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Food Security in the Era of Climate Change and Digitalization: A Bibliometric Analysis

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Food Security, Technology, Bibliometric, Vosviewer.

Food security has become a global strategic issue which, over time, has increasingly involved the digital technology sector. The adoption of technology is expected food security to bring positive impacts, particularly in improving production efficiency and contributing to climate change mitigation. However, its implementation also presents unique challenges within the food sector, making it an intriguing subject for further investigation. This study aims to provide a global perspective on scientific research related to food security and technology challenges by identifying trends over the years, key terms, influential articles, and highly cited publications. The research analyses 1,639 documents retrieved from the Scopus database, limited to journal articles only. In addition, a relational mapping technique using VOSviewer software was employed to generate graphical visualisations. The findings indicate an increasing trend in both the number of publications and citations concerning food security and technology challenges. The most significant keywords identified include food security, food supply, climate change, agriculture, and sustainable development. Meanwhile, research on smart agriculture and the use of digital technologies such as AI, blockchain, and deep learning remains relatively under-cited, highlighting a promising area for future research development.

1. Introduction

Food security remains a strategic issue demanding global attention. Six years out from 2030, the ambition of achieving zero hunger is still an unmet commitment (United Nations, 2022). Worryingly, the global problem of hunger and food insecurity has shown a concerning increase since 2015 (World Meteorological Day, 2024). This escalating trend of food insecurity is being compounded by a combination of diverse factors including pandemics, conflicts, climate change, and entrenched inequalities (Iannotti et al., 2024).

According to the latest Global Report on Food Crises (GRFC), nearly 282 million people across 59 countries and territories experienced high levels of acute hunger in 2023, a worldwide increase of 24 million people compared to the previous year (Alrozzi, 2024). The challenge of food insecurity is also driven by disruptions to fisheries production due to climate change, which triggers more frequent and intense extreme weather events such as droughts and dry seasons (Dasgupta & Robinson, 2022). The escalating issues of poverty, hunger, food insecurity, and related health concerns constitute an urgent problem. Agriculture encompassing crops, livestock, and fisheries is arguably the sector most vulnerable to climate variability and change. This is underscored by the fact that over 90% of Nationally Determined Contributions (NDCs) from developing countries highlight the necessity of adaptation support (Hotta, 2020).

Digitalisation within the food sector offers a solution to the influence of climate change on productivity. Mubarak & Petraite (2020) note that digitalisation is the integration of digital technology into daily life, where contemporary technology can transform the application of socio-economic research, environmental, sustainability, and climate fields. The development of the Internet of Things (IoT) represents an increasingly powerful technological disruption, enabling real-time analysis, artificial intelligence (AI), and machine learning to manage vast amounts of data (Morchid et al., 2024). This ultimately generates new opportunities that will accelerate the transition to more efficient and sustainable activities across numerous sectors, including the entire supply chain for fisheries and agriculture (John & Mishra, 2024; Shoomal et al., 2024).

Ultimately, the technological modernisation of food sector production has offered solutions to many of the problems caused by traditional farming practices, reducing resource use inefficiencies, minimising environmental impact, and enhancing productivity. However, despite the potential benefits, the adoption of technology amongst small-scale farmers and fishers remains limited. This limited technological adoption is attributable to numerous factors, notably the massive development of technology which does not match the knowledge of farmers and fishers. Therefore, through literature mapping, food security challenges in technological change can be identified. Literature mapping utilizes bibliometric analysis to build a robust foundation by mapping and articulating cumulative scientific knowledge (Donthu et al., 2021). This is done in order to gain a comprehensive overview, identify knowledge gaps, and obtain new research ideas. This analysis is useful for exploring the intellectual structure of a specific domain within the literature using large and subjective data (Lima & Bonetti, 2020).

2. Material and Methods

This study utilizes bibliometric techniques to gather and analyze the topic of technological challenges in food security. The collection of studies concerning the topic of technological challenges in food security is obtained from the Scopus database, featuring open access journal types. This technique is employed to identify publication patterns, author networks, and the development of related research topics (Rusydiana, Rahardjo, & Soeparno, 2021). The measurement of scientific impact is conducted through a number of metrics, including the accumulation of publications, total citations, the quality of citations per document, as well as the ranking of the most contributing journals or institutions during the research period (Ozdemir, Kulak, & Sekertekin, 2025). There are two primary focuses: the first measures the number of publications, which assesses productivity, and the second measures the number of citations, which assesses popularity and influence. Thus, this study is useful for mapping the knowledge landscape whilst simultaneously uncovering research gaps (knowledge gaps).

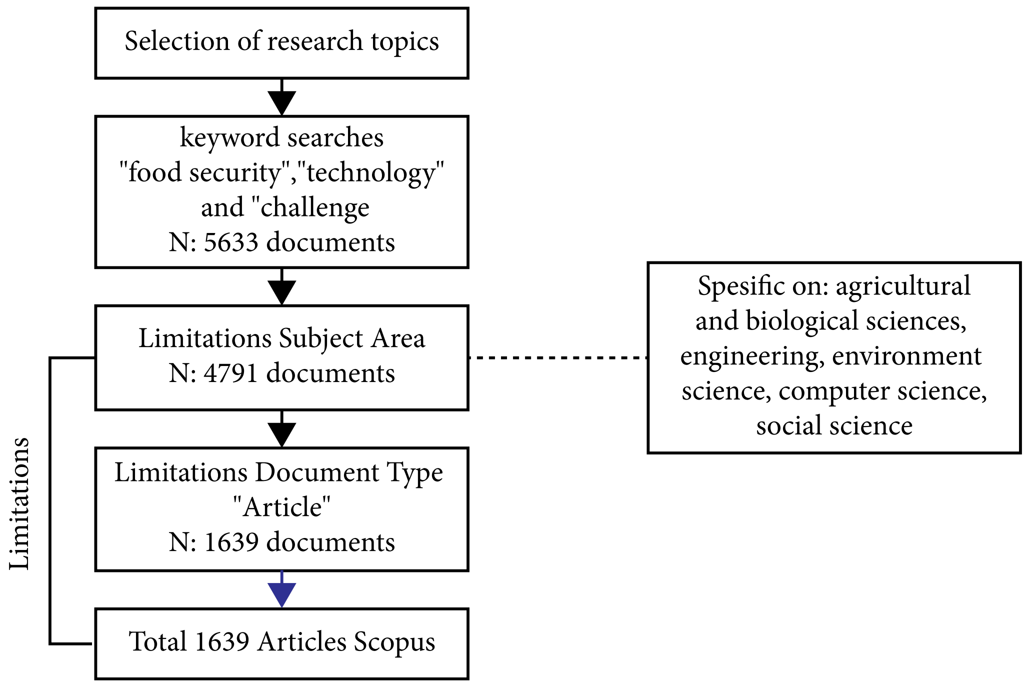

Figure 1: The Data and Research Techniques.

The data and research techniques employed in this study are illustrated in Figure 1. This study selected the Scopus database. We chose this database because it compiles scientific publications of the highest relevance and is a key factor in academic decision-making (Donthu et al., 2021). Scopus indexes over 25,000 titles from more than 5,000 publishers worldwide, making it one of the largest abstract and citation databases available for academic research (Magadán-Díaz & Rivas-García, 2022). Furthermore, Scopus has been consistently employed in bibliometric studies across various disciplines, particularly in agriculture, environmental science, and technology-related fields, which aligns with the interdisciplinary scope of this study. To ensure transparency and reproducibility, the search and screening protocol was conducted in four following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.

In The first stage, following exact Boolean search string was applied to titles, abstracts and keywords: TITLE-ABS-KEY ('Food Security" AND 'Technology' AND 'Challenge'), which yielded 5,602 documents. In the second stage, result was filtered by limiting to five subject areas, namely Agriculture and Biological Science Engineering, Environmental Science, Computer Science, and Social Sciences, reducing the database to 4,763 documents.

In the third stage, documents re included based on the following criteria: peer-reviewed journal articles only, written in English, and directly relevant to the intersection of food security, technology, and challenges. In the fourth and final stage, only documents categorized as "articles" were included in the analysis, while other types of documents (e.g., reviews, conference papers, and book chapters) were excluded.

The processed database deliberately did not restrict the time period, utilizing data from the inception of research on the related topic, which was 1968, up to 2025. It should be noted that the data search was conducted on 23rd September 2025, meaning data for 2025 only covers up to the month of September. This was done to capture the historical development of the topic and avoid omitting crucial early publications essential to the foundation of knowledge. This approach allows for a more comprehensive analysis of long-term trends and citation dynamics.

3. Result and Discussion

3.1. General Structure of Publication and Citation

According to the Scopus database, 1,639 articles have been published on food security, technology and challenge, focusing solely on the journal article publication type. Over the last fifty years, the number of publications in this area has experienced exponential growth (Figure 1). In greater detail, during the 1978–2008 period, the number of publications was very low, below 10 documents. The subsequent period, 2013–2016, was highly volatile. However, since 2016, the growth of publications has continued to increase, peaking in 2025, which contributed 20.8% of the total publications. This upward trend demonstrates the increasing importance of the topic in contemporary literature.

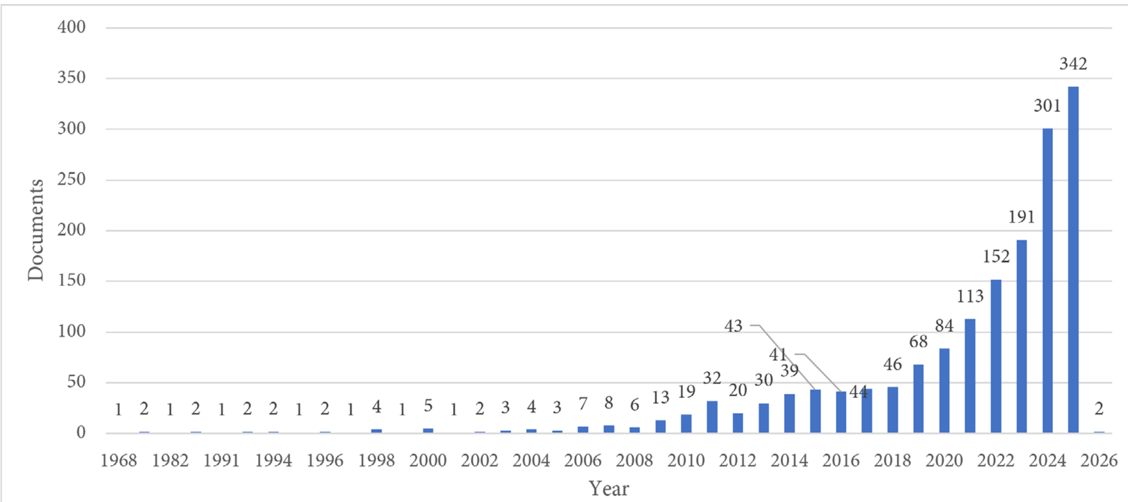

Figure 2: Evolution of Published Papers.

The Scopus journal article database obtained indicates that from 1968 to 2025, there are 1,639 articles with a total of 46,783 citations, giving a ratio of 28.54 citations per article. Figure 3 demonstrates that the percentage of citations was highly volatile throughout the period. Furthermore, during the initial period, journal production was below 10 documents for forty years (1968–2008) with an average of 68 citations. Conversely, during the period of consistent increase in the number of documents, from 2016 to 2025, an average of 138 documents received 3,185 citations. The peak of journal production was in 2025 with 342 documents, which received 469 citations. Meanwhile, the highest citation peak occurred in 2019 with 3,253 citations from a total of 68 documents. Thus, the post-2016 surge in publications can be interpreted as a response to the increasing urgency of food security issues triggered by global factors related to climate (Clarens & Peters, 2016), population growth (Mulungu et al., 2024; Subramaniam, 2024), policy and politics (Levytska & Kotsiubanska, 2023; Tan et al., 2024), Food Industry (Gao et al., 2024; Ronquest-Ross & Sigge, 2024; Vargas-Bello-Pérez et al., 2024).

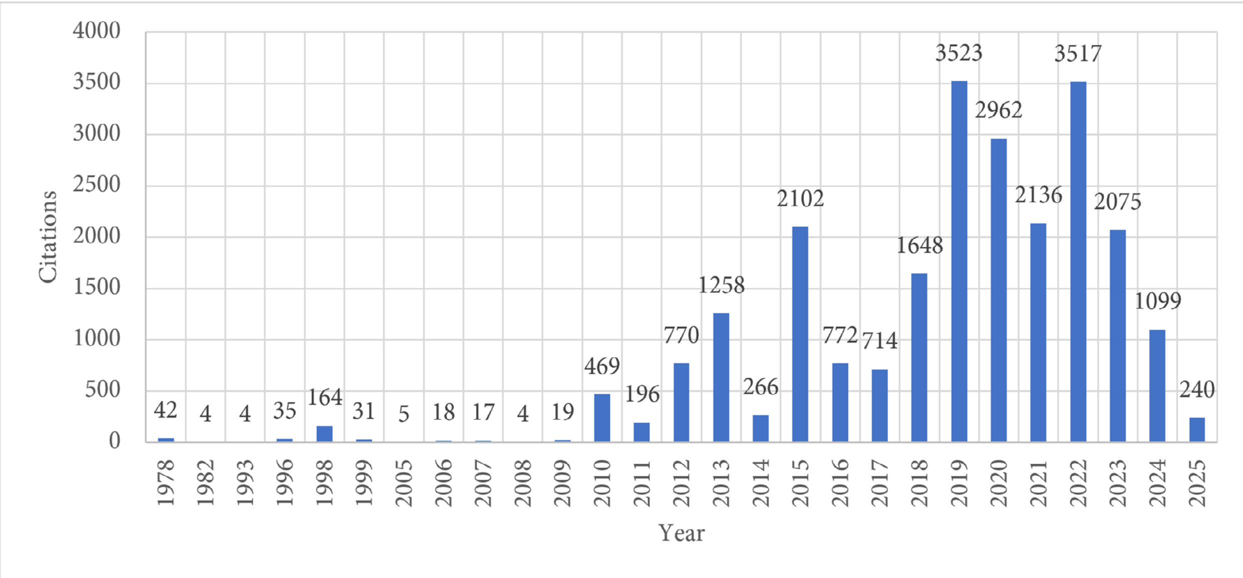

Figure 3: Evolution of Citation Research.

Table 1 presents the general citation structure for this research topic over the period of 1987 to 2025. Overall, many articles fall into the high citation category, defined as over 1,000 citations. There are only 12 documents that have fewer than 100 citations. This is likely due to the rapid development of modern technology which began to accelerate in 2010, resulting in an average of almost 3,000 citations with only an average of 52 documents. The trend indicates that the research topic 'Food Security', 'Technology' and 'Challenge' has become a significant issue recently, particularly considering that the SDG goals are due for completion in five years, in 2030.

More critically, the post-2010 surge in citations is likely to be influenced by several interrelated factors: the increasing global urgency of food security issues, especially in the wake of the food crisis, the environment is increasingly intensely discussed on the international agenda (Cuong et al., 2024; Duisenbekuly et al., 2024; Moss et al., 2025), Multidisciplinary integration (Banda et al., 2025), where the issue of food security begins to be studied together with technology, economics, and policy (Stevens & Ruperti, 2024), Increased international collaboration (Mugambwa, Lixia, & Xiuli, 2025) which has been empirically proven to increase the number of citations.

Table 1: General Citation Structure.

Numbers of Citations	TP	%of	TC	%of	TC/TP
1000-6000 citations	1223	74,62	44756	95,67	36,60
500 - 1000 citations	342	20,87	469	1,00	1,37
100-500 citations	40	2,44	1122	2,40	28,05
50-100 citations	3	0,18	127	0,27	42,33
10-50 citations	24	1,46	296	0,63	12,33
0-10 citations	7	0,43	13	0,03	1,86
Total	1639	100	46783	100	

Source: Scopus database (September 2025).
Note: TP = Total number of articles journal; TC = Total number of citations; TC/TP = Average Citations per Article.

3.2. Keywords

VOSviewer identified 9,988 keywords related to this topic from 1,639 articles. However, during the assessment and standardization process, only 57 keywords appeared at least 30 times (Table 2). Consequently, the number of keywords was adjusted and divided into four clusters (red, green, blue, yellow) based on similarity, as shown in Figure 4.

Table 2: Keywords Occurrence.

No	keywords	O	TLS	No	keywords	O	TLS
1	Africa	49	195	29	Food supply	279	1360
2	Agricultural production	60	240	30	Internet of things	61	178
3	Agricultural technology	95	421	31	Machine learning	49	157
4	Agricultural development	31	131	32	Precision agriculture	50	141
5	Alternative agriculture	54	284	33	Smart agriculture	35	134
6	China	82	390	34	Supply chains	36	172
7	Climate change	207	875	35	Sustainable agriculture	69	257
8	Crop production	62	366	36	Remote sensing	56	216
9	Crop yield	55	285	37	Agriculture	193	880
10	Food production	68	322	38	Catering service	30	215
11	Food security	584	1804	39	Economics	34	241
12	Innovation	61	177	40	Environmental impact	35	204
13	Maize	38	199	41	Environmental protection	35	246
14	Productivity	39	173	42	Food industry	37	207
15	Rice	48	168	43	Humans	45	274
16	Smallholder	46	200	44	Human	79	478
17	Sub-saharan africa	30	103	45	Land use	37	172
18	Technology adoption	69	237	46	Nonhuman	49	288
19	Decision making	54	283	47	Nutrition	30	105
20	Sustainability	139	538	48	Procedures	43	228
21	Agricultural robots	40	197	49	Technology	44	182
22	Artificial intelligence	55	175	50	Water	34	207
23	Blockchain	65	190	51	Cultivation	51	299
24	Block-chain	37	142	52	Irrigation	60	327
25	Crops	84	463	53	Sustainable development	148	707
26	Deep learning	52	143	54	Water conservation	35	240
27	Farms	33	209	55	Water management	51	308
28	Food safety	54	175	56	Water supply	39	264

Source: Own elaboration based on VOSviewer Note: O = occurrence; TLS = total link strength.

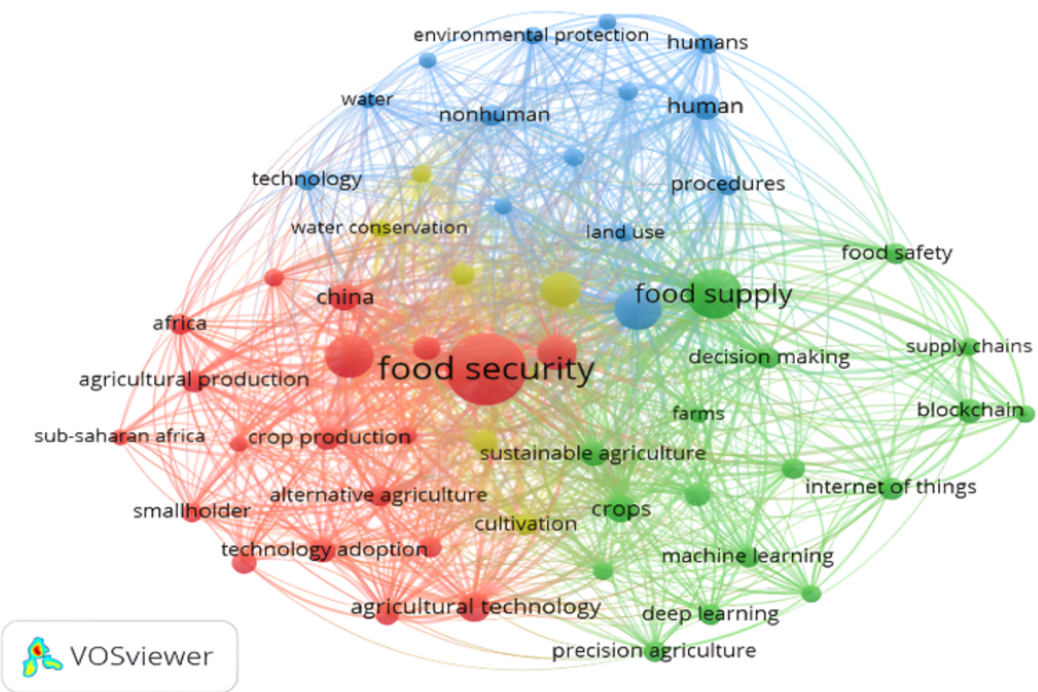

Figure 4: Co-occurrence of Author Keywords.
Source: VOS viewer 2025

Based on the VOSviewer findings in Figure 4, in the red cluster, the most frequently used keywords are food security, climate change and sustainability, with 584, 207, and 139 occurrences, respectively. This group of articles is clustered based on the direct relationship between agriculture production and climate change, which is how to address and simultaneously reduce the negative impacts of climate change through changes in agricultural technology.

For the green cluster, the focus is on artificial intelligence technology and food safety. This cluster has a relationship in the need for AI-based smart agriculture in building sustainable agriculture and meeting food supply needs (Alazzai et al., 2024; Narsareddygari & Naik, 2025; Yalamati, 2024). Furthermore, the relationship between AI technology and food supply in this cluster reflects that data-driven approaches are becoming increasingly important in ensuring stable and sustainable food availability. This technology has the potential to increase productivity while reducing the risk of crop failure due to environmental factors (Chavan et al., 2024; Kumar, Jarial, & Patil, 2025; Olawale, Olawumi, & Oladapo, 2025). However, the relatively lower frequency of AI-related keyword occurrences compared to conventional keywords suggests that the integration of advanced technologies in food security research is still in its early stages.

The most popular keyword in the green cluster is food supply, reaching 279 occurrences, while the others are below 100 occurrences. The remaining clusters are blue and yellow. The blue cluster highlights the balance between food production, environmental sustainability, and human welfare. In the blue cluster, the most frequently used keywords are agriculture with 193 occurrences, followed by humans with 79 occurrences; the remaining thirteen have a co-occurrence of less than 50 times. Meanwhile, the yellow cluster emphasizes sustainable agricultural practices with a focus on water resource management.

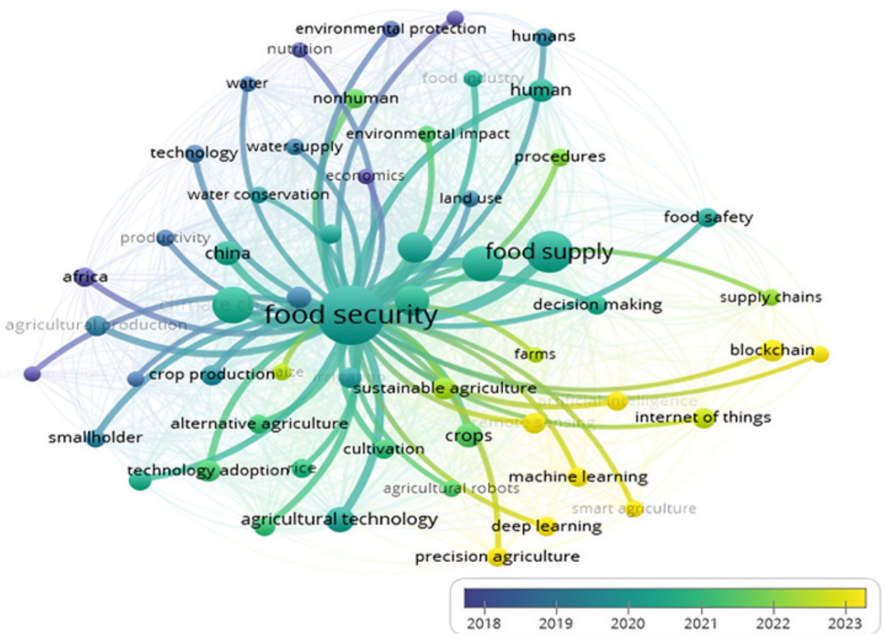

Figure 5: Evolution of Co-occurrence of Author Keywords.

Based on Figure 5, yellow cluster only has six keywords, with the most popular being sustainable development with 148 occurrences, irrigation with 60 occurrences, and water management with 51 occurrences. The focus is on the optimization of cultivation and irrigation techniques whilst preserving and managing water to achieve sustainable agricultural development.

Furthermore, VOSviewer chronologically reveals current research trends. When linked to Figure 4 and Table 2, strong relevance is shown in exploring technological challenges in food security, which consists of keywords concerning the red cluster highlighting the technological dimension of food security, comprising keywords related to smart and precision agriculture as researched by Poortinga et al. (2020), Martinho et al. (2022), Biibosunov et al. (2023), Mhanna et al. (2023) and Zysk, Mroczkowski, & Dawidowicz (2022) and advanced digital devices (AI, ML, IoT, blockchain) as studied by Wang, He, & Wu (2022), Shao & Marwa

(2024), Kumar et al. (2023), Ahmad et al. (2024), Qian et al. (2022), Sammer et al. (2024), Gupta et al. (2023) and Makkar (2018).

Another interesting aspect is to analyses the most cited and influential articles and authors on Food Security and Technological Challenges over the last decade. The more frequently an article is cited, it is usually considered to have a greater influence on the development of scientific knowledge. However, this measure does not always reflect the true level of influence. Thus, the Impact Factor of each article will be taken into account.

Table 3: Ranking of the most Cited Papers.

No	Title	Author	Year	Source title		Q	TC	IF
1	An Overview of Internet of Things (IoT) and Data Analytics in Agriculture: Benefits and Challenges	Elijah, Olakunle; Rahman, Tarek Abd; Orikumhi, Igbafe ; Leow, Chee Yen; Hindia, Mhd Nour	2018	IEEE Internet of Things Journal	Institute of Electrical and Electronics Engineers Inc.	Q1	1206	8.2
2	Blockchain technology in supply chain operations: Applications, challenges and research opportunities	Dutta, Pankaj; Choi, Tsan Ming; Somani, Surabhi ; Butala, Richa	2020	Transportation Research Part E: Logistics and Transportation Review	Elsevier Ltd	Q1	1185	8.8
3	Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security	Shiferaw, Bekele; Smale, M. ; Braun, Hans Joachim; Duveiller, Etienne M.; Reynolds, M. P.; Muricho, Geoffrey Simiyu	2013	Food Security	Springer Science and Business Media B.V.	Q1	1001	6.2
4	Internet-of-Things (IoT)-based smart agriculture: Toward making the fields talk	AYAZ, Muhammad; Ammad-Uddin, Mohammad; Sharif, Zubair; Mansour, Ali; Aggoune, El Hadi M.	2019	IEEE Access	Institute of Electrical and Electronics Engineers Inc.	Q1	934	3.6
5	The agroecological revolution in Latin America: Rescuing nature, ensuring food sovereignty and empowering peasants	Altieri, Miguel Angel; Toledo, Víctor Manuel	2011	Journal of Peasant Studies	Routledge	Q1	814	4.8
6	Millet grains: Nutritional quality, processing, and potential health benefits	Saleh, Ahmed S.M., Zhang, Qing; Chen, Jing; Shen, Qun	2013	Comprehensive Reviews in Food Science and Food Safety	John Wiley and Sons Inc	Q1	773	14.1
7	Modeling the blockchain enabled traceability in agriculture supply chain	Kamble, Sachin S.; Gunasekaran, Angappa; Sharma, Rohit	2020	International Journal of Information Management	Elsevier Ltd	Q1	770	27.0
8	Towards global phosphorus security: A systems framework for phosphorus recovery and reuse options	Cordell, Dana J.; Rosemarin, Arno S.; Schröder, Jaap J.; Smit, A. L.	2011	Chemosphere	Elsevier Ltd	Q1	767	-
9	A systematic literature review on machine learning applications for sustainable agriculture supply chain performance	Sharma, Rohit; Kamble, Sachin S.; Gunasekaran, Angappa; Kumar, Vikas; Kumar, Anil	2020	Computers and Operations Research	Elsevier Ltd	Q1	612	4.3
10	Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions	Zhao, Guoqing; Liu, Shaofeng; Lopez, Carmen; Lu, Haiyan Emma; Elgueta, Sebastián A.; Chen, Huilan; Mileva Boshkoska, Biljana	2019	Computers in Industry	Elsevier B.V.	Q1	579	9.1

Source: Own elaboration based on Scopus Data Based (2025). Note : Q = Quartile Scopus TC = Total citations; IF = Impact Factor

Research concerning technological challenges in food security demonstrates a dominance in the topics of the Internet of Things (IoT), blockchain, and machine learning. These technologies are employed to optimize production, distribution, and the transparency of the food supply chain.

Analysis of the top 10 articles concerning technological challenges in food security indicates that the number of citations and the Journal Impact Factor (IF) are not always directly proportional. Citations reflect the actual influence of an article amongst researchers, whereas IF measures the reputation and visibility of the journal where the article was published. Articles with a high IF are typically published in reputable journals, such Kamble, Gunasekaran, & Sharma (2020) regarding blockchain in the food supply chain. This signifies that the journal holds considerable appeal and influence in the field of information technology. Likewise, *Comprehensive Reviews in Food Science and Food Safety* (IF 14.1) plays a crucial role in the topic of food safety. However, an article in *IEEE Access* (IF 3.6) by Ayaz et al. (2019) successfully achieved 934 citations, demonstrating that the relevance and novelty of the topic—such as IoT and smart agriculture—can surpass the impact of the journal's reputation on the number of citations. All articles originate from Q1 journals, meaning they are in the top quartile of reputable journals. This finding confirms that journal reputation (Q1) enhances publication credibility, but the citation rate is influenced by the urgency of the topic, the novelty of the technology, and the global need for food security solutions.

4. Conclusion

This bibliometric study highlights the increasing significance of Food Security and Technological

Challenges as a global research area. Over the last five decades, publications show an exponential increase, especially since 2016, reflecting the urgent need to address food insecurity through technological innovation.

Analysis of 1,639 Scopus-indexed journal articles with 46,783 citations reveals that research in this field has evolved from climate-focused agricultural studies towards the integration of digital technologies such as IoT, blockchain, artificial intelligence, and machine learning. These technologies demonstrate the potential to optimize production, enhance supply chain transparency, and address environmental constraints. Interestingly, this study shows that the number of citations does not always correlate with a high Impact Factor (IF). Although articles published in Q1 journals with high IF show strong journal reputation and visibility, they have high citation impact due to the relevance and novelty of the topic. Overall, these findings confirm the importance of integrating technology into food systems and suggest that future research should focus on overcoming adoption barriers, particularly for small-scale farmers and fishers. Bridging the gap between advanced digital technology and end-user capacity will be key to achieving global food security targets, including the second SDG, Zero Hunger, by 2030. Despite the contributions of this research, several limitations of this bibliometric study need to be noted and considered in subsequent research.

This research has several limitations. The analysis only utilizes Scopus-indexed publication data. Furthermore, this study does not deeply assess the methodological content and empirical results of each article but rather focuses on publication patterns and bibliometric metrics. This limitation opens opportunities for subsequent research to integrate qualitative analysis and broader data sources to obtain a more comprehensive understanding.

5. Disclosure Statement

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References

Ahmad, R. W., Ko, K.-M., Rashid, A., & Rodrigues, J. J. P. C. (2024). Blockchain for Food Industry: Opportunities, Requirements, Case Studies, and Research Challenges. *IEEE Access, 12*, 117363–117378. doi: https://doi.org/10.1109/ACCESS.2024.3447918

Alazzai, W. K., Obaid, M. K., Abood, B. S. Z., & Jasim, L. (2024). Smart Agriculture Solutions: Harnessing AI and IoT for Crop Management. *E3S Web of Conferences, 477*, 00057. doi: https://doi.org/10.1051/e3sconf/202447700057

Alrozzi, Y. (2024). *Global Report on Food Crises: Acute Hunger Remains Persistently High in 59 Countries with 1 in 5 People Assessed in Need of Critical Urgent Action*. FAO. Retrieved from https://www.fao.org/newsroom/detail/global-report-on-food-crises---acute-hunger-remains-persistently-high-in-59-countries-with-1-in-5-people-assessed-in-need-of-critical-urgent-action

Ayaz, M., Ammad-Uddin, M., Sharif, Z., Mansour, A., & Aggoune, E.-H. M. (2019). Internet-of-Things (IoT)-Based Smart Agriculture: Toward Making the Fields Talk. *IEEE Access, 7*, 129551–129583. doi: https://doi.org/10.1109/ACCESS.2019.2932609

Banda, L. O. L., Banda, C. V., Banda, J. T., & Chidimbah Munthali, G. N. (2025). Food insecurity in Malawi: Regional disparities, sociocultural determinants, and the role of mobile advisory services. *Food and Humanity, 5*, 100695. doi: https://doi.org/10.1016/j.foohum.2025.100695

Biibosunov, B., Sabitov, B., Biibosunova, S., Sheishenov, Z., Zhusupkeldiev, S., & Mamadalieva, Z. (2023). Machine learning for crop yield forecasting. *Cybernetics and Physics, 12*(3), 174–181. doi: https://doi.org/10.35470/2226-4116-2023-12-3-174-181

Chavan, L., Kumbhalkar, R., Agrawal, P., Rakesh, N., Parvathi, R., & Shahid, M. (2024). AI in Agriculture: Yield Optimization and Food Security. In *2024 4th International Conference on Technological Advancements in Computational Sciences (ICTACS)* (pp. 536–541). IEEE. doi: https://doi.org/10.1109/ICTACS62700.2024.10840614

Clarens, A. F., & Peters, C. A. (2016). Mitigating Climate Change at the Carbon Water Nexus: A Call to Action for the Environmental Engineering Community. *Environmental Engineering Science, 33*(10), 719–724. doi: https://doi.org/10.1089/ees.2016.0455

Cuong, H. N., Thuan, T. D., Tiep, N. C., Thuan, N. Q., Diep, N. X., & Huyen, V. T. K. (2024). Agriculture Growth and Environmental Degradation in Vietnam: Do Natural Resources Play a Vital Role in this Regard. *AgBioForum, 26*(1), 155–164. Retrieved from https://agbioforum.org/menuscript/index.php/agb/article/view/355

Dasgupta, S., & Robinson, E. J. Z. (2022). Attributing changes in food insecurity to a changing climate. *Scientific Reports, 12*(1), 4709. doi: https://doi.org/10.1038/s41598-022-08696-x

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

Duisenbekuly, A.-k., Kulbay, B., Bigeldiyeva, Z., Zhakipbekova, D., & Daurbayeva, M. (2024). Food security in Kazakhstan and Azerbaijan: Challenges and strategies for economic and sustainable development. *International Journal on Food System Dynamics, 15*(3), 267–277. doi: https://doi.org/10.18461/ijfsd.v15i3.K5

Gao, N., Liang, W., Gou, F., Liu, Y., Fu, B., & Lü, Y. (2024). Assessing the impact of agriculture, coal mining, and ecological restoration on water sustainability in the Mu Us Sandyland. *Science of The Total Environment, 929*, 172513. doi: https://doi.org/10.1016/j.scitotenv.2024.172513

Gupta, S., Campos Zeballos, J., del Río Castro, G., Tomičić, A., Andrés Morales, S., Mahfouz, M., et al. (2023). Operationalizing Digitainability: Encouraging Mindfulness to Harness the Power of Digitalization for Sustainable Development. *Sustainability, 15*(8), 6844. doi: https://doi.org/10.3390/su15086844

Hotta, M. (2020). *The Sustainable Contribution of Fisheries to Food Security in the Asia and Pacific Region: Regional Synthesis*. FOA. Retrieved from https://www.fao.org/4/x6956e/x6956e02.htm

Iannotti, L., Kleban, E., Fracassi, P., Oenema, S., & Lutter, C. (2024). Evidence for Policies and Practices to Address Global Food Insecurity. *Annual Review of Public Health, 45*, 375–400. doi: https://doi.org/10.1146/annurev-publhealth-060922-041451

John, E. P., & Mishra, U. (2024). Integrated multitrophic aquaculture supply chain fish traceability with blockchain technology, valorisation of fish waste and plastic pollution reduction by seaweed bioplastic: A study in tuna fish aquaculture industry. *Journal of Cleaner Production, 434*, 140056. doi: https://doi.org/10.1016/j.jclepro.2023.140056

Kamble, S. S., Gunasekaran, A., & Sharma, R. (2020). Modeling the blockchain enabled traceability in agriculture supply chain. *International Journal of Information Management, 52*, 101967. doi: https://doi.org/10.1016/j.ijinfomgt.2019.05.023

Kumar, M., Choubey, V. K., Raut, R. D., & Jagtap, S. (2023). Enablers to achieve zero hunger through IoT and blockchain technology and transform the green food supply chain systems. *Journal of Cleaner Production, 405*, 136894. doi: https://doi.org/10.1016/j.jclepro.2023.136894

Kumar, S., Jarial, S., & Patil, N. D. C. (2025). Challenges, Opportunities, and the Future of Agricultural Innovations Through AI. In P. Lal & P. Mishra (Eds.), *Transforming Agriculture through Artificial Intelligence for Sustainable Food Systems* (pp. 201–212). Springer Nature Singapore. doi: https://doi.org/10.1007/978-981-96-4795-8_12

Levytska, N., & Kotsiubanska, O. (2023). Food industry of Ukraine during the Russian invasion: losses, experience, adaptation. *Ukrainian Food Journal, 12*(2), 199–206. doi: https://doi.org/10.24263/2304-974X-2023-12-2-4

Lima, C. O., & Bonetti, J. (2020). Bibliometric analysis of the scientific production on coastal communities' social vulnerability to climate change and to the impact of extreme events. *Natural Hazards, 102*(3), 1589–1610. doi: https://doi.org/10.1007/s11069-020-03974-1

Magadán-Díaz, M., & Rivas-García, J. I. (2022). Publishing Industry: A Bibliometric Analysis of the Scientific Production Indexed in Scopus. *Publishing Research Quarterly, 38*(4), 665–683. doi: https://doi.org/10.1007/s12109-022-09911-3

Makkar, H. P. S. (2018). Review: Feed demand landscape and implications of food-not feed strategy for food security and climate change. *Animal, 12*(8), 1744–1754. doi: https://doi.org/10.1017/S175173111700324X

Martinho, V. J. P. D., Cunha, C. A. d. S., Pato, M. L., Costa, P. J. L., Sánchez-Carreira, M. C., Georgantzís, N., et al. (2022). Machine Learning and Food Security: Insights for Agricultural Spatial Planning in the Context of Agriculture 4.0. *Applied Sciences, 12*(22), 11828. doi: https://doi.org/10.3390/app122211828

Mhanna, S., Halloran, L. J. S., Zwahlen, F., Asaad, A. H., & Brunner, P. (2023). Using machine learning and remote sensing to track land use/land cover changes due to armed conflict. *Science of The Total Environment, 898*, 165600. doi: https://doi.org/10.1016/j.scitotenv.2023.165600

Morchid, A., El Alami, R., Raezah, A. A., & Sabbar, Y. (2024). Applications of internet of things (IoT) and sensors technology to increase food security and agricultural Sustainability: Benefits and challenges. *Ain Shams Engineering Journal, 15*(3), 102509. doi: https://doi.org/10.1016/j.asej.2023.102509

Moss, A., Peh, J. H., Afiqah-Aleng, N., Segaran, T. C., Gao, H., Wang, P., et al. (2025). Aquaculture And Climate Change: A Data-Driven Analysis. *Annals of Animal Science, 25*(2), 547–568. doi: https://doi.org/10.2478/aoas-2024-0085

Mubarak, M. F., & Petraite, M. (2020). Industry 4.0 technologies, digital trust and technological orientation: What matters in open innovation? *Technological Forecasting and Social Change, 161*, 120332. doi: https://doi.org/10.1016/j.techfore.2020.120332

Mugambwa, J., Lixia, T., & Xiuli, X. (2025). Community leadership, policy implementation and rural revitalization in China: perspectives for Africa. *Cogent Social Sciences, 11*(1), 2535512. doi: https://doi.org/10.1080/23311886.2025.2535512

Mulungu, K., Abro, Z., Niassy, S., Muriithi, B., Picthar, J., Kidoido, M., et al. (2024). The economic, social, and environmental impact of ecologically centered integrated pest management practices in East Africa. *Journal of Environmental Management, 371*, 123241. doi: https://doi.org/10.1016/j.jenvman.2024.123241

Narsareddygari, S., & Naik, S. M. (2025). Harnessing AI for Progressive and Sustainable Education in the 21st Century: Case Studies and Insights. *Journal of Engineering Education Transformations, 38*, 159–165. Retrieved from https://www.journaleet.in/index.php/jeet/article/view/2268

Olawale, R. A., Olawumi, M. A., & Oladapo, B. I. (2025). Sustainable farming with machine learning solutions for minimizing food waste. *Journal of Stored Products Research, 112*, 102611. doi: https://doi.org/10.1016/j.jspr.2025.102611

Ozdemir, E., Kulak, M., & Sekertekin, A. (2025). Bibliometric Analysis of Monitoring and Mapping of Soil Salinity Using Remote Sensing Approaches: Reports from the Past Three Decades. *Eurasian Soil Science, 58*(11), 141. doi: https://doi.org/10.1134/S1064229325601027

Poortinga, A., Aekakkararungroj, A., Kityuttachai, K., Nguyen, Q., Bhandari, B., Soe Thwal, N., et al. (2020). Predictive Analytics for Identifying Land Cover Change Hotspots in the Mekong Region. *Remote Sensing, 12*(9), 1472. doi: https://doi.org/10.3390/rs12091472

Qian, J., Yu, Q., Jiang, L., Yang, H., & Wu, W. (2022). Food cold chain management improvement: A conjoint analysis on COVID-19 and food cold chain systems. *Food Control, 137*, 108940. doi: https://doi.org/10.1016/j.foodcont.2022.108940

Ronquest-Ross, L.-C., & Sigge, G. O. (2024). South Africa's food system: An industry perspective on past, present and future applications of science and technology. *South African Journal of Science, 120*(7-8), 1–6. doi: 10.17159/sajs.2024/16536

Rusydiana, A. S., Rahardjo, S., & Soeparno, W. S. (2021). Mapping Research on Halal Logistics using VoSviewer. *Library Philosophy and Practice (e-journal)*, 5895. Retrieved from https://scholarworks.sjsu.edu/libphilprac/5895

Sammer, M., Seong, K., Olvera, N., Gronseth, S. L., Anderson-Fletcher, E., Jiao, J., et al. (2024). AI-FEED: Prototyping an AI-Powered Platform for the Food Charity Ecosystem. *International Journal of Computational Intelligence Systems, 17*(1), 259. doi: https://doi.org/10.1007/s44196-024-00656-9

Shao, D., & Marwa, N. (2024). Blockchain-enabled smart contracts for enhancing seed certification transparency: A design science approach. *Smart Agricultural Technology, 9*, 100651. doi: https://doi.org/10.1016/j.atech.2024.100651

Shoomal, A., Jahanbakht, M., Componation, P. J., & Ozay, D. (2024). Enhancing supply chain resilience and efficiency through internet of things integration: Challenges and opportunities. *Internet of Things, 27*, 101324. doi: https://doi.org/10.1016/j.iot.2024.101324

Stevens, H., & Ruperti, Y. (2024). Smart food: novel foods, food security, and the Smart Nation in Singapore. *Food, Culture & Society, 27*(3), 754–774. doi: https://doi.org/10.1080/15528014.2022.2163455

Subramaniam, Y. (2024). Population Growth, Biofuel Production, and Food Security. *Green and Low-Carbon Economy, 2*(4), 259–268. doi: https://doi.org/10.47852/bonviewGLCE3202948

Tan, B., Sheng, L.-S., Yuan, Q., Xu, D.-F., Hao, Y.-Y., Zhou, S.-Q., et al. (2024). Chinese adapting land policy is guiding "photovoltaic plus" as a nature-based solution towards future. *Nature-Based Solutions, 6*, 100201. doi: https://doi.org/10.1016/j.nbsj.2024.100201

United Nations. (2022). *Goal 2: Zero Hunger.* United Nations. Retrieved from https://www.un.org/sustainabledevelopment/hunger

Vargas-Bello-Pérez, E., Espinoza-Sandoval, O. R., Rodríguez-Piñeros, S., & Ghavipanje, N. (2024). Supply and value chain of the dairy industry in Mexico. *International Journal of Agriculture and Natural Resources, 51*(3), 219–230. doi: https://doi.org/10.7764/ijanr.v51i3.2643

Wang, L., He, Y., & Wu, Z. (2022). Design of a Blockchain-Enabled Traceability System Framework for Food Supply Chains. *Foods, 11*(5), 744. doi: https://doi.org/10.3390/foods11050744

World Meteorological Day. (2024). *Agriculture and Food Security.* World Meteorological Organization. Retrieved from https://wmo.int/site/frontline-of-climate-action/priorities/agriculture-and-food-security

Yalamati, S. (2024). The Contribution of Artificial Intelligence to Foster Sustainable Food Systems in Agriculture. In P. Whig, P. Sharma, N. Aneja, A. A. Elngar, & N. Silva (Eds.), *Artificial Intelligence and Machine Learning for Sustainable Development* (pp. 236–248). CRC Press. doi: https://doi.org/10.1201/9781003497189-18

Zysk, E., Mroczkowski, T., & Dawidowicz, A. (2022). Small Farms as "Data Producers" for the Needs of Agricultural Management Information System. *Geomatics and Environmental Engineering, 16*(3), 79–109. doi: https://doi.org/10.7494/geom.2022.16.3.79

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