e.g., AI, blockchain, and IoT) and circular economy principles. Despite rapid thematic expansion, the study highlights ongoing gaps in connecting sustainability research to actionable food security strategies in low- and middle-income regions.

Keywords agri-food industry, sustainability, sustainable development, food security, food supply, biblioshiny

JEL Classification L66, Q18, F52, Q01, Q56

Received on: 13th of March, 2025
Accepted on: 29th of May, 2025
Published on: 9th of June, 2025

Anar Abbasov, Doctor of Economics, Professor, Department of Business Organisation and State and Municipal Management, Azerbaijan Cooperation University, Azerbaijan. (Corresponding author)

Azer Gurbanzade, Ph.D. in Economics, Associate Professor, Department of International Trade and Logistics, Azerbaijan Cooperation University, Azerbaijan.

Conflict of interest statement:
Author(s) reported no conflict of interest

INTRODUCTION

The agri-food industry constitutes a complex, multidimensional sector that encompasses activities from primary agricultural production to food processing, distribution, and consumption. It plays a crucial role in economic development and advancing environmental sustainability, public health, and social equity. In countries where agriculture often serves as a cornerstone of livelihoods and national economies, the sustainable development of agri-food systems is closely linked to food security, poverty reduction, and resilience against socio-economic and environmental shocks.

The relevance of this topic has become especially evident in the wake of recent global crises. The COVID-19 pandemic, for instance, severely disrupted global food systems through supply chain bottlenecks, labor shortages, and reduced access to inputs, leading to income instability, food loss, and heightened nutritional vulnerability (UNCTAD, 2020). These disruptions also exacerbated environmental degradation through increased methane emissions from decomposing waste. Furthermore, the Russia-Ukraine war has exposed the fragility of international grain and fertilizer supply chains, intensifying food insecurity in import-dependent regions.

In parallel, the world faces structural challenges related to rapid population growth and climate change. The global population is projected to reach 9.2 billion by 2050, with the majority of this increase expected to occur in Africa and Asia. To meet the rising food demand, estimated to grow by 59% to 102%, sustainable intensification of agri-food systems, efficient resource use, and equitable food distribution mechanisms are required (Elferink & Schierhorn, 2016; Fukase & Martin, 2020). Simultaneously, the magnitude of food waste, estimated at 2.5 billion tons annually, represents a critical inefficiency and a missed opportunity to combat hunger (WWF-UK, 2021).

Despite growing academic attention to sustainability, digital transformation, and food system resilience, the literature remains fragmented. Many studies focus narrowly on elements such as blockchain, waste management, or precision agriculture without integrating these into a broader, systems-based perspective that captures regional disparities, policy contexts, and socio-economic dimensions.

Given the increasing relevance of achieving sustainable and food-secure agri-food systems, there is a clear need to consolidate and critically assess global research trends. Bibliometric analysis can help identify dominant patterns, conceptual gaps, and emerging directions in the scholarly discourse, thereby informing more holistic research agendas and evidence-based policy development. This study contributes to bridging the gap between sustainability research and practical food security strategies by identifying how global scholarly trends can inform interventions in each country's context.

1. LITERATURE REVIEW

The sustainable development of the agri-food industry and its impact on food security have become increasingly important areas of academic inquiry. The literature in this field is diverse, ranging from conceptual explorations and review studies to bibliometric analyses and sector-specific investigations. A foundational distinction often made in the literature is between the broader "agri-food industry" and the narrower "food industry." The agri-food sector includes all components from agricultural input provision and primary production to processing, logistics, and retail (Doddapaneni & Kikas, 2021; Rizzut, 2022). In contrast, the food industry typically focuses on the processing and distributing of consumables (Saito, 2016; Santos et al., 2023). Clarifying this distinction is essential when evaluating sustainability across the entire value chain.

Several studies have used bibliometric or systematic literature reviews to map the intellectual structure of sustainability in agri-food systems. Agnusdei and Coluccia (2022) conducted a comprehensive bibliometric and content analysis on sustainable supply chains, identifying innovation, governance, and environmental impact as key research domains. Atashov et al. (2025) provide a bibliometric analysis of research related to government policies aimed at food security, particularly in the context of the Russia-Ukraine war and its impact on global supply chains. Şimşek et al. (2024) and Hroma (2024) offer targeted bibliometric studies on sustainability trends in the food industry and organic agriculture. Singh and Pandey (2023) systematically review how India addresses the Sustainable Development Goals (SDGs) through agri-food initiatives. Makarenko et al. (2022) investigated the transparency of sustainable development and the disclosure of SDGs 2 and 12, as well as their impact on the overall performance of Ukrainian agricultural companies. Guliyev et al. (2024) analyze factors affecting Ukraine's economic and food security under martial law, emphasizing budget flows and institutional challenges. Badea et al. (2023) add a geopolitical perspective by analyzing digitalization trends and their influence on food system performance. Elias et al. (2024) contribute to this area with a bibliometric review of agri-food and blockchain applications.

Multiple sources establish a strong connection between sustainable agri-food development and food security (Huzenko & Kononenko, 2024; Bilan et al., 2018). The literature highlights the role of climate change and demographic shifts as key drivers of food system vulnerabilities (Fukase & Martin, 2020). Benbekhti et al. (2024) and Juhászová et al.

http://dx.doi.org/10.21511/ee.16(2).2025.11

(2023) analyze specific national contexts, such as Algeria and Ukraine, where food security is linked to economic resilience and agricultural policy. Richardson (2024) explores how the COVID-19 pandemic disrupted food systems, emphasizing the importance of building resilience.

The issue of food loss and agri-food waste is widely addressed in both empirical and review studies. Prabakusuma et al. (2023) examine the valorization of agri-food waste for sustainable aquaculture. Sánchez-Teba et al. (2021) shifted the focus from waste quantification to waste management strategies. Doddapaneni and Kikas (2021) comprehensively review waste recovery technologies. These works collectively argue that improved efficiency and closed-loop systems are central to sustainability.

Digital transformation is a growing focus, primarily through the lens of Industry 4.0. Trevisan and Formentini (2024) and Morella et al. (2021) explore digital solutions for reducing food loss and enhancing traceability. Stoica et al. (2022), Rejeb et al. (2021, 2022), and Sklavos et al. (2022) analyze how technologies such as IoT, big data, and machine learning are reshaping agri-food systems. Hadouga (2023), Mursalov et al. (2023), and Zhou (2024) highlight the strategic importance of AI and digital tools in forecasting and decision-making. Blockchain technology has been widely recognized for its potential to improve transparency and traceability in agri-food supply chains (Steiner et al., 2024; Makarenko et al., 2024). Antonucci et al. (2019), Niknejad et al. (2021), Sugandh et al. (2023), and Elias et al. (2024) explore its applications and evolution. Kafi et al. (2023) focus on the role of blockchain before, during, and after the COVID-19 pandemic, presenting it as a resilience-enabling tool.

The governance dimension is critical in understanding system vulnerabilities. Studies on food fraud, like Bannor et al. (2023), reveal the systemic risks of weak regulation. Ray (2023) evaluates the sustainability of the U.S. Supplemental Nutrition Assistance Program, offering insights into how such large-scale public nutrition initiatives can serve as models for addressing food insecurity and policy design in countries where similar programs are often underfunded or structurally limited. Guemidi et al. (2024) present a digital policy solution for consumer goods regulation.

Integrating financial systems with agri-food sustainability has gained traction in recent years. NatureFinance (2021a, 2021b) presents detailed analyses of how finance can support the transition to sustainable food systems. Chater and Soussou (2023) examine how geopolitical crises influence financial volatility, indirectly affecting food security.

Finally, several studies address emerging subthemes and interdisciplinary intersections. Richardson (2023) explores the ecological benefits of beekeeping, while Morin (2025) critically examines the role of corporate interests in food and healthcare costs. These works reflect a broader shift toward integrating environmental, economic, and public health concerns.

The existing literature offers a rich yet fragmented view of the sustainable development of the agri-food industry. While considerable attention has been paid to individual components such as food waste, digitalization, and supply chain resilience, a comprehensive, systems-based perspective remains underdeveloped. Bibliometric methods provide a powerful means of consolidating this fragmented knowledge.

This study aims to perform a bibliometric analysis of global research concerning the sustainable development of the agri-food industry and its implications for food security across nations. It seeks to identify dominant themes, emerging areas of interest, and conceptual gaps to inform future scholarly and policy-oriented work.

2. METHODOLOGY

2.1. Data collection

The foundation of this bibliometric study rests on a comprehensive search and extraction of relevant scholarly publications from the Scopus database. In line with previous scholarly recommendations (Hyland & Zou, 2022; Sampagnaro, 2023), particular attention was given to titles, abstracts, and author keywords, which are crucial for conveying academic articles' thematic focus and conceptual intent.

Therefore, this study synonymously treated search terms extracted from article titles, abstracts, and keywords, ensuring a broader dataset. The ini-

tial search was conducted using a combination of Boolean operators with key phrases, including:

((TITLE-ABS-KEY("agri-food" AND "industr*" AND "eco") OR TITLE-ABS-KEY("agri-food" AND "industr*" AND "organic") OR TITLE-ABS-KEY("agri-food" AND "industr*" AND "bio") OR TITLE-ABS-KEY("agri-food" AND "industr*" AND "sustainable") OR TITLE-ABS-KEY("agri-food" AND "industr*" AND "sustainability") OR TITLE-ABS-KEY("agri-food" AND "industr*" AND "food supply") OR TITLE-ABS-KEY("agri-food" AND "industry" AND "food" AND "security")))

This search strategy yielded 2,112 documents.

No geographic filter was applied in the search criteria. Instead, a comprehensive approach was adopted by collecting literature that addressed sustainable agri-food industry development and food security across all regions. This choice reflects the global nature of food systems and recognizes that developed countries' policies, innovations, and disruptions can significantly impact food availability and stability across nations. For example, the Black Sea Grain Initiative during the Russia-Ukraine war showed how international coordination can help prevent famine in parts of Africa and the Middle East.

2.2. Data screening

To enhance the relevance and precision of the dataset, a series of inclusion and exclusion criteria were applied. First, regarding the type of publication, only peer-reviewed journal articles, conference papers, books, and book chapters were included; other document types, such as editorials or reports, were excluded. Second, no language restrictions were imposed; however, most results were in English due to Scopus indexing practices. Third, given the interdisciplinary nature of the topic, publications from all subject areas were considered. Finally, no temporal restrictions were applied; all documents indexed in Scopus during data extraction were eligible.

After applying these filters, the final dataset comprised 1,704 documents, the basis for the bibliometric analysis.

2.3. Bibliometric analysis

To analyze and visualize the structure of academic knowledge surrounding the sustainable development of the agri-food industry and its relationship to food security, a combination of bibliometric software tools was employed:

- Bibliometrix R package and Biblioshiny App – for conducting quantitative analysis, generating performance metrics, and mapping thematic evolution.
- Microsoft Excel – for data cleaning, tabulation, and additional descriptive analysis.

3. RESULTS

Although this analysis did not impose any temporal limitations, the critical importance of sustainable development in the agri-food industry and its connection to food security would have attracted consistent scholarly attention over time. However, bibliometric evidence indicates that the first relevant Scopus-indexed publication appeared only in 1993 (Hedley, 1993). That early work explored the evolving scope of agricultural economics, including themes such as human capital development, biotechnology, and environmental sustainability, indirectly touching upon the foundational issues of agri-food system development.

The publication trend over time reveals three distinct phases of scholarly engagement with the topic (see Figure 1). During 1993–1996, virtually no academic activity was recorded, indicating the nascent stage of academic discourse on the sustainable agri-food sector. From 1997 to 2020, a modest but steadily increasing trend in publication output was present, albeit with fluctuations. The exponential growth equation for this phase is $y = 0.5423e^{0.1834x}$, with a strong coefficient of determination (R^2 = 0.9814), indicating a gradually intensifying scholarly interest. During 2021–2024, a dramatic acceleration in publication activity occurred. The trend follows a steeper exponential curve ($y = 0.0426e^{0.2823x}$ with R^2 = 0.9962), reflecting the explosive growth in academic output on the topic. During the first quarter of 2025, the number of publications (355) has far exceeded previous years, suggesting continued momentum in the research field.

http://dx.doi.org/10.21511/ee.16(2).2025.11

This exponential increase, especially from 2021 onward, can be attributed to a convergence of major global events, policy commitments, and technological advancements. The adoption of the United Nations Sustainable Development Goals (SDGs) in 2015, particularly Goals 2 (Zero Hunger) and 12 (Responsible Consumption and Production), played a catalytic role in elevating the visibility of sustainable food systems in academic and policy discourse. The Paris Climate Agreement further underscored the urgency of climate-smart agriculture and sustainable food production systems.

Technological transformations, including the rise of blockchain, artificial intelligence, and IoT, have also energized research by offering novel solutions for transparency, efficiency, and resilience in food supply chains. The COVID-19 pandemic exposed systemic vulnerabilities, prompting scholars to investigate food system resilience, local supply chains, and emergency response strategies. Similarly, geopolitical disruptions, such as the Russia-Ukraine war and its impact on global grain and fertilizer flows, further emphasized the need for localized yet globally connected, sustainable agri-food systems.

These factors have collectively driven an unprecedented surge in multidisciplinary research and highlighted the global relevance of sustainable agri-food development in ensuring long-term food security.

The co-occurrence network reveals a well-connected thematic landscape in the research on sustainable agri-food systems. Five prominent keyword clusters are identified, each reflecting a distinct yet interconnected research focus.

Green Cluster (top, central) is the largest and most central Cluster, anchored by terms such as food supply, agri-food, supply chain, and food safety. It reflects the core of research concerned with the structure and logistics of food systems, technological integration, and risk management across supply chains. This Cluster emphasizes operational and governance-related approaches to ensuring sustainability and food security.

Blue Cluster (bottom-left) focused on themes such as nutrition, public health, human consumption, and agricultural practices. This Cluster addresses the human-centric and socio-economic dimen-

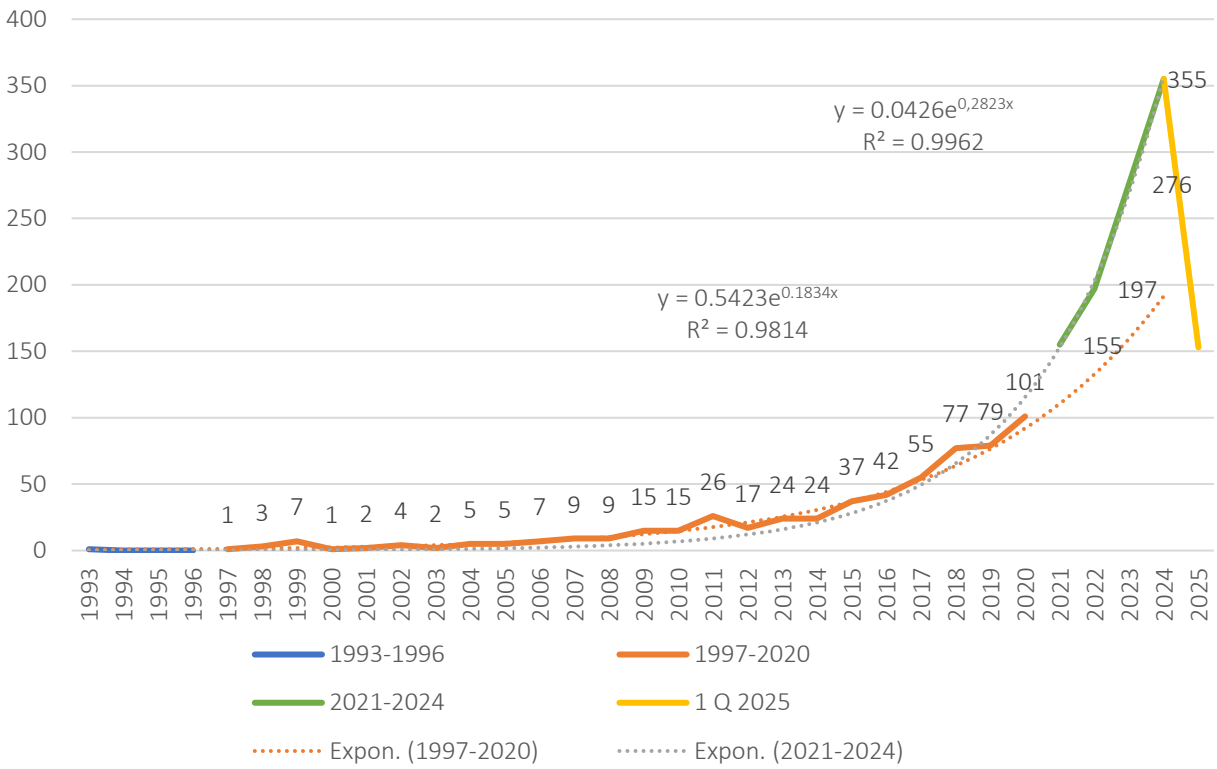

Figure 1. Dynamics of publications on sustainable development of the agri-food industry and its impact on food security/supply

sions of sustainable agri-food development. It reflects a growing body of work that ties sustainability directly to health, consumption behavior, and regional development policies.

Red Cluster (bottom-right), centered around keywords like climate change, greenhouse gases, bioenergy, carbon footprint, and waste management, captures the environmental and ecological discourse surrounding agri-food sustainability. It deals with pollution mitigation, circular economy strategies, and the broader climate implications of food production.

Purple Cluster (left side) is a smaller but distinct cluster emphasizing terms like dietary supplements, bio-based products, and consumer behavior. It reflects emerging intersections between biotechnology, food science, and market trends, highlighting innovation in sustainable product development and alternative food sources.

Grey Core Terms (center) include highly interconnected central terms, such as the food industry, sustainable development, and food security, that act as bridging nodes between clusters. Their positioning reflects their cross-cutting relevance across technological, environmental, and human systems.

The network structure indicates a high degree of interdisciplinarity and thematic convergence. The boundaries between clusters are porous, suggesting growing integration between technological innovation, environmental sustainability, and socioeconomic outcomes in agri-food research. This supports the need for systems-based approaches and multi-stakeholder collaboration in both academic inquiry and policy implementation.

To track the evolution and maturation of research themes related to the sustainable development of the agri-food industry and its relationship with food security, the Biblioshiny App was used, part of the Bibliometrix R package (Aria & Cuccurullo, 2020). This tool visualized the longitudinal flow and transformation of keywords in the literature indexed in Scopus.

Figure 3 presents an alluvial diagram that maps the progression of dominant research themes from 2000 to the first quarter of 2025. The year 2000 was used as the starting point for this analysis due to the scarcity and inconsistency of keyword indexing in earlier publications, making reliable thematic tracking infeasible before this date.

Thematic development is divided into four major chronological phases. The early phase (2000–2010) features foundational topics such as agroindustry, organic farming, food quality, and wastewater treatment. While fragmented, this stage laid the groundwork for later concep-

Source: Developed by the authors based on the Scopus database using the Biblioshiny App.

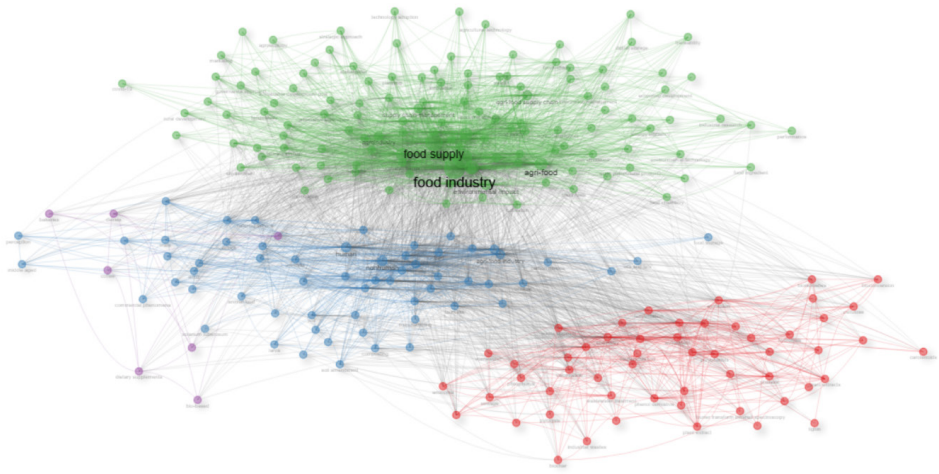

Figure 2. Keyword co-occurrence network in publications on the sustainable development of the agri-food industry and its impact on food security/supply

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Source: Developed by the authors using Biblioshiny and Scopus data.

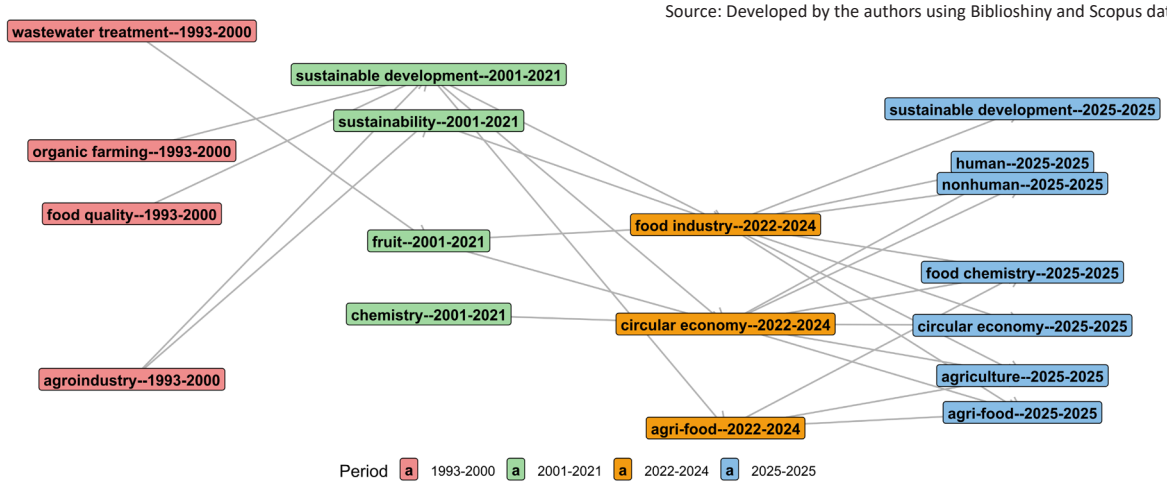


Figure 3. Thematic evolution of publications on the sustainable development of the agri-food industry and its impact on food security

tualizations of sustainability in food systems. Topics were relatively isolated and reflected initial experimentation with sustainability-related terminology.

During the intermediate phase (2011–2021), more structured and integrative themes emerged, with sustainability, fruit, chemistry, and the food industry becoming more prominent. The field showed early signs of convergence, especially around sustainable practices, food processing, and health-related research. This period also marked a transition from sector-specific to system-wide discussions.

The recent past (2022–2024) shows the consolidation of cross-disciplinary concepts such as circular economy, agri-food, and sustainable development as central research foci. This period also marks the expansion of technology-driven and policy-relevant approaches to food system sustainability, including a growing focus on resource efficiency and economic circularity.

The current period (Q1 of 2025) indicates increasing specialization and thematic diversification. Emerging keywords such as agriculture, food chemistry, human, nonhuman, and circular economy demonstrate new directions within the literature. The persistence of agri-food and sustainable development as core themes suggests ongoing interest in systems-level research. At the same time, the appearance of precise subtopics signals continued fragmentation and innovation in research focus.

This thematic progression illustrates how the field has shifted from foundational agricultural and industrial concepts to more sophisticated, interconnected models incorporating environmental science, health, technology, and circular economic thinking. The increasing density and specificity of research themes highlight a maturing academic field with growing relevance for interdisciplinary policy and innovation efforts in food security and sustainability.

An in-depth analysis of the thematic landscape from 1993 to 2000 (Figure 4a) indicates that early research in the field was relatively fragmented and exploratory. During this foundational period, the main themes included agroindustry, organic farming, food quality, and wastewater treatment. These themes reflected early concerns with agricultural productivity, product quality, and environmental management, although their centrality and development density remained low. Organic farming appeared as an emerging niche, while agroindustry and food quality were the period's most relevant and recurring topics, forming the preliminary intellectual base for future thematic expansion.

The thematic map from 2001 to 2021 (Figure 4b) reveals significant structural maturation. While agroindustry and food industry remained central (as basic themes), newer areas such as food quality, wastewater treatment, and effluent management gained momentum. Food quality moved into the upper-right quadrant, becoming a motor

theme – both highly relevant and well-developed. Meanwhile, themes like sustainable development, food consumption, and reuse appeared in the lower-left quadrant as emerging or declining topics, suggesting either new areas of investigation or fading interest.

At the same time, valorization, food ingredients, and food chemistry emerged as moderately dense, high-potential topics. Notably, the circular economy and carbon footprint began to intersect with agri-food waste, showing the initial clustering of environmental sustainability concerns around waste reduction and resource efficiency.

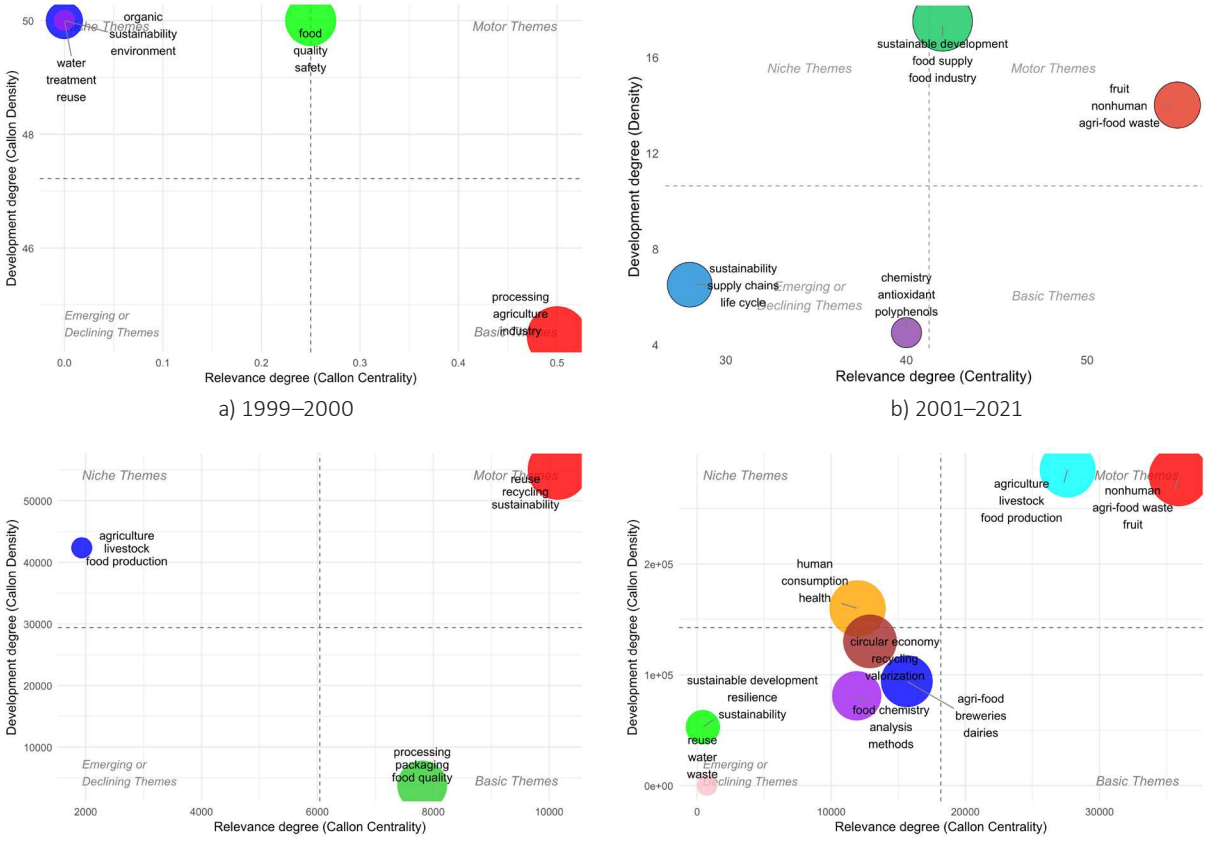
Between 2022 and 2024 (Figure 4c), thematic complexity intensified. Two strong motor themes emerged:

- The environmental Cluster, comprising circular economy, agri-food waste, and nonhuman actors.
- The technological-agricultural Cluster, led by agriculture, effluent treatment, chemistry, and procedure.

These motor themes indicate that sustainability in agri-food is no longer just a conceptual ambition but is now tied to operational, environmental, and technological challenges. Meanwhile, agri-food, food industry, and agribusiness maintained their relevance but with moderate development, remaining basic themes. Human health and demographic aspects (human, adult, fruit) entered the niche zone, hinting at nutrition and behavioral science crossovers. At the same time, reuse, energy use, and sustainable development lingered in the lower-left quadrant, still visible but underdeveloped.

The most recent data slice from Q1 2025 (Figure 4d) reflects further refinement and specialization. Two strong clusters now dominate the upper-right (motor theme) quadrant. One focused on nonhu-

Source: Developed by the authors using the Scopus database and the Biblioshiny App.



a) 1999–2000 b) 2001–2021

c) 2022–2024 d) 2025–2025

Figure 4. Mapping thematic relevance and development levels in documents related to the sustainable development of the agri-food industry and its impact on food security/supply

http://dx.doi.org/10.21511/ee.16(2).2025.11

man, fruit, and agri-food waste. The other centered around sustainable development, food supply, and the food industry.

This indicates that sustainability and food industry resilience remain pivotal. At the same time, the concept of nonhuman entities (possibly related to AI, automation, or environmental components) is increasingly recognized in the transformation of the agri-food system. In contrast, traditional themes such as sustainability, agroindustry, and food production shifted into the emerging/declining quadrant, suggesting a thematic handoff to newer, more specific topics. Technical and biochemical topics like antioxidants, polyphenols, and chemistry also appeared as niche or declining, highlighting evolving research frontiers.

Together, these visualizations demonstrate how the scholarly discourse has transitioned from general agricultural and environmental themes in the 1990s to highly specialized, cross-sectoral, and technology-driven topics by 2025. The data reflect growing interdisciplinarity and thematic fragmentation, signaling the field's maturation and the increasingly nuanced exploration of sustainability within agri-food systems and food security contexts.

4. DISCUSSION

The results reveal a sharp and sustained increase in research output on the sustainable development of the agri-food industry and its connection to food security, particularly since 1996. Bibliometric analysis shows that publication activity has accelerated exponentially between 1996 and 2024. This surge corresponds with major global events such as the adoption of the SDGs and the COVID-19 pandemic. These findings align with Agnusdei and Coluccia (2022), who observed an expanding research focus on innovation, governance, and environmental sustainability in agri-food supply chains.

Thematic clustering of keywords identified five dominant areas: food supply, environmental sustainability, technological transformation, public health, and cross-sectoral governance. While Şimşek et al. (2024) and Hroma (2024) also identified similar domains, current findings show a clearer evolution from early agricultural themes (e.g., organic farming, agroindustry) toward more integrated systems-level topics like circular economy and digital agriculture. This progression indicates not only topic diversification but also thematic maturity, especially as it pertains to resilience and sustainability in vulnerable regions.

A particularly distinctive finding is the growing presence of digital technologies, especially blockchain, AI, and IoT, within the core of agri-food sustainability discourse. These results reinforce and expand the conclusions of Trevisan and Formentini (2024), who emphasized the role of digitalization in reducing food loss. These technologies now appear embedded as fundamental enablers within sustainability research rather than niche innovations. This interpretation is further supported by the increasing frequency of terms such as "nonhuman," potentially reflecting automation, AI systems, or machine-enabled processes in agri-food chains.

In contrast to earlier bibliometric works like those of Rejeb et al. (2021, 2022), which primarily focused on digital supply chain efficiency in general terms, this analysis highlights how digital tools are increasingly being explicitly examined in the context of food security. This shift in research focus reflects a growing awareness of the need to adapt innovation to local contexts and constraints rather than apply solutions uniformly across regions.

Moreover, while blockchain has been widely studied for its traceability benefits (Antonucci et al., 2019; Niknejad et al., 2021), it now appears more frequently alongside terms like "sustainability," "resilience," and "compliance." This suggests a broader understanding of blockchain's role in tracking products and supporting governance and regulatory alignment, as echoed in recent studies by Sugandh et al. (2023) and Elias et al. (2024).

The findings also confirm that food security is increasingly being studied not in isolation but in relation to broader themes such as climate resilience, digital transformation, and socio-economic policy. This integrated approach is particularly critical in countries where systemic vulnerabilities, highlighted by Richardson (2024) and Benbekhti et al.

(2024), demand cross-cutting solutions. In contrast to many previous bibliometric studies lacking regional specificity, this paper emphasizes the global South, identifying how food security challenges in these regions influence scholarly inquiry.

This contribution to the literature offers a more targeted, systems-based bibliometric analysis focused on the sustainable development of the agri-food industry and its impact on food security/supply, complementing and extending previous reviews. The analysis confirms major research trends identified in earlier studies and introduces a new layer of regional analysis essential for aligning global research agendas with local development priorities. The identification of five interconnected clusters not only illustrates the multidimensional nature of sustainable agri-food development but also offers insight into which research areas may have the highest impact on improving food security in vulnerable economies.

Despite its contributions, this study has several limitations. It draws exclusively on the Scopus database, potentially omitting relevant publications from regional or non-English sources, which may be particularly common in the context of developing countries. Moreover, reliance on bibliometric techniques limits the ability to assess the research findings' depth, impact, or implementation. Future research should combine bibliometric mapping with qualitative and field-based studies to assess how innovations in sustainability are being applied and their effects on real-world agri-food systems, particularly in low- and middle-income regions.

CONCLUSION

This study set out to perform a bibliometric analysis of global research concerning the sustainable development of the agri-food industry and its implications for food security across nations. The primary objective was to identify dominant research trends, thematic clusters, and conceptual gaps through a comprehensive bibliometric analysis of the field.

The findings revealed four key periods in the development of the field: an initial exploratory phase (1993–2000), a stage of thematic consolidation and gradual growth (2001–2021), a surge in interdisciplinary, technology-focused studies (2022–2024), and a more specialized and fragmented research landscape emerging in Q1 2025. A pronounced increase in publication volume was observed after 2016, reflecting the impact of global policy initiatives, such as the Sustainable Development Goals, and growing concern over food system vulnerabilities amid crises like COVID-19 and geopolitical disruptions.

The analysis identified five interconnected thematic areas: agri-food supply chains and logistics; nutrition and public health; environmental sustainability, including climate and waste concerns; technological and consumer innovation; and systemic issues of food security and sustainable development.

Recent trends point to increasing attention on circular economy principles, digital tools such as blockchain and AI, and cross-sectoral integration, signaling the field's maturation and growing complexity.

From a policy standpoint, the findings reinforce the urgency of strengthening food system resilience across the nations where vulnerabilities to climate shocks, supply chain disruptions, and socio-economic inequalities are most acute. Governments, development agencies, and international organizations should prioritize investments in digital infrastructure, sustainable agriculture practices, and cross-sectoral coordination aligned with the SDGs. Enhancing research collaboration, knowledge transfer, and policy alignment will ensure that agri-food innovation translates into tangible improvements in food security for the world's most vulnerable populations.

http://dx.doi.org/10.21511/ee.16(2).2025.11

AUTHOR CONTRIBUTIONS

Conceptualization: Anar Abbasov, Azer Gurbanzade.
Data curation: Azer Gurbanzade.
Formal analysis: Anar Abbasov.
Funding acquisition: Anar Abbasov, Azer Gurbanzade.
Investigation: Azer Gurbanzade.
Methodology: Anar Abbasov.
Project administration: Azer Gurbanzade.
Resources: Anar Abbasov.
Software: Azer Gurbanzade.
Supervision: Anar Abbasov.
Validation: Azer Gurbanzade.
Visualization: Anar Abbasov.
Writing – original draft: Anar Abbasov, Azer Gurbanzade.
Writing – review & editing: Anar Abbasov, Azer Gurbanzade.

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