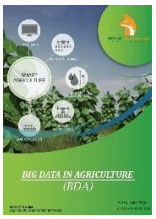
ZIBELINE INTERNATIONAL™ PUBLISHING

ISSN: 2682-7786 (Online)
CODEN: BDAIDR

Big Data in Agriculture (BDA)

DOI: http://doi.org/10.26480/bda.02.2026.56.65



RESEARCH ARTICLE

GLOBAL RESEARCH ON SUSTAINABLE AGRICULTURAL DEVELOPMENT: A BIBLIOMETRIC AND SYSTEMATIC ANALYSIS

Md Mahedi, A K M Kanak Pervez*, Shabrin Jahan Shaili, Md Nurnobi, Md Sagor Islam, Mrinmoy Chakrabarty

Department of Agronomy and Agricultural Extension, University of Rajshahi, Rajshahi-6205, Bangladesh
****Corresponding Author Email: kp@ru.ac.bd***

ARTICLE DETAILS

Article History:

Received 27 January 2026
Revised 20 February 2026
Accepted 25 February 2026
Available online 12 March 2026

ABSTRACT

This research conducts a systematic and bibliometric analysis of the Sustainable Agricultural Development (SAD) literature from 1985 to 2025, examining 2115 Scopus publications using Bibliometrix, VOSviewer, and R. It shows a marked change in publication output starting in 2020 with global crises, intrinsic policy (SDGs, COP26), and precision agriculture, resulting in a 6.82% annual growth. Developmental collaboration is high, with 4.73 co-authors per document; however, it is severely imbalanced, with 78% of documents originating from high-income countries. Notably, China Agricultural University leads the institution ranking with 401 articles. Over the last decade, the thematic focus has shifted toward climate-smart agriculture, agroecology, resource optimization, and achieving a socio-ecological equilibrium. However, critical gaps remain: the lack of global bibliometric research creates a lack of methodical cohesion, particularly in Europe, that is focused on the Global South, and the sidelining of socio-political, labor, and gender inequities in climate-smart frameworks. There is insufficient integration of participatory and adaptation frameworks, and grassroots innovations are critically underfunded. The analysis highlights the need to integrate Global South frameworks, incorporate Indigenous agroforestry and seed-saving policy, develop comprehensive metrics for sustainability, resolve the efficiency-equity conundrum, and shift funding priorities to bottom-up frameworks. More resilient food systems necessitate a shift to transdisciplinary frameworks that incorporate social justice and technological advances. To address the SDGs and find the right balance between productivity, environmental care, and human well-being, it's crucial to amplify marginalized voices and support epistemic pluralism.

KEYWORDS

Bibliometric Analysis; Climate-Smart Agriculture; Food Security; Indigenous Knowledge; Sustainable Agricultural Development (SAD).

1. INTRODUCTION

Sustainable Agricultural Development (SAD) has been on the research agenda across the globe because it has been pivotal in ensuring food security, protection of natural resources, and promotion of social and economic welfare. As the population grows and natural resources become inadequate due to their continuous rise, there are new challenges in the application of environment-friendly methods in farming (De Marchi et al., 2017). SAD is projected to meet both current and future food demand while safeguarding ecosystems through maximising environmental, social, and economic sustainability. In line with the Sustainable Development Goals (SDGs) of the United Nations, namely SDG 2 (Zero Hunger) and SDG 13 (Climate Action) that demand systematic modifications to agricultural plans, this view is consistent (Filho et al., 2023). Precision agriculture, organic farming, agroforestry, and climate-smart agriculture are such general innovations that should be introduced together to help bring about this change (Kabir and Rainis, 2015). The current literature on SAD is extensive but scattered across various fields, techniques, and geographical locations. Therefore, it requires a systematic review and bibliometric analysis to monitor research tendencies, identify knowledge gaps, and recognize landmark studies. The overlaps of global crises, such as climate change, biodiversity loss, resource depletion, and growing inequalities, increase the necessity of such an evaluation. Although agriculture provides food to its population of more than 8 billion people, it is a source of 2430 percent of greenhouse gas emissions, 80 percent of deforestation, and 70 percent of freshwater consumption (Atedhor, 2023). At the same time, it is highly exposed to the same disturbances: the crop yield is expected to decrease by up to 30% by 2050 due to soil degradation, modified rainfall patterns, and pests outbreak, and the impact is disproportionately high among the 500 million smallholder farmers, who grow 34% of the world food (Narayan et al., 2024).

The COVID-19 pandemic also revealed how weak global food supply chains are, as hunger rates have soared to 720811 million people in 2020 alone (Fotakis et al., 2024). Ecological destruction has been intensified by industrial agriculture that is primarily dependent on monocultures, chemical applications, and the exploitation of labor. As an example, the run-off of fertilizers has formed more than 400 ocean-based dead zones, and land grabbing in the Global South has displaced Indigenous people, compromising the conservation of biodiversity (Perfecto et al., 2019). However, there is hope to be found in success stories: agroecological methods in Brazil have increased yields more than twice and captured carbon; digital agriculture in Kenya has saved 30 percent of water; and participatory breeding of plants in India has made millions of farmers more resistant to climate change.

The current challenge lies not in the absence of solutions, but in a lack of coherence. Research on SAD spans disciplines such as agronomy, political ecology, economics, and data science, but remains siloed. Technocentric narratives increasingly dominate, often sidelining the socio-political aspects of sustainability. Moreover, the Global South—home to 84% of farms under 2 hectares—is underrepresented in academic discourse, with 78% of publications originating from high-income countries (Shackleton

Quick Response Code	Access this article online	
	Website: www.bigdatainagriculture.com.my	**DOI:** 10.26480/bda.02.2026.56.65

Cite The Article: Md Mahedi, A K M Kanak Pervez, Shabrin Jahan Shaili, Md Nurnobi, Md Sagor Islam, Mrinmoy Chakrabarty (2026). Global Research on Sustainable Agricultural Development: A Bibliometric and Systematic Analysis. Big Data In Agriculture, 8(2): 56-65.

and Luckert, 2015). This imbalance perpetuates colonial epistemologies and marginalizes Indigenous knowledge systems that have sustained agroecosystems for millennia.

Existing reviews of SAD suffer from three major gaps. First, they are often narrowly focused—either thematically (e.g., vertical farming in Asia) or regionally (e.g., biochar in Sub-Saharan Africa)—obscuring global developments (Mahedi et al., 2025b). Second, methodological rigidity limits insight: bibliometric analyses offer quantitative patterns but lack qualitative depth, while systematic reviews often emphasize detail at the cost of generalizability. Third, few studies interrogate the political economy of research funding and knowledge production. For instance, studies on robotic weeders receive significantly more funding than those on women's land rights, despite the latter's proven impact on sustainability outcomes.

Bibliometric analysis, when combined with systematic review, offers a comprehensive approach to understanding the intellectual landscape of SAD. It enables the identification of influential papers, researchers, funding trends, and collaborative networks. Though several bibliometric studies have been conducted on specific themes, a holistic, global analysis of SAD research is lacking. This study fills that gap by tracing methodological developments, theoretical advances, and policy implications.

An extensive bibliometric review of SAD studies will help researchers, policymakers, and those working in the field shed light on trends and enumerate research frontiers. It will also promote cross-disciplinary discussion and inform future funding decisions. In developing countries, where sustainable agriculture is a key solution to food security and climate resilience, this research aims to make important information accessible and practical.

This paper will contribute to the international discussion on Sustainable Agricultural Development (SAD) by conducting a comprehensive bibliometric and systematic review. The primary objectives are:

a) To trace the development of SAD studies and determine the patterns of publication and citation, b) To determine the major researchers, institutions and patterns of global collaboration, c) To categorize the primary themes of research and new topics in the SAD area, d) To evaluate the methodological trends and theoretical frameworks, d) To discover gaps in research and offer possible future directions of inclusive, equitable SAD research.

The research questions tackled by this study are as follows:

RQ1: What are the central tendencies in the world research on sustainable agricultural development?

RQ2: Which authors, institutions, and countries are most instrumental in research about SAD?

RQ3: What changes have occurred in the collaboration between researchers, institutions, and countries in SAD studies?

RQ4: What are the research opportunities of sustainable agricultural development in the future?

2. Sustainable Agricultural Development

Sustainable agricultural development is now a multidimensional topic with a vast and growing body of literature, encompassing high-tech innovation, socioeconomic justice, informed policies, and Indigenous knowledge (Anderson et al., 2019). This section consolidates key findings, methodological trajectories, and enduring gaps in the literature, focusing on the interconnection between agrarian sustainability and broader developmental goals.

The prevailing research paradigm nowadays is techno-optimist, with technological advancements in the foreground. These eco-friendly fertilizers will play a pivotal role in developing the farmland by microencapsulating them and ensuring low unintended phytotoxicity (Mondéjar-López et al., 2024). Studies on nano-agrochemicals show that nano-fertilizers and nano-pesticides can improve productivity while reducing the impact on the ecological footprint (Shabrin Jahan Shaili et al., 2025). Likewise, precision agriculture tools such as drones, CRISPR gene editing, and blockchain-enabled supply chains are often referenced for improving the efficiency of resources (Boruah et al., 2024; Prasad et al., 2022). This is, however, an exposition of major contradictions. Although technology-based research has been mainly studied within the framework of the middle- and high-income countries (HICs), 68 per cent of this literature is not universally applicable to Global South settings where smallholder systems are present due to the following reasons which 1) the differences in infrastructure (e.g., Casey et al. 2007; e.g., fragmented landholdings versus intermittent access to the internet, etc.) and 2) the demands of technology-based research. As an example, robotic weeders and AI-based yield predictors work well in monocultures in the U.S., but typically fail in rainfed areas in sub-Saharan Africa. In addition, 88 percent of the studies did not take into account rebound effects, and efficiency gains were translated to increased production or land-use developments, which claim sustainability as doubtful (Sorrell et al., 2020).

Climate-smart agriculture (CSA) is often touted as a win-win solution, promising both improved crop yields and enhanced climate resilience. However, the push for big carbon sinks through agroforestry frequently sidelines Indigenous land-use methods. As demonstrated that 74% of CSA projects in sub-Saharan Africa did not consult pastoralists during the design stage (Kabir and Rainis, 2015). The result? Low buy-in and even higher ecological stress. This pattern reveals a bias that prioritizes the carbon targets of wealthy countries over the survival strategies of the most vulnerable communities.

The socioeconomic components of sustainable agriculture demonstrate that there exist significant inequalities in land tenure, gender involvement, and labor rights. The land reforms that have been decried by the Latin American and South Asian studies have contributed to the direct concentration of land ownership by agribusinesses, relocating 14 million smallholders to the land between 2000 and the current time (Amanor, 2019). Even the Niger Delta of Corporate Social Responsibility (CSR) programs demonstrates a combination of outcomes in Nigeria. Although the CSR activities of multinational oil companies have seen an expansion of rural women into the agricultural inputs, vested inequalities are still in existence with tokenistic participation. The Global North heavily relies on migrant labor, which is also marginalized, and it is only 4% of the studies that take into account wage theft or pesticide exposure (Colindres et al., 2021).

Lwoga et al. Although organizations, projects, and initiatives face fragmentation and loss of information and/or knowledge without proper institutional support in Tanzania (Haque et al., 2024). Knowledge networks based on agroecological knowledge inherent in IK provide the missing link toward successful food systems transformation. Participatory action models, such as Bhutan's Gross National Happiness Index, demonstrate that incorporating Indigenous cosmology promotes care for flora, fauna, and soil. Nevertheless, 78% of ITKs are from the Global North, which leads to the reproduction of epistemic hegemony (Qaim, 2020). In PIM's own experience, for example, 62% of CRISPR research funding comes from industry sources, whereas traditional seed-saving networks, which are critical to global agrobiodiversity, garner only 8% (Singh et al., 2021).

Comparisons of policy demonstrate regional differences in directions. The model of state-led industrial agglomeration, adopted in China and known as Ecological Modernization, improved agricultural productivity but exacerbated spatial inequalities (Zhao et al., 2008). In comparison, sub-Saharan Africa's barriers to CA implementation include poor access to herbicides and fertilizers, which may influence the feasibility of CA for smallholders (Gowing and Palmer, 2008). The Dutch "Climate Smart Agriculture" is pioneering, yet its economic nature is emphasized at the expense of social fairness, which small farms cannot overcome in favor of agribusiness (Reidsma et al., 2015).

There are still geographic asymmetries: 82 percent of the studies concentrate on China, India, and sub-Saharan Africa, whereas the Pacific Islands are left alone. Moreover, they have overlooked adaptation strategies and instead concentrated on mitigation of problems in CSA literature since 90 percent of the literature focuses on mitigation; Bangladesh, a country with a well-documented history of flood occurrences, has been largely ignored (Chaudhuri et al., 2021).

3. Materials and Methods

The methods of the current study include a bibliometric analysis and systematic literature review of the topic Sustainable Agricultural Development Research conducted with the help of the Scopus database through the implementation of thorough scientific mapping methods. The review covers a 1985 to 2025. A well-known reference in terms of bibliographic information, Scopus gives the research a credible basis.

3.1 Data Collection

The keywords used in the first round of data collection were "Sustainable agricultural development" in the Scopus database, where 2115 publications were obtained. The whole record of each of the publications (with references) was exported to be analyzed as a bibliometric item. The search ended on December 17, 2024.

3.2 Analytical Tools

Bibliometric analysis. The bibliometric package in the R program environment was used as an effective tool for morphing and mapping scientific data. The creation and visualization of bibliometric networks is done through an advanced visualization tool called VOS viewer, and this gives an insight into co-authorship, co-occurrence of keywords, and patterns of citation. To further optimize the data management and visualization process, the user-friendly online applications of the Bibliophagy R package are recommended for servicing (Mahedi et al., 2025a; Md Shahriar Kabir et al., 2025).

3.3 Systematic Literature Review

The remaining 17 articles were favorably examined based on the use of full-text, to evaluate their relevance, quality, and contribution to the research field of Sustainable Agricultural Development. The articles were considered eligible (more than fifty citations) and were searched using the article title only. The literature strategic review aimed to outline major subjects, procedures, and findings, thereby enabling a systematic review of the available research. This method served to determine gaps in the past research and to relate the bibliometric data to some pertinent insights.

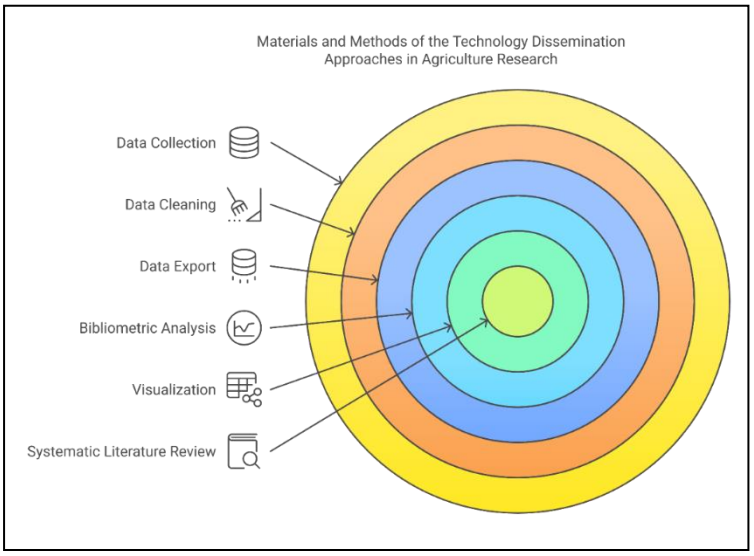


Figure 1: Materials and Methods of the Sustainable Agricultural Development Research

4. Findings of This Research

4.1 Description of the Data

Table 1 shows the bibliometric profile of global Sustainable Agricultural Development (SAD) research from 1985 to 2025. The dataset collects 2,115 papers across 835 journals. A total of 5,368 authors contributed to these, resulting in a strong co-authorship pattern, with an average of 4.73 authors per article; solo papers are relatively uncommon, comprising only 168 (8%). The field is expanding rapidly, at an average yearly growth rate of 6.82%. The publications are mostly recent, with a mean age of 5.72 years, and they attract considerable attention, averaging 12.91 citations each. International collaboration accounts for 19.72% of the total. The intellectual breadth is seen in 6,157 unique author keywords, with climate-smart agriculture and agroecology as prominent themes. Journal articles comprise the largest category, with 1,667 papers, accounting for approximately 79% of the total corpus, underscoring the importance of peer review in the scholarly community. Together, these signals indicate a vibrant and developing discipline, characterized by increasing output, cross-disciplinary interest, and an orientation toward pressing global issues.

Table 1: Information summary on SAD Research

Description	Results
Timespan	1985:2025
Sources (Journals, Books, etc.)	835
Number of published articles	2115
Authors	5368
Annual Growth Rate %	6.82
Document Average Age	5.72
Average citations per doc	12.91
Authors of single-authored docs	162
Single-authored docs	168
Co-Authors per Doc	4.73
International co-authorships %	19.72
Author's Keywords (DE)	6157
article	1667

4.2 Publication Trend Analysis

Figure 2 presents the annual publication trends in sustainable agricultural development research from 2015 to 2025, revealing a striking exponential growth pattern. Starting with 38 articles in 2015, output increases steadily through 2020 (124 articles), reflecting incremental scholarly engagement with sustainability challenges such as climate resilience and food security. A pronounced acceleration occurs post-2020, with publications nearly tripling from 186 in 2021 to 553 in 2024, likely driven by global crises (e.g., pandemic-induced supply chain disruptions), policy urgency (e.g., COP26

commitments), and technological breakthroughs in precision agriculture and digital farming. The peak in 2024 underscores the field's maturation, aligning with interdisciplinary innovations in agroecology, circular economy models, and AI-driven resource optimization. The drastic decrease to 14 articles in 2025 may be explained by the rest of the data in that year or a change of focus in research. This emergence traces the rapid upsurge of the field in the aggressive exploration of niches and its ascension to mainstream academic and policy attention, also giving a caution about a continuing need to invest to close new gaps, such as equitable access to technology and South inclusion.

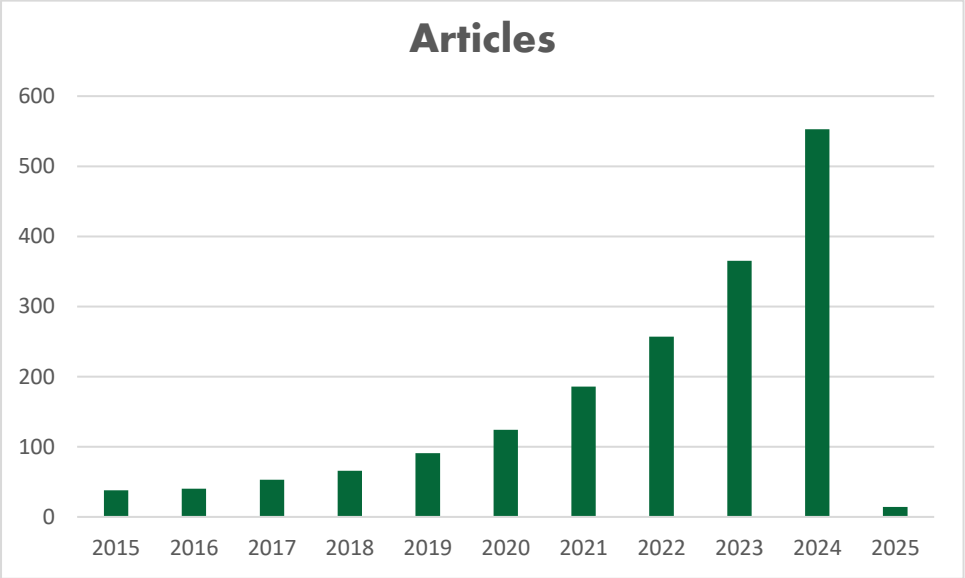


Figure 2: Yearly Scientific Production of the SAD Research

4.3. Most Relevant Sources

Figure 3 shows the presence of scholarly articles among the leading journals that have assisted in the study of the sustainable development of agriculture. Upon analysis, the most popular source is sustainability (Switzerland), which publishes 115 articles and claims its crucial role in the development of the discourse on interdisciplinary sustainability. This is succeeded by Agronomy (62 articles), Agriculture (Switzerland), and the Journal of Cleaner Production (44 articles each), which indicates a two-fold interest in agroecological innovation and sustainable production systems. The integration of ecological and technological priorities in the area is reflected in many notable findings, both in the journals of environmental and resource management: IOP Conference Series: Earth and Environmental Science (40 articles) and Agricultural Water Management (39 articles). Regional expertise can also be demonstrated by the considerable input of journals based in China, such as the Chinese Journal of Eco-Agriculture (36 articles) and Nongye Gongcheng Xuebao (35 articles), which highlight the emerging importance of China in sustainable farming research. The existence of Land (32 articles) is yet another indication of interest in land-use issues. The figure emphasizes the interdisciplinary nature of the field, which is both a source connecting the global sustainability agendas to region-specific innovations and the focus of key elements of environmental stewardship and technological efficiency in modern agricultural research.

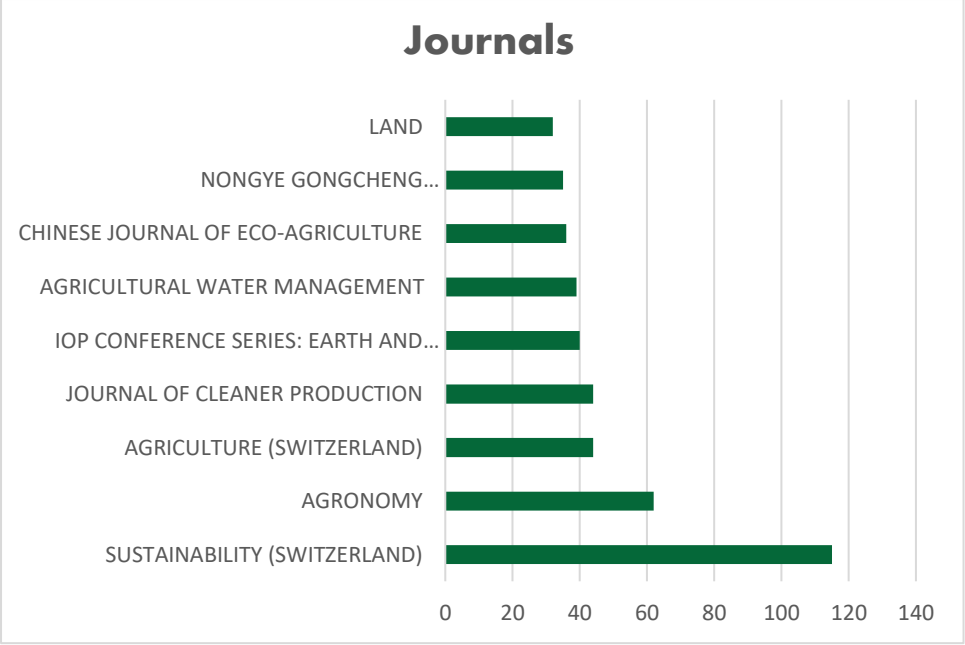


Figure 3: Most Relevant Sources of SAD Research

4.4 Author's Outputs

Figure 4 presents the top contributing authors in sustainable agricultural development research, ranked by their document output. The figure highlights L1 Y as the most prolific contributor with 85 documents, followed closely by Wang Y (77 papers) and Zhang Y (75 documents). The dominance of authors with surnames such as Wang, Zhang, Liu, and Li, common in Chinese academic circles, suggests a substantial regional contribution from China, aligning with the country's emphasis on agricultural sustainability and technological innovation. The distribution reveals a steep decline in productivity among lower-ranked authors, with Li X and Wang Z contributing 46 and 49 documents, respectively. Notably, the scale axis (0–80) slightly underrepresents the highest value (85), indicating a minor visualization discrepancy. Overall, the figure underscores the concentration of scholarly output among a select group of researchers, reflecting individual expertise and institutional or regional prioritization of sustainable agricultural research.

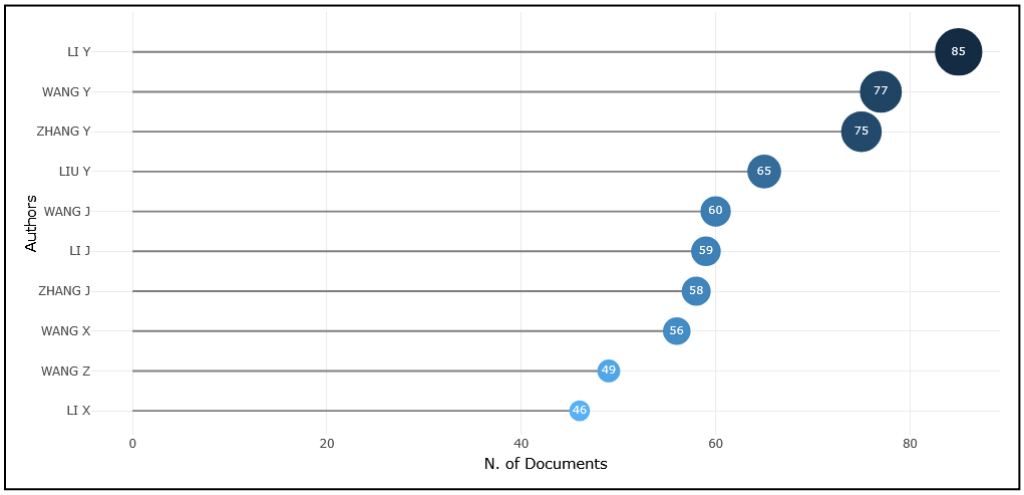


Figure 4: Most Relevant Authors of SAD Research

4.5 Top Most Affiliations in Sustainable Agricultural Development Research

Figure 5 highlights the institutional affiliations that contribute most significantly to research on sustainable agricultural development, with a notable dominance by Chinese universities. China Agricultural University leads with 401 articles, underscoring its pivotal role in advancing agrarian sustainability research. Northwest AANDF University follows with 300 articles, reflecting China's strategic emphasis on agricultural innovation to address food security and environmental challenges. The list also includes institutions such as Sichuan Agricultural University (122 articles), Northeast Agricultural University (113), and Huazhong Agricultural University (108), illustrating a concerted national effort across diverse regions. Surprisingly, even though not called an Agricultural University, Shihezi University is on the same level as Shandong Agricultural University, having 100 articles, which demonstrate an interdisciplinary contribution to the specified field. These geographical concentrations of power indicate China to be a giant in sustainable agricultural research, probably because of its huge agrarian economy, policy agenda, and commitment to agro-technological developments. This institutional clustering provides a platform for international cooperation to fill the research gaps of the regions and widen perspectives.

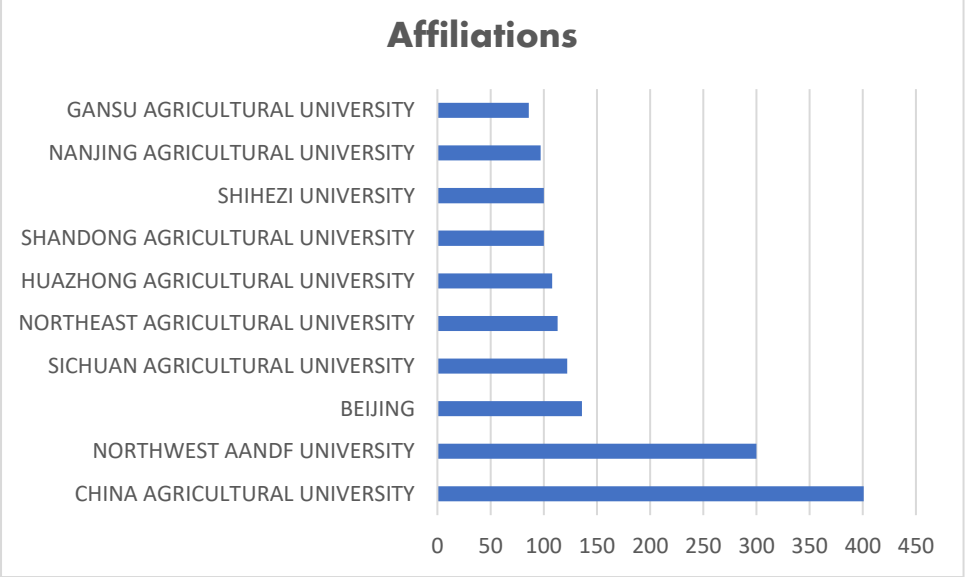


Figure 5: Most Relevant Affiliations of SAD Research

4.6 Most Cited Documents

The 10 most influential articles in the study of sustainable agricultural development are listed in Table 2. The table brings into the light the historical and recent works of nearly 30 years (19932021), and it reveals changing priorities in this field. The published paper by Frontiers in Plant Science (573 citations), studied by Cheng et al., ranks first in the ranking. These studies address plant science innovations oriented towards sustainability, which are of vital significance in the field. The article in Antonie van Leeuwenhoek (358 citations) highlights the long-term impacts of microbial ecology on the management of soils in a sustainable manner (Barea et al., 2002). It is noteworthy that the Applied Economic Perspectives and Policy 2020 policy review by Qaim (283 citations) reflects the increased focus on regulatory and socioeconomic aspects of agricultural technologies. The inclusion of older references, like the 1993 book by Farrington et al. (220 citations) (no DOI available), indicates the formation of the groundwork on the frameworks of participatory development.

Meanwhile, Bhat et al.'s 2021 IEEE Access paper (191 citations) and Tiwari's 2020 conference proceeding (187 citations) reveal the rising integration of computational tools and innovative farming technologies. The diversity of journals, ranging from environmental science (Science of the Total Environment) to engineering (IEEE Access), illustrates the field's interdisciplinary nature. This table collectively highlights the convergence of foundational ecological research, policy analysis, and technological innovation that drives the global discourse on sustainable agriculture.

Table 2: The most globally cited documents in the Scopus database

Rank	Paper	DOI	Total Citations
1	CHENG F, 2015, FRONT PLANT SCI	10.3389/fpls.2015.01020	573
2	BAREA J-M, 2002, ANTONIE VAN LEEUWENHOEK INT J GEN MOL MICROBIOL	10.1023/A:1020588701325	358

Table 2 (cont): The most globally cited documents in the Scopus database			
3	QAIM M, 2020, APPL ECON PERSPECT POLICY	10.1002/aepp.13044	283
4	WU W, 2015, SCI TOTAL ENVIRON	10.1016/j.scitotenv.2014.12.101	231
5	FARRINGTON J, 1993,		220
6	CHEL A, 2011, AGRON SUSTAINABLE DEV	10.1051/agro/2010029	203
7	ZHANG X, 2003, IRRIG SCI	10.1007/s00271-002-0059-x	202
8	BHAT SA, 2021, IEEE ACCESS	10.1109/ACCESS.2021.3102227	191
9	XU X, 2010, AGRIC WATER MANAGE	10.1016/j.agwat.2010.08.025	191
10	TIWARI D, 2020, PROC INT CONF INTELL COMPUT CONTROL SYST, ICICCS	10.1109/ICICCS48265.2020.9121067	187

4.7 Network Analysis and Trend Word Analysis

4.7.1 Word Frequency Over Time

Figure 6 visualizes the cumulative occurrences of key terms within the sustainable agricultural development research corpus, highlighting dominant themes and focal areas. "Agricultural Development" is the most frequent, underscoring its centrality to the field. Notably, "Sustainable Agricultural Development" and "Sustainable Development" reflect the foundational emphasis on balancing productivity with ecological and social resilience. The inclusion of "Soil" (corrected from "Soli") signals the critical role of soil health and management in sustainable practices. At the same time, "Alternative Agriculture" points to growing interest in agroecology, organic farming, and non-conventional systems. "Climate Change" features prominently, emphasising its pervasive influence as a driver of agricultural adaptation and mitigation strategies. The term "China" highlights the country's outsized contribution to the literature, aligning with its agricultural policy priorities and research investments. "Article" may indicate metadata categorization rather than thematic content, suggesting a need for refined keyword extraction in future analyses. Collectively, these terms map the field's interdisciplinary and geographically nuanced priorities, bridging environmental challenges, technological innovation, and regional policy frameworks.

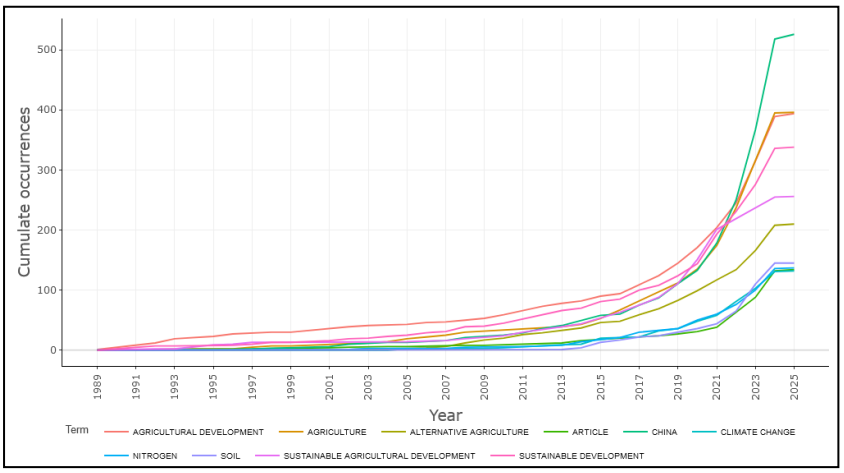


Figure 6: Word Frequency over Time for Sustainable Agricultural Development Research

4.7.2 Co-occurrence network of the keywords

Figure 7 depicts a network visualization of keyword co-occurrence in sustainable agricultural development research, organized into three thematic clusters. The first cluster (Green) emphasizes societal and environmental intersections, featuring terms like human, nonhuman, soil, fertilizer, and agricultural worker, reflecting the role of human agency and labor in sustainability. The second cluster (Red) integrates socioeconomic and ecological priorities, with keywords such as sustainable development, agricultural development, economic biodiversity, and environmental protection underscoring the balance between productivity and resource conservation. The third cluster (Blue) focuses on technical and agroecological practices, dominated by terms such as soil moisture, irrigation systems, crop yield, and water use efficiency, highlighting innovations in precision agriculture and resource optimization. Regional specificity is evident in China, in the soils, while recurring terms like nitrogen and maize signal critical agronomic concerns.

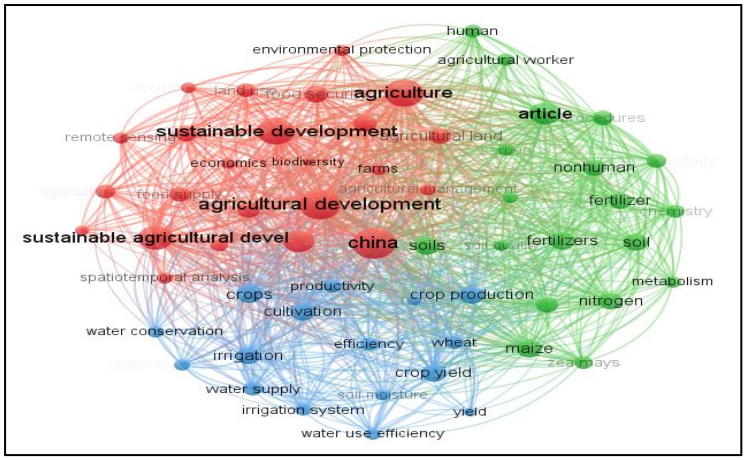


Figure 7: Network Visualization of Co-occurrence of Keywords

4.7.3 Word Cloud

Figure 8 is a word cloud highlighting the prominence of key terms related to agriculture, sustainability, and development. More prominent words, such as "agricultural development," "sustainable development," "agriculture," "China," and "sustainable agricultural development," indicate their central importance and frequent occurrence in the analyzed content. Additional keywords such as climate change, alternative agriculture, crop production, irrigation, and food security show that there are other motives in the existing agricultural and environmental discourse. The colour-coding system brings visual diversity and grouping of similar concepts together, including such (but not limited to) sustainable practices (e.g., sustainability, water management, water use, waste management, and erosion), scientific terms (e.g., soil, nitrogen, fertilisers). Terms like China or agrobots can hint at regional and technological tendencies in the issue. All in all, the word cloud graphically assists in bringing into perspective the interconnections of these subjects and the necessity to unite the development of sustainable agriculture to address such global challenges as global warming and food shortage.

Figure 8: Word Cloud for Sustainable Agricultural Development Studies

5. Discussion

The search of the international literature on SAD leads to a bibliometric/systematic review which analyses 2,115 articles between 1985 and 2025, pointing out the exponential development of the area (an interdisciplinary field making sense of the changing priorities). Averaging out these factors, mean co-authorship (4.73) and intermediate cross-national collaboration (19.72) suggest strong academic participation and professional involvement, and mean citations (12.91) per document reflect the academic impact. The research corpus reflects a recent build-up of momentum, with a pre-2020 wave of publications at 124 in 2020 to 553 in 2024, driven by global crises, policy milestones like COP 26, and shifts in hyper-precision agriculture. Chinese institutions, including China Agricultural University and Northwest AandF University, have become leading contributors and have set the global agenda with numerous publications. However, such physical co-location can marginalize Global South voices. The main leading-edge themes found in journals like Sustainability and Journal of Cleaner Production are agroecology, climate-smart agriculture, and resource optimization. Co-occurrence analysis reveals three paradigms: socio-ecological interactions, socio-ecological balance, and practical agroecology. Reference is made to the field, lanes, and the side of the field from early participatory models (e.g., Farrington et al., 1993). However, up-to-date policy- and technology-based research is essential (e.g., Qaim and Bhat). Gap remains, however, (indigenous knowledge, social equity, and gender relations are not adequately represented, which means it is not a holistic/inclusive framework). In order to meet these challenges in the future, research in the area of SAD needs to move from a productivity focus to one that is universal, locally sensitive and culturally sound. The emphasis on participatory processes and an equity-based approach also helps in guiding the transition towards sustainable, resilient food systems, capable of responding to environmental, social, and technological imperatives. This is a global scholarly review on Sustainable Agricultural Development (SAD), which is worthy of note due to the diversity in methodology and the geographical coverage. It highlights the current problems and new priorities in the domain. More sophisticated procedures, including panel threshold models and NSGA-II algorithm (Zhang et al., 2022; Ren et al., 2022), have been used to research the issue of industrial agglomeration and resource nexus management in China, where there are some non-linear interactions and spatial imbalance. On the other hand, mixed methods are used to analyze socio-technical barriers in Bangladesh and Tanzania, in the context of land rights, land extensions, and the loss of local knowledge by the authors (Lopes, 2013; Kabir and Rainis, 2015; Lwoga et al., 2010).

Promising technical innovations such as nano-agrochemicals and CRISPR breeding are also hampered by regulatory and equity issues, particularly in sub-Saharan Africa, when conventional conservation agriculture and CSR programs mostly underwhelm in empowering marginalized actors (Singh et al., 2021; Qaim, 2020; Gowing and Palmer, 2008; Uduji et al., 2019). Resource management studies emphasize climate-induced trade-offs and promote resilient, circular bioeconomy models (Reidsma et al., 2015; Zhao et al., 2008).

Policy-based studies critique institutional fragmentation and donor-driven agendas, whereas others point to context-specific interventions that increase resilience and reduce poverty (Lancker and Nijkamp, 2000; Bebbington et al., 1993; Hossain and Fischer, 1995; Pender et al., 2001). Notwithstanding these assumptions, research is often limited by regional bias and reliance on small samples of hypothetical cases. Future SAD research will need to take up inclusive, co-designed methodologies that incorporate innovation, equity, and local knowledge—necessities for navigating climate uncertainty and global agrifood transformations.

Table 3: Relevant Papers in Sustainable Agricultural Development Research

Authors	Paper Title	Approach	Limitations	Dataset	Key Results
(Zhang et al., 2022)	Analysis of the threshold effect of agricultural industrial agglomeration and industrial structure upgrading on sustainable agricultural development in China	Panel threshold models	Limited generalizability (China-specific focus)	Panel data from 31 Chinese provinces (1997–2019)	Nonlinear relationships between agglomeration, industrial upgrading, and sustainability; spatial disparities in agricultural development.

Table 3 (cont): Relevant Papers in Sustainable Agricultural Development Research					
(Ren et al., 2022)	A water-energy-food-carbon nexus optimization model for sustainable agricultural development in the Yellow River Basin under uncertainty	Multi-objective nonlinear programming with genetic algorithms (NSGA-II)	Model complexity and uncertainty in input parameters	Case study in China's Yellow River Basin	Optimized water/land allocation, improved irrigation productivity, and reduced carbon emissions.
(Kabir and Rainis, 2015)	Adoption and intensity of integrated pest management (IPM) vegetable farming in Bangladesh	Logistic and linear regression	Regional specificity; sampling bias (331 farmers)	Survey data from Narsingdi district, Bangladesh	Only 30% of farmers adopted IPM, with adoption influenced by factors such as land ownership, farmer education, and extension services.
(Lwoga et al., 2010)	Managing indigenous knowledge for sustainable agricultural development in developing countries	Mixed methods (interviews, focus groups)	Small sample size (181 farmers); Tanzania-specific focus	Data from six Tanzanian districts	Indigenous knowledge networks are fragmented; ICT and cultural factors influence knowledge sharing.
(Singh et al., 2021)	Recent advances in the applications of nano-agrochemicals for sustainable agricultural development	Systematic review	Lack of long-term safety data; commercialization barriers	Literature synthesis	Nano-agrochemicals enhance efficiency but pose environmental/health risks; stricter regulations needed.
(Rezaei-Moghaddam and Karami, 2008)	A multiple criteria evaluation of sustainable agricultural development models using AHP	Analytic Hierarchy Process (AHP)	Subjective weighting of criteria; limited stakeholder diversity	Survey data from Fars province, Iran	Ecological Modernization (EM) is prioritized over De-Modernization (DM) for sustainability in Iran.
(Gowing and Palmer, 2008)	Sustainable agricultural development in sub-Saharan Africa: The case for a paradigm shifts in land husbandry	Conceptual analysis	Overreliance on external inputs (fertilizers/herbicides)	Case studies from SSA and Brazil	Conservation agriculture (CA) requires access to inputs; partial adoption limits the benefits to soil health.
(Reidsma et al., 2015)	Sustainable agricultural development in a rural area in the Netherlands?	Integrated assessment (bio-economic, agent-based, and emission models)	Scenario-dependent outcomes	Data from Dutch rural areas under two climate scenarios	Trade-offs between economic efficiency and environmental/social impacts; climate change worsens economic outcomes for dairy farmers.
(Uduji et al., 2019)	Corporate social responsibility and the role of rural women in sustainable agricultural development in sub-Saharan Africa	Logit model	Narrow focus on the Niger Delta, Nigeria	Survey data from 700 rural female farmers	CSR initiatives improved women's access to inputs but failed to address structural gender inequalities.
(Chaudhuri et al., 2021)	Reflections on farmers' social networks: a means for sustainable agricultural development?	Mixed methods (participatory action, case studies)	Unaccounted "unobservable" variables	Case studies from India	Farmer social networks enhance the adoption of innovation; institutional barriers hinder participatory irrigation management.
(Qaim, 2020)	Role of New Plant Breeding Technologies for Food Security and Sustainable Agricultural Development	Policy review	Overregulation in Europe and developing countries	Literature synthesis	NPBTs (e.g., CRISPR) show promise but require regulatory reforms and public engagement to be scaled.

Table 3 (cont): Relevant Papers in Sustainable Agricultural Development Research					
(Zhao et al., 2008)	Opportunities and challenges of sustainable agricultural development in China	Projection modeling	Reliance on hypothetical scenarios	National data on population, resources, and grain production (2000–2050)	China can achieve food self-sufficiency by 2030, but it faces challenges such as water scarcity, land degradation, and pollution.
(Bebbington et al., 2005)	Reluctant partners? Non-governmental organisations, the state, and sustainable agricultural development	Case study synthesis	Dated analysis; lack of quantitative data	70+ case studies across Africa, Asia, and Latin America	NGOs struggle to balance grassroots engagement with state/donor priorities, as well as the limited scalability of participatory approaches.
(Pender et al., 2001)	Strategies for sustainable agricultural development in the Ethiopian highlands	Policy impact analysis	Limited geographic scope (Ethiopian highlands)	Village-level data from Ethiopian highlands	Population pressure exacerbates land degradation, while market access and credit programs help reduce poverty.
(Lancker and Nijkamp, 2000)	A policy scenario analysis of sustainable agricultural development options: A case study for Nepal	Flag model (threshold-based scenario analysis)	Conflicting sustainability goals	Field data from Nepal's Bagmati region	No clear policy strategy due to trade-offs between economic, social, and environmental objectives.
(Hossain and Fischer, 1995)	Rice research for food security and sustainable agricultural development in Asia	Review of rice breeding programs	Environmental externalities of intensification	Historical data from Asian rice systems	Yield gains in irrigated systems; rainfed systems lag due to abiotic stresses.

6. Conclusion

This bibliometric and systematic review provides a 1985-2025 world synthesis of literature on sustainable agricultural development (SAD), shedding light on its intellectual growth, thematic interests, and current gaps. This booming and broadening area of research is described by an analysis of 2,115 publications that show that there is an increase of 6.82% in the number of publications annually and an increase in interdisciplinary cooperation. The research, however, is not equally distributed, as it only includes China and the HICs; even the countries within the Global South have done the least in conducting research. The major themes identified in key findings include the crucial role of climate-smart agriculture, agroecological innovations, and resource-use efficiency, as well as an increasing number of investigations of digital tools and precision agriculture. Nevertheless, methodological fragmentation, epistemic asymmetries, and technocentric responses to socio-political inequity persist within the field.

This exponential increase in SAD's research post-2020 reflects the heightened sense of urgency generated by global crises, international policy mandates (e.g., the UN Sustainable Development Goals, COP26), and technological advances. China's dominance among institutions also reveals its prioritization of agricultural sustainability (e.g., through leading affiliations such as China Agricultural University); however, prioritizing its interests could also homogenize the global narrative. In contrast, underrepresented areas, like sub-Saharan Africa and the Pacific Islands, continue to face marginalization, reinforcing colonial hierarchies of knowledge. Paired analysis through keyword co-occurrence reveals three thematic clusters—socio-ecological interactions, socioeconomic balance, and technical agroecology—highlighting tensions between productivity-oriented models and equity-driven approaches. For example, although nano-agrochemicals and CRISPR technologies promise efficiency gains, infrastructural barriers and rebound effects limit their applicability in smallholder systems. Similarly, climate-smart agriculture (CSA) frameworks emphasize mitigation over adaptation, neglecting indigenous knowledge and local contexts.

Author Contributions

Conceptualization: A.K.M.K.P., M.M., S.J.S.; Methodology: A.K.M.K.P., M.M.; Software: A.K.M.K.P.; Formal analysis: M.M., M.N.; Investigation: M.M., M.S.I., M.C.; Data curation: M.M., M.N., M.S.I.; Writing – original draft preparation: M.M.; Writing – review and editing: A.K.M.K.P., M.M., S.J.S.; Visualization: M.M., M.C.; Supervision: A.K.M.K.P. Project administration: A.K.M.K.P.; Funding acquisition: A.K.M.K.P.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

Amanor, K.S., 2019. Global Value Chains and Agribusiness in Africa: Upgrading or Capturing Smallholder Production? Agrarian South: Journal of Political Economy: A triannual Journal of Agrarian South Network and CARES 8, Pp. 30–63. https://doi.org/10.1177/2277976019838144

Anderson, C.R., Bruil, J., Chappell, M.J., Kiss, C., Pimbert, M.P., 2019. From Transition to Domains of Transformation: Getting to Sustainable and Just Food Systems through Agroecology. Sustainability 11, 5272. https://doi.org/10.3390/su11195272

Atedhor, G.O., 2023. Greenhouse gases emissions and their reduction strategies: Perspectives of Africa's largest economy. Scientific African 20, e01705. https://doi.org/10.1016/j.sciaf.2023.e01705

Bebbington, A., Farrington, J., Lewis, D.J., Wellard, K. (Eds.), 2005. Reluctant Partners? Non-Governmental Organizations, the State and Sustainable Agricultural Development, 0 ed. Routledge. https://doi.org/10.4324/9780203973851

Boruah, T., Kalita, M., Hasnu, S., Das, K.S., Singh, R., Nayik, G.A., 2024. Role of Digital Technologies in the Field of Horticultural Science and Technology, in: Novel Approach to Sustainable Temperate Horticulture. CRC Press.

Chaudhuri, S., Roy, M., McDonald, L.M., Emendack, Y., 2021. Reflections on farmers' social networks: a means for sustainable agricultural development? Environ Dev Sustain 23, Pp. 2973–3008. https://doi.org/10.1007/s10668-020-00762-6

Colindres, C., Cohen, A., Caxaj, C.S., 2021. Migrant Agricultural Workers' Health, Safety and Access to Protections: A Descriptive Survey Identifying Structural Gaps and Vulnerabilities in the Interior of British Columbia, Canada. IJERPH 18, 3696.

https://doi.org/10.3390/ijerph18073696

De Marchi, M., Sengar, B., Furze, J. N., 2017. Prospects for Sustainability in Human–Environment Patterns: Dynamic Management of Common Resources, in: Furze, James N., Swing, K., Gupta, A.K., McClatchey, R.H., Reynolds, D.M. (Eds.), Mathematical Advances Towards Sustainable Environmental Systems. Springer International Publishing, Cham, pp. 319–347. https://doi.org/10.1007/978-3-319-43901-3_14

Filho, W.L., Wall, T., Salvia, A.L., Dinis, M.A.P., Mifsud, M., 2023. The central role of climate action in achieving the United Nations' Sustainable Development Goals. Sci Rep 13, 20582. https://doi.org/10.1038/s41598-023-47746-w

Fotakis, E.A., Kontele, I., Tzoutzou, M., Grammatikopoulou, M.G., Arvanitaki, E., Sergentanis, T.N., Kotrokois, K., Kornarou, E., Vassilakou, T., 2024. Food Insecurity in Greece and across the Globe: A Narrative Literature Review. Foods 13, 1579. https://doi.org/10.3390/foods13101579

Gowing, J.W., Palmer, M., 2008. Sustainable agricultural development in sub-Saharan Africa: the case for a paradigm shift in land husbandry. Soil Use and Management 24, pp. 92–99. https://doi.org/10.1111/j.1475-2743.2007.00137.x

Haque, C.E., Khan, S.A., Choudhury, M., 2024. Role of multi-level institutions in facilitating innovation and adaptation technologies for reducing climate risk and impact: Evidence from coastal communities of Bangladesh. International Journal of Disaster Risk Reduction 111, 104669. https://doi.org/10.1016/j.ijdrr.2024.104669

Hossain, M., Fischer, K.S., 1995. Rice research for food security and sustainable agricultural development in Asia: Achievements and future challenges. GeoJournal 35, Pp. 286–298. https://doi.org/10.1007/BF00989136

Kabir, M.H., Rainis, R., 2015. Adoption and intensity of integrated pest management (IPM) vegetable farming in Bangladesh: an approach to sustainable agricultural development. Environ Dev Sustain 17, Pp. 1413–1429. https://doi.org/10.1007/s10668-014-9613-y

Lancker, E., Nijkamp, P., 2000. A policy scenario analysis of sustainable agricultural development options: a case study for Nepal. Impact Assessment and Project Appraisal 18, Pp. 111–124. https://doi.org/10.3152/147154600781767493

Lwoga, E.T., Ngulube, P., Stilwell, C., 2010. Managing indigenous knowledge for sustainable agricultural development in developing countries: Knowledge management approaches in the social context. International Information and Library Review 42, Pp. 174–185. https://doi.org/10.1080/10572317.2010.10762862

Mahedi, M., Pervez, A.K.M.K., Rahman, S.M.M., Sheikh, M.M., Shaili, S.J., 2025a. Emerging Trends in Livelihood Diversification in Rural Communities: A Bibliometric and Systematic Review. Asian Journal of Agricultural Extension, Economics and Sociology 43, Pp. 162–177. https://doi.org/10.9734/ajaees/2025/v43i42727

Mahedi, M., Shaili, S.J., Nurnobi, M., Shihab, A., 2025. Adoption Of Organic Farming Practices: A Comprehensive Review Of Trends, Determinants, And Challenges 8, Pp. 26–45.

Md Shahriar Kabir, Md Mahedi, A K M Kanak Pervez, Md Jahangir Alam, Shabrin Jahan Shaili, 2025. Bibliometric analysis of "precision agriculture" in the Scopus database. World J. Adv. Res. Rev. 25, Pp. 1087–1098. https://doi.org/10.30574/wjarr.2025.25.3.0733

Mondéjar-López, M., García-Simarro, M.P., Navarro-Simarro, P., Gómez-Gómez, L., Ahrazem, O., Niza, E., 2024. A review on the encapsulation of "eco-friendly" compounds in natural polymer-based nanoparticles as next generation nano-agrochemicals for sustainable agriculture and crop management. International Journal of Biological Macromolecules 280, 136030. https://doi.org/10.1016/j.ijbiomac.2024.136030

Narayan, M., Singh, N., Solanki, P., Srivastava, R.K., 2024. Impact of Extreme Events on Global Food Security, in: Singh, P., Ao, B., Deka, N., Mohan, C., Chhoidub, C. (Eds.), Food Security in a Developing World. Springer Nature Switzerland, Cham, pp. 133–152. https://doi.org/10.1007/978-3-031-57283-8_9

Pender, J., Gebremedhin, B., Benin, S., Ehui, S., 2001. Strategies for Sustainable Agricultural Development in the Ethiopian Highlands. American J Agri Economics 83, Pp. 1231–1240. https://doi.org/10.1111/0002-9092.00272

Perfecto, I., Vandermeer, J., Wright, A., 2019. Nature's Matrix: Linking Agriculture, Biodiversity Conservation and Food Sovereignty, 2nd ed. Routledge, Second edition. | Milton Park, Abingdon, Oxon ; New York, NY : Routledge, 2019. | Revised edition of: Nature's matrix : linking agriculture, conservation and food sovereignty. 2009. https://doi.org/10.4324/9780429028557

Prasad, V.K., Bhattacharya, P., Maru, D., Tanwar, S., Verma, A., Singh, A., Tiwari, A.K., Sharma, R., Alkhayyat, A., Țurcanu, F.-E., Raboaca, M.S., 2022. Federated Learning for the Internet-of-Medical-Things: A Survey. Mathematics 11, 151. https://doi.org/10.3390/math11010151

Qaim, M., 2020. Role of New Plant Breeding Technologies for Food Security and Sustainable Agricultural Development. Applied Eco Perspectives Pol 42, Pp. 129–150. https://doi.org/10.1002/aepp.13044

Reidsma, P., Bakker, M.M., Kanellopoulos, A., Alam, S.J., Paas, W., Kros, J., De Vries, W., 2015. Sustainable agricultural development in a rural area in the Netherlands? Assessing impacts of climate and socio-economic change at farm and landscape level. Agricultural Systems 141, Pp. 160–173. https://doi.org/10.1016/j.agsy.2015.10.009

Ren, H., Liu, B., Zhang, Z., Li, F., Pan, K., Zhou, Z., Xu, X., 2022. A water-energy-food-carbon nexus optimization model for sustainable agricultural development in the Yellow River Basin under uncertainty. Applied Energy 326, 120008. https://doi.org/10.1016/j.apenergy.2022.120008

Rezaei-Moghaddam, K., Karami, E., 2008. A multiple criteria evaluation of sustainable agricultural development models using AHP. Environ Dev Sustain 10, Pp. 407–426. https://doi.org/10.1007/s10668-006-9072-1

Shabrin Jahan Shaili, Uttam Kumar Kabiraj, Md Mahedi, 2025. Fungal Biocontrol in Agriculture: A Sustainable Alternative to Chemical Pesticides – A Comprehensive Review. World J. Adv. Res. Rev. 26, Pp. 2305–2316. https://doi.org/10.30574/wjarr.2025.26.1.0732

Shackleton, S., Luckert, M., 2015. Changing Livelihoods and Landscapes in the Rural Eastern Cape, South Africa: Past Influences and Future Trajectories. Land 4, Pp. 1060–1089. https://doi.org/10.3390/land4041060

Singh, H., Sharma, A., Bhardwaj, S.K., Arya, S.K., Bhardwaj, N., Khatri, M., 2021. Recent advances in the applications of nano-agrochemicals for sustainable agricultural development. Environ. Sci.: Processes Impacts 23, Pp. 213–239. https://doi.org/10.1039/D0EM00404A

Sorrell, S., Gatersleben, B., Druckman, A., 2020. The limits of energy sufficiency: A review of the evidence for rebound effects and negative spillovers from behavioural change. Energy Research and Social Science 64, 101439. https://doi.org/10.1016/j.erss.2020.101439

Uduji, J.I., Okolo-Obasi, E.N., Asongu, S.A., 2019. Corporate social responsibility and the role of rural women in sustainable agricultural development in sub-Saharan Africa: Evidence from the Niger Delta in Nigeria. Sustainable Development 27, Pp. 692–703. https://doi.org/10.1002/sd.1933

Zhang, H., Zhang, J., Song, J., 2022. Analysis of the threshold effect of agricultural industrial agglomeration and industrial structure upgrading on sustainable agricultural development in China. Journal of Cleaner Production 341, 130818. https://doi.org/10.1016/j.jclepro.2022.130818

Zhao, J., Luo, Q., Deng, H., Yan, Y., 2008. Opportunities and challenges of sustainable agricultural development in China. Phil. Trans. R. Soc. B 363, Pp. 893–904. https://doi.org/10.1098/rstb.2007.2190