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Forecasting disruptions in global food value chains to tackle food insecurity: The role of AI and big data analytics – A bibliometric and scientometric analysis

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ABSTRACT

Globalization and interconnected supply chains have led to complex disruptions in global value chains, caused by various factors such as natural disasters, climate events, geopolitical conflicts, and economic crises. Recent breakthroughs in AI, machine learning, blockchain, and big data analytics offer new possibilities for forecasting and managing these disruptions effectively. This study examines the role of AI in forecasting and managing disruptions within global value chain to tackle food insecurity. We conducted a bibliometric and scientometric analysis using comprehensive data from Scopus and Web of Science to explore emerging research trends, influential publications, leading institutions, collaborations, themes, policy implications, and future research avenues. The research revealed an average yearly growth rate of 13.78 % in publications from 1973 to 2022. China, the United Kingdom, and the United States lead in AI applications to address supply chain disruptions, particularly concerning food insecurity. Frequently used keywords include "food security," "supply chain management," "agriculture," "modelling," "climate change," and "COVID-19." Themes identified focus on the impact of COVID-19 on food supply chains, achieving food security amidst climate change, leveraging predictive models in agriculture, and assessing the impact of disruptions on food price volatility and global supply chain risk assessment approaches. The insights gained from this research offer valuable guidance for policymakers and researchers to enhance food security. The identified themes provide direction for future research efforts in advancing food security amidst uncertainties and disruptions in global value chains.

1. Introduction

Global value chains are crucial in the production and distribution of food, impacting food security and accessibility worldwide [1]. However, disruptions in these chains, caused by various factors such as climate change, pandemics, natural disasters, or geopolitical events, can severely affect food availability and exacerbate food insecurity [2–7]. The role of AI and big data analytics in forecasting disruptions in global value chains to tackle uncertainties has been explored in several scientific publications [8–16]. Previous studies have highlighted the potential of AI and big data analytics to improve predictions of agricultural yields throughout Africa, identify food deserts, fix supply chain inefficiencies, and predict food insecurity [17–23]

According to the Food and Agriculture Organization (FAO), Africa is not on track to meet the Sustainable Development Goal (SDG) 2 targets to end hunger and ensure access by all people to safe, nutritious, and sufficient food all year round, and to end all forms of malnutrition EAST, N., & AFRICA, N [24]. In 2020, over one-fifth of the African population, or 281.6 million people, faced hunger, which is 46.3 million more than in 2019 EAST, N., & AFRICA, N [24]. The prevalence of

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undernourishment in Africa was 20.2 % in 2021, compared to 9.1 % in Asia, 8.6 % in Latin America, and the Caribbean Unicef [25]. The situation is particularly severe in sub-Saharan Africa, where the prevalence of food insecurity is higher than in Northern Africa Unicef. [25]; Unicef [26]. The COVID-19 pandemic has further exacerbated the food insecurity situation in Africa and other parts of the world Unicef. [27]; Unicef [26].

Zero hunger is a core objective of the United Nations Sustainable Development Goals (UNSDGs), aiming to eliminate hunger, ensure food security, and promote sustainable agriculture by 2030 [24]. Regrettably, recent reports from the Food and Agriculture Organization (FAO) emphasize the persistently sluggish progress in achieving these goals [24]. Sustainable Development Goal 2, often referred to as "Zero Hunger," aspires to create a world entirely free from hunger by 2030. Unfortunately, in 2020, the global hunger crisis continued to pose a significant challenge, impacting between 720 million and 811 million individuals, marking an increase of approximately 161 million people compared to the previous year [28]. Additionally, in the same year, a staggering 2.4 billion people, representing over 30% of the world's population, grappled with moderate to severe food insecurity, struggling to access a consistent and adequate food supply [28].

Addressing another significant challenge, the World Resources Institute reports that approximately one-third of food produced globally is lost or wasted, resulting in economic losses of an estimated $1 trillion a year. In sub-Saharan Africa, the estimate is roughly 37 % or 120–170 kg/year per capita [29,30]. Food waste in Africa and other developing nations is an entirely different problem than it is in developed regions. In developing regions, often the biggest chunk of food loss — more than 40% — occurs during the post-harvest phase [31,32]. The waste is an economic loss, but it is also a loss of precious nutrition and calories. The World Bank report estimated that the value of annual losses, $4 billion, could feed 48 million people [31,32]. Therefore, reducing food waste is crucial to achieving food security in Africa.

Addressing these disruptions and making provisions for food security is a complex and pressing challenge for policymakers, researchers, and stakeholders in the agricultural and food sectors. The agri-food sector has been revolutionized by AI technology, leading to increased efficiency, waste reduction, and significant improvements in food safety standards and quality [33]. For example, The Africa Agriculture Watch (AAgWa) platform integrates remote sensing data, satellite imagery, and historical data and applies machine learning techniques to predict yields for farmers and policymakers. Additionally, it is now incorporating the utilization of AI.

Despite the increasing interest in AI and Big Data Analytics in global value chains and food security, there is a need for a comprehensive analysis of the existing literature. While several studies have explored the use of AI and Big Data Analytics in various domains, the literature is fragmented, and there is a need for a systematic evaluation and synthesis of the extant studies focusing specifically on forecasting disruptions in global value chains to address food insecurity. Furthermore, there is a wide array of methodologies employed in the field, and a lack of a comprehensive synthesis of all studies and methodologies; [34–38] employed empirical methods to address food insecurity outcomes [39], employed a simulation model to improve performance of food reclamation center [40], carried out a comprehensive review to study supply chain disruptions during COVID. A bibliometric and scientometric analysis of the literature can provide valuable insights into the key themes, trends, and gaps in the research landscape, allowing for a deeper understanding of the advancements and potential areas of improvement (see for example: [7,41,42])

Given the above-identified gap, this research aims to identify the latest trends in AI and big data use in analytics for forecasting disruptions in global value chains, specifically related to food security in Africa. This analysis will shed light on the most recent advancements and areas, research gaps, and future research areas. To address the stated objective, the researchers utilize scientometric and bibliometric analysis. By applying these analytical techniques, the study will identify the most influential publications, authors, articles, institutions, and countries in the field. This can help researchers and practitioners understand the key contributions and insights that have shaped the current understanding of forecasting disruptions in global value chains and identify future areas of study.

Related to the set study objectives, the following research questions are set to be tackled:

RQ1. What are the current research trends in using AI and big data analytics to forecast disruptions in global value chains, specifically focusing on food security in Africa? This includes identifying the most influential articles and authors in the field and the prolific institutions and countries leading the research agenda on AI and food security.

RQ2. Which publications have had the most significant influence in the domain of forecasting disruptions in global value chains using AI and big data analytics?

RQ3. Which institutions and research collaborations have been actively contributing to the field of forecasting disruptions in global value chains using AI and big data analytics?

RQ4. What are the prevailing themes and topics addressed in the research related to AI and big data analytics in forecasting disruptions in global value chains, particularly concerning food security? How can the findings inform decision-making processes and policy development in addressing food security challenges?

RQ5. What are the potential future research directions that can guide further advancements in the field of forecasting disruptions in global value chains using AI and big data analytics?

The proposed study will make several contributions to the existing literature and research community. Firstly, the bibliometric analysis will provide a comprehensive overview of the scholarly output in the field, showcasing the growth and development of research on forecasting disruptions in global value chains for food security. It will also highlight the collaborative networks among researchers and institutions and identify potential areas for international cooperation.

Secondly, previous studies have primarily focused on exploring the application of AI technologies to enhance efficiency and reduce waste in food value chains [22]. This study employs scientometric and bibliometric analysis to identify emerging trends and patterns in the use of AI and big data analytics for forecasting disruptions in global value chains and addressing food insecurity, specifically in Africa. The analysis delves deeper into the content of the publications, revealing the primary research themes, methodologies, gaps, and research frontiers, guiding future research directions, and supporting evidence-based decision-making.

Furthermore, the study will offer insights into utilizing AI and Big Data Analytics in addressing food security challenges. It will critically assess the strengths and limitations of these technologies and propose ways to optimize their applications in forecasting disruptions and implementing effective strategies for food security.

Bibliometric and scientometric evaluation offers a quantitative assessment of research quality and its productivity across different classification years, fields of research, most relevant countries, and other [43]. Adopting these procedures can assist in identifying research trends and scientific evolution in a research field, the impact of research publications, the most relevant authors, and the most cited papers [44]. Broadly, these two approaches help scholars monitor research direction, assess the contribution of authors and journals, as well as assessing the spreading process of scientific knowledge.

The rest of the paper is structured as follows: Section 2 presents the literature review, and Section 3 provides the methodology, describing the bibliometric and scientometric analysis, including the search strategy and data sources. Section 4 presents the results and analysis and describes key findings. Section 5 presents the discussion and policy recommendations are presented in Section 6. Finally, Section 7 presents the conclusion by summarizing the key findings and pointing out the study's limitations.

2. Literature review

One of the common challenges affecting many nations of the world is food insecurity. For example it impacts millions of people across Africa, and the prevalence is twice the average of the entire world [45–47]. According to Ref. [48], 20 million persons, including 10 million children, have a severe lack of appropriate food in 2022 due to climate change that impacted crop production. Climate change seems to amplify the food shortage across African countries [49] while the recent geopolitical conflicts did intensify the pre-existing issue adding the recent pandemic, the issue is affecting countries worldwide.[1]

Ensuring food security in developing countries relies on the accurate forecasting of disruptions in global value chains (GVC) [23,50–52]. Such disruptions can arise from various sources, including natural disasters, geopolitical conflicts, operational issues, and pandemics [53]. Disturbance of food flow from suppliers and/or producers to end-users can negatively affect food quality, food safety, and prices [54–57]. Even the slightest disruption in the supply chain can significantly impact global food prices and the ability of societies to manage them.

By examining the circumstances that preceded the global food crisis of 2007-08 and the food price hike in 2010-11 [58], valuable insights can be obtained regarding the increased risks confronting the current global food system. These historical analyses provide crucial knowledge for understanding and addressing the challenges and vulnerabilities in today's global food supply chain. In this context, the urgent need to foster resilience becomes paramount, especially in an era characterized by the escalating climatic extremes linked to climate change. Understanding these historical precedents and the potential impacts of climate change is crucial for addressing the multiple risks confronting the global food system today and ensuring its sustainability and adaptability [59–63].

A comprehensive assessment of the ramifications of environmental shocks on food security and nutrition, requires the establishment of a coherent nexus between food production and consumption, encompassing the entire spectrum of steps within the supply chains. This holistic approach is vital for gaining a comprehensive understanding of the multifaceted interactions and interdependencies that shape the complex dynamics of food systems in the face of environmental disruption [54]. The disruptions encountered in global supply chains, coupled with the escalation of materials and labor costs, present substantial challenges and opportunities across diverse domains. These domains include demand forecasting, cost forecasting, dispute resolution, business forecasting, and asset valuation. By understanding these interconnected domains, stakeholders must leverage innovative strategies, advanced technologies, and data-driven approaches to navigate these complexities effectively and capitalize on the potential opportunities that arise amid changing conditions.

Moreover, the COVID-19 pandemic has brought about far-reaching consequences, not only imposing immense challenges on the healthcare industry but also intensifying demand volatility and jeopardizing the resilience of supply chains, especially within the food sector [3,40,55,64–68]. Consequently, numerous countries have witnessed a surge in food prices, leading to periodic scarcity of food supplies globally, affecting populations worldwide in some cases leading to an increase in household poverty [69–71].

In recent years, there has been a significant expansion in the application of AI technologies across a diverse spectrum of areas within the food industry. These AI technologies have found utility in a wide range of applications, spanning from optimizing food packaging and streamlining distribution processes to revolutionizing agricultural practices and enhancing customer service experiences. This broad deployment of AI reflects the industry's recognition of its potential to not only enhance operational efficiency but also to elevate the standards of food quality and safety.

It is worth emphasizing that researchers from various domains have actively contributed to the development and refinement of AI applications within the food sector. This is clearly demonstrated by the numerous references provided in Table 1. A summary of the application of AI technologies in various segments of the food value chain is presented in Table 1.

AI and big data analytics play a crucial role in forecasting disruptions in the supply chain. By leveraging historical and real-time data, AI and big data analytics can provide managers with valuable insights to accurately predict future demand patterns [83]. AI-powered predictive analytics tools utilize data mining, statistical modeling, and machine learning techniques to identify patterns and deliver precise forecasting, drawing on historical and real-time data [84–88]. With such advanced capabilities, companies can proactively prepare for potential disruptions and comprehend and manage risks well in advance to prevent major disruptions from occurring [83,88].

Moreover, AI-powered supply chain risk management tools can assess the potential impact of geopolitical events or natural disasters on a company's supply chain [89–91]. Additionally, AI enables significantly faster reaction times by promptly notifying managers of disruptions within seconds. This swift notification empowers managers to respond quickly and effectively, minimizing potential damages and mitigating the impact of disruptions. Integrating AI and big data analytics in supply chain forecasting and risk management presents transformative opportunities for companies to bolster their resilience and ensure uninterrupted operations, even in unexpected disruptions.

AI is crucial in developing early warning systems for various scenarios, including weather conditions, transportation bottlenecks, and labor strikes [92–95]. By anticipating and identifying potential issues in advance, AI assists in devising alternate shipment routes to mitigate their impact, thereby reducing costs and minimizing disruptions within supply chains. One of the key contributions of AI lies in its advanced forecasting capabilities, which significantly impact businesses. Accurate demand predictions enable businesses to optimize inventory levels, effectively preventing overstock or shortages [84,96–98]. A successful example of AI implementation can be seen in IKEA, where AI technology has been utilized to enhance the precision of demand forecasting across their stores and markets [99]. This effort has resulted in an impressive 98 % accuracy rate in their forecast predictions, showcasing the tangible benefits of utilizing AI to optimize demand forecasting processes. The enhanced operational efficiency and customer satisfaction achieved through this implementation highlight AI's value to demand forecasting.

3. Methodology

In recent years, there has been a substantial increase in the use of bibliometrics and scientometric analysis in academic research. This surge is attributed to its capacity to objectively and logically identify various characteristics of the literature [100]. Bibliometrics enables researchers to comprehensively analyze the connections between keywords and citations in the examined articles, providing valuable and easily understandable insights about the research [101]. Scientometrics researchers help evaluate and map scientific areas. It helps explore research topics, find collaborations between researchers, and discover gaps and future trends in science [102].

3.1. Tools used in the bibliometric and scientometric review

Various software options exist for conducting bibliometric and scientometric analysis, including VOSviewer [103], bibliometrics in R, and

[1] https://www.imf.org/en/Blogs/Articles/2022/09/14/how-africa-can-escape-chronic-food-insecurity-amid-climate-change (Accessed on 05.07.2023).

Table 1
Summary of AI technologies, segment of the food value chain, and applications developed and their domains.

AI Technology	Where it is applied in food value chain	Applications	Reference
Image processing (Hyperspectral imaging, CNN)	Food packaging	Fault detection of food trays	[72]
Supply chain Optimization (Evolutionary machine learning)	Food distribution and transportation	Scheduled transportation	[21]
AI-powered drone	Farmer (agriculture)	Monitor crop health and detect diseases	[73]
Natural Language Processing (NLP)	Customer service and feedback analysis	Online dataset reviews to understand customer preferences	[74]
AI-driven robotic arms	Food processing and packaging	Assemble and pack ready-to-eat kits efficiently.	[75]
Distribution network (DN) optimization	Food distribution	Optimization of distribution and delivery of fresh food and carbon footprint reduction	[76]
Autonomous Vehicles	Food delivery	Deliver to customers' without human drivers	[77]
Augmented Reality (AR)	Food retail and marketing	Visualize a particular product	[78]
Expert Systems	Recipe and ingredients optimization	Personalized recipes and menu	[79]
Internet of Things (IoT)	Food safety and storage	IoT monitoring sensors	[80,81]
Block Chain	Food traceability, including the origin	Organic food and nutrient and ingredients list	[82]

Biblioshiny [104]. In this study, the authors utilized Biblioshiny to get the descriptive statistics and trends of publications. The researchers obtained valuable insights into the relationships among publications and identified emerging research themes.

3.2. Design of the bibliometric and scientometric review

The initial phase of the research methodology commenced by conducting a bibliometric search using Scopus and Web of Science (WoS) and then combining these two databases (the data was gathered on July 12, 2023), encompassing the years 1990–2023. Previous studies such as [7,105] have utilized Scopus as a preferred for their bibliometric review studies. Scopus offers a wider selection of recent journals than the Web of Science index. Although the Web of Science has more in-depth scientific citations, Scopus surpasses it in terms of the number of journals and records it covers, drawing from a broader array of sources for citation data. Moreover, Scopus provides a more extensive range of metrics to assess research impact compared to the Web of Science [106–110].

The study established the inclusion and exclusion criteria in Table 2 to ensure comprehensive coverage and adherence to specific quality standards. Additionally, a flow chart illustrated in Fig. 1 was designed to guide the review process.

3.3. Eligibility criteria

Scopus and Wos possess unique advantages and research coverage, combining the two databases can yield significant strengths and leverage their respective benefits. The data gathered focuses on the role of AI and big data in addressing food insecurity, utilizing search query strings from Table 2.

3.4. Inclusion criteria

The inclusion criteria in Table 2 were designed to ensure that the documents met specific requirements. Firstly, they had to be present in the Scopus and WoS databases. Secondly, the documents must be classified as articles and in their final state. The inclusion criteria mandated that the documents contain specific key terms related to food insecurity, machine learning, and global value chains. Furthermore, the documents were limited to the subject areas of Business, Economics, or Social Science, aiming to capture literature that directly addresses the economic and social aspects of global value chains (GVCs) and their influence on food security. These disciplines offer valuable insights into the mechanisms, drivers, and implications of disruptions in GVCs, which are crucial for this study. Finally, only documents written in English were considered for inclusion in the study. This decision was made because English is the most widely used language for academic research, ensuring that the findings are accessible to a broader audience.

Table 2
Search query string used in SCOPUS and Web of Science (WoS) databases to gather the data.

	Criteria
Logical Statement	ALL (("Food security" OR "Food poverty" OR "Food shortage" OR "Food deserts" OR "Hunger" OR "Food insecurity" OR "Food crisis" OR "Food vulnerability" OR "Malnutrition" OR "Nutritional insecurity" OR "Food sovereignty" OR "Food safety" OR "Food quality") AND ("Machine learning" OR "Deep learning" OR "Prediction" OR "Forecasting" OR "Data-driven" OR "Image recognition" OR "Smart sensors" OR "Internet of Things (IoT)" OR "Satellite imagery" OR "Remote sensing" OR "Artificial neural networks" OR "Data mining" OR "Predictive modeling" OR "Unsupervised learning" OR "Supervised learning" OR "Reinforcement learning" OR "Transfer learning" OR "Deep reinforcement learning" OR "Real-time monitoring") AND ("Global value chains" OR "Supply chains" OR "Food availability" OR "Food supply" OR "Food demand" OR "Food production" OR "Food sustainability" OR "Food resilience" OR "Chain resilience")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "ECON")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))
Inclusion Criteria	1. Document is located in SCOPUS/WoS databases 2. Documents classified as articles 3. Documents in their final state 4. Documents that include the keywords 5. Documents related to the subject areas of Business, Economics, or Social Sciences 6. Documents written in the English language
Exclusion Criteria	1. Document is not written in English 2. Document type is not a journal article

Source: Author's Elaboration

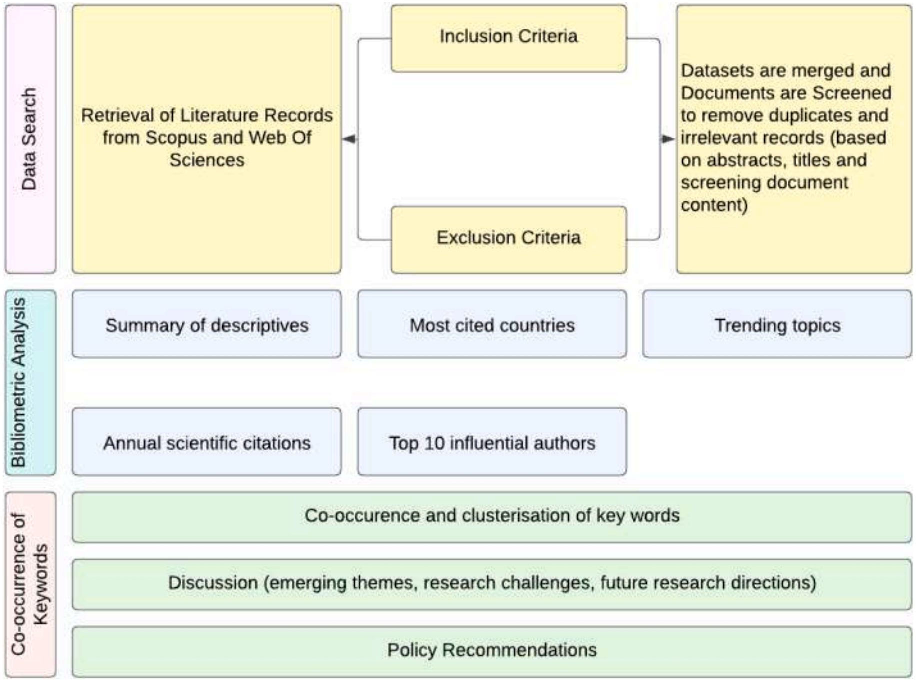

Fig. 1. Flow chart of the bibliometric review process.

The search query comprises three distinct sets of keywords relevant to the research goal of forecasting disruptions in global value chains to tackle food insecurity through AI and big data analytics.

i) **Food Security as the first field of research:** this field encompasses terms related to food security, including "Food security" OR "Food poverty" OR "Food shortage" OR "Food deserts" OR "Hunger" OR "Food insecurity" OR "Food crisis" OR "Food vulnerability" OR "Malnutrition" OR "Nutritional insecurity" OR "Food sovereignty" OR "Food safety" OR "Food quality". These keywords capture various aspects of food security, such as access, availability, and food quality.
ii) **AI and Big Data Analytics as the second field of research:** this field takes into consideration terms associated with AI and big data analytics, such as "Machine learning" OR "Deep learning" OR "Prediction" OR "Forecasting" OR "Data-driven" OR "Image recognition" OR "Smart sensors" OR "Internet of Things (IoT)" OR "Satellite imagery" OR "Remote sensing" OR "Artificial neural networks" OR "Data mining" OR "Predictive modeling" OR "Unsupervised learning" OR "Supervised learning" OR "Reinforcement learning" OR "Transfer learning" OR "Deep reinforcement learning" OR "Real-time monitoring". These terms represent the technological aspects of AI and big data analytics related to forecasting disruption and addressing food insecurity.
iii) **Global Value Chains and Food Systems as the third field of research:** this field includes terms associated with global value chains, supply chains, and global food system context. This third field comprises terms such as "Global value chains" OR "Supply chains" OR "Food availability" OR "Food supply" OR "Food demand" OR "Food production" OR "Food sustainability" OR "Food resilience" OR "Chain resilience". These terms highlight the interconnectedness of value chains, supply chains, and the broader food system in relation to aspects like food access, availability, production, and sustainability. To implement these three fields in the search query string, Boolean operators (OR, AND) and parentheses were used to specify the search conditions.

3.5. *Exclusion Criteria*

The exclusion criteria listed in Table 2 were carefully formulated to exclude documents that did not meet specific conditions. This included non-English documents, those that were not classified as articles, and documents that were not related to the subject areas of Business, Economics, or Social Sciences. These criteria were established to ensure that the selected documents are aligned and relevant to the research purpose.

4. Results and analysis

First, the collected data from Scopus and WoS in BibTeX format were converted into a bibliometric data frame using the convert2df() function from the bibliometrix package.

Table 3
Summary of Descriptives (information of the literature gathered from WoS, Scopus, and the merged databases).

Main Information About Data	WoS	Scopus	Merged
Timespan	1991-2023	1973-2023	1973-2023
Sources (Journals, Books, etc.)	265	876	1098
Documents	489	4715	5122
Annual Growth Rate %	14.25	13,77	13,98
Document Average Age	3.85	4,09	4,06
Average citations per doc	25.63	23,28	23,52
References	31033	366823	393929
DOCUMENT CONTENTS			
Keywords Plus (ID)	1657	9818	10915
Author's Keywords (DE)	1843	13085	14092
AUTHORS			
Authors	2127	15871	16406
Authors of single-authored docs	28	426	449
AUTHORS COLLABORATION			
Single-authored docs	29	441	464
Co-Authors per Doc	4.98	4,32	4,39
International co-authorships %	45.19	40,72	3,709
DOCUMENT TYPES			
Article	383	4715	5017

Source: Data analyzed using the biblioshiny app developed by Aria M, Cuccurullo C [104].

The gathered data from Scopus contained a total of 4715 documents. Similarly, the WoS database contained 489 documents in total. Next, the two data were merged to create a combined bibliographic dataset using the merged Sources() function from the bibliometix package. The merging removed 82 duplicated documents, resulting in a global merged dataset with 5122 documents. The combined data now serves as the basis for our analysis using biblioshiny, also developed by Aria M, and Cuccurullo C [104], the same as the bibliometrix package in R.

4.1. The state of research metrics related to food security and AI and big data analytics

Table 3 provides a comprehensive overview of the literature on studies that utilize AI and big data analytics to forecast disruptions in global value chains for addressing food insecurity. The information collected from the Web of Science (WoS) and Scopus databases was initially presented separately and combined to offer a merged data view.

The comparison of the data collected from Web of Science (WoS), Scopus, and the merged dataset reveals several key findings. First, Scopus has the longest period of data coverage, spanning from 1973 to 2023, while Web of Science covers the period from 1991 to 2023. The merged dataset includes both sources, providing comprehensive temporal coverage. Second, Scopus includes the highest number of sources (876), followed by WoS (265), and the merged dataset combines a total of 1,098 sources. Thirdly, Scopus contains the most documents (4,715), followed by the merged dataset (5,122), while WoS has the least number of documents (489). The merging process eliminated 82 duplicated documents, ensuring data integrity. Finally, when comparing average citations per document, Web of Science has the highest average (25.63 citations), followed by the merged dataset (23.52 citations) and Scopus (23.28 citations). These comparisons shed light on the strengths and characteristics of each dataset, including coverage duration, sources, document quantity, and citation impact.

4.2. Discussion of the emerging trends and patterns in the use of AI and big data analytics to forecast disruptions in global value chains to tackle food insecurity

Using the search string from Table 2, Fig. 2 is generated to depict the evolution of annual citations based on years for WoS, Scopus, and the merged dataset. The search string from Table 3 shows that from 1973 to 1979, citation production was relatively low in the early years, with most years showing zero citations. However, starting from the 1980s, there was an increasing trend in citation production across all three datasets. Scopus consistently had higher citation counts than WoS, indicating a greater recognition and impact of the documents indexed in Scopus. The merged dataset, which combines the data from WoS and Scopus, generally exhibited higher citation production than either database alone, demonstrating the benefit of merging the two sources.

From the 2000s onward, citations have grown significantly, with a notable increase in the number of citations received yearly. This indicates a growing interest and relevance of research in the field, as evident from the citations it has garnered. The sudden surge in citations can be attributed to several factors. Firstly, the establishment of the eight Millennium Development Goals (MDGs) by the United Nations in 2000, with one of the goals aimed at tackling hunger by the year 2015, resulted in increased research focus on food security and raised global awareness of the issue. Although this goal was not achieved, it prompted more research in the field. Additionally, the Sustainable Development Goals of 2015, particularly Goal 2 on "zero hunger" by 2036, further emphasized the importance of addressing hunger globally.

Moreover, the 2007–2008 global financial crisis triggered a surge in food prices, leading to widespread food shortages and extreme insecurity in numerous countries. This crisis underscored the susceptibility of certain regions' food systems, spurring the research community to investigate strategies to improve food security. Consequently, these events collectively stimulated a rise in research activity and citations pertaining to food security concerns ([111]*: The Global Social Crisis | Department of Economic and Social Affairs*, n.d.).

The annual citations continued to rise steadily until 2022, coinciding with the increasing prominence of big data. The utilization of big data has significantly enhanced data collection and analysis in various aspects of food production. For example, satellite imagery and remote sensing data are now used to monitor crops [112–115], allowing for more accurate and efficient assessments. Additionally, high-frequency data is utilized to monitor food distribution and consumption patterns [116]. The integration of big data in these areas has contributed to the growing interest and research in the field, reflected in the increasing number of citations over the years. This data is used as input to train machine and deep learning models that can help to either forecast or understand the issues related to food security.

The US Global Leadership Coalition reports that the COVID-19 pandemic worsened food insecurity worldwide, primarily due to income reductions and disruptions in food supply chains. Additionally, the subsequent Russia-Ukraine war further aggravated the situation. These two effects played a major role in the observed increase in citations regarding food security issues. Even in 2023, while the citation production slightly decreased (as the year is not yet completed), it still remained relatively high. The increased accessibility to augmented computing power has made using and training large machine learning

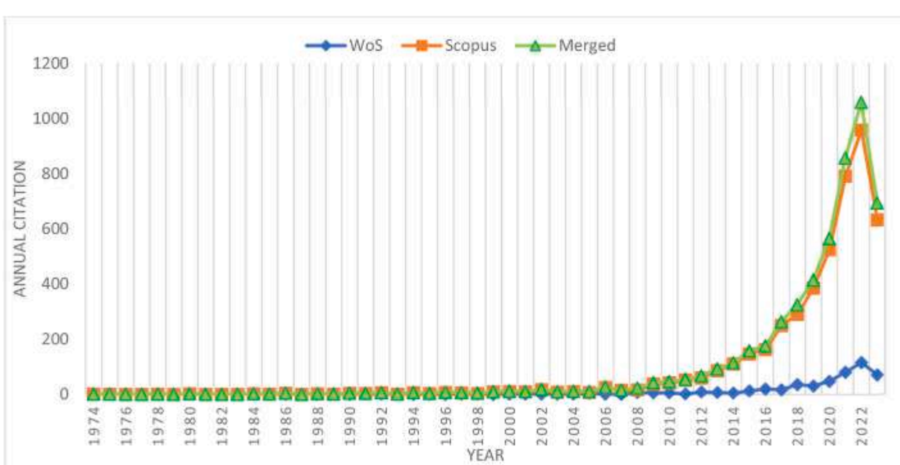

Fig. 2. Annual citations for the three databases.
Source: Author's Elaboration

Table 4
Most cited countries in this field of research in the three databases.

WoS		Scopus		Merged	
Country	TC	Country	TC	Country	TC
USA	2843	USA	18492	USA	20679
China	1812	China	12692	China	14328
UK	1739	UK	10411	UK	11659
Canada	919	Netherlands	5229	Netherlands	5799
Netherlands	586	Australia	4827	Australia	5255
Kenya	509	Germany	4752	Germany	5102
India	507	Italy	3562	Italy	3718
Australia	470	Canada	2408	Canada	3288
Germany	351	India	2253	India	2729
Austria	267	Sweden	2206	Kenya	2357
Korea	236	France	2149	Sweden	2341
Ireland	172	Denmark	2011	France	2282
Sweden	164	Belgium	2010	Denmark	2028
Italy	157	Norway	1861	Belgium	2010
France	133	Kenya	1848	Norway	1869
Brazil	131	Spain	1762	Spain	1785
Switzerland	130	Korea	1122	Korea	1301
Japan	122	Malaysia	1093	Brazil	1202
Israel	97	Switzerland	1072	Switzerland	1202

Note: TC is the total citation.
Source: Data analyzed using the biblioshiny app developed by Aria M, Cuccurullo C [104].

models and robotics and smart sensors easier, opening up new opportunities to address food security challenges using AI models [117–121].

In addition to the events mentioned above, another significant factor contributing to the challenges in food security is the increasing prevalence of climate change, causing instability in the global food system. Additionally, the continuous growth of the world population is adding pressure to the food system. As a result, these factors present new challenges in food security. However, scholars are actively responding to these challenges by exploring the potential of AI techniques. In this context, there will likely be a significant increase in research in the field of food security, with scientists dedicating their research efforts to develop innovative AI-driven models. These models are expected to be crucial in effectively addressing food security issues. As researchers leverage the potential of AI, we can anticipate groundbreaking advancements in ensuring food production, distribution, and resilience, thereby making substantial progress toward global food security. While the following Table 4 presents the most cited countries in this field of research in the three databases.

As shown in Table 4, the United States, China, and the United Kingdom are clearly the leading countries in machine learning for food security. This is not surprising considering their extensive history of research and development in artificial intelligence, which reinforces their leading positions in the applications of AI and technology in food security. Furthermore, they are home to advanced research and innovation hubs, boasting top-notch universities, research institutions, and technology companies. Their vibrant ecosystems encourage cutting-edge research and the application of machine learning in various domains [122–124]. China, on the other side, has made significant R&D investments and the development of technology parks [125,126]. This has helped develop a strong research community in China working on various cutting-edge technologies, including AI.

Moreover, the results presented in Table 4 may have been influenced by several other factors. One significant factor is the increasing awareness of climate change. Climate change has considerable implications for the global food system, causing disruptions and challenges in ensuring food security [63,127–133]. Moreover, the continuous growth of the world's population exerts significant pressure on the global food supply [1,134–141]. As the population continues to expand, the demand for food increases, leading to challenges in meeting the nutritional needs of many people. Furthermore, the ongoing process of urbanization also plays a crucial role in shaping the food system [142,142,143]. With more people moving to urban areas, how food is produced, distributed, and consumed undergoes significant changes. This shift in urban food systems can impact food security and access to nutritious food in urban settings [46,144–148].

4.3. Most influential authors

Table 5 shows the bibliometric data for the top 10 most impactful authors based on total citations authors, including various metrics related to their publications such as the number of articles, the H-Index, Total Citations (TC), total citations per year (TC/yr)

As illustrated in Table 5, Liu Y is ranked number 1 and authored a total of 49 articles since the start of his publishing journey in 2010. The h-index, which measures the productivity and impact of his work, is reported to be 14, signifying significant influence in their field of research. Liu Y's publications have garnered a total of 1309 citations, translating to an average of 101 citations per year since the author began publishing. This suggests that his research contributions have received substantial recognition and have been widely cited by other researchers in their field.

An important point to highlight is that even though Zhang X is ranked number 7 in the list based on total citations, the author has the highest TC/yr (Total Citations per Year). Since his first publication in 2018, Zhang X's TC/yr value has reached approximately 119 citations per year. This metric indicates that Zhang X's publications receive a significant number of citations annually, showcasing the substantial impact and recognition of his research within a relatively short period. In comparison to other authors on the list, some of whom have been publishing for a longer duration, Zhang X's TC/yr value suggests that the his work has rapidly gained attention and influence in the academic community. High TC/yr values are often associated with research that is highly relevant and influential, leading to frequent citations by other researchers in their own studies.

4.4. A historical analysis of popular topics related to the use of AI and big data analytics to tackle food insecurity across years

Fig. 3 and Table 6, see Appendix A, presents the trend topics literature of using AI and big data analytics to forecast disruptions in global

Table 5
Top 10 most influential authors based on total citations (TC).

Author	No of Articles	Year of Start of Publications	h-Index	TC	TC/yr	Ranking based on TC
Liu Y	49	2010	14	1309	101	1
Wang J	35	2009	13	1106	79	2
Wang X	38	2007	13	981	61	3
Wang Y	40	2015	14	942	118	4
Liu J	32	2009	17	780	56	5
Li Y	47	2009	13	655	47	6
Liu X	27	2010	11	611	47	7
Zhang X	28	2018	11	597	119	8
Zhang Y	39	2010	11	531	41	9
Li J	27	2014	9	400	44	10

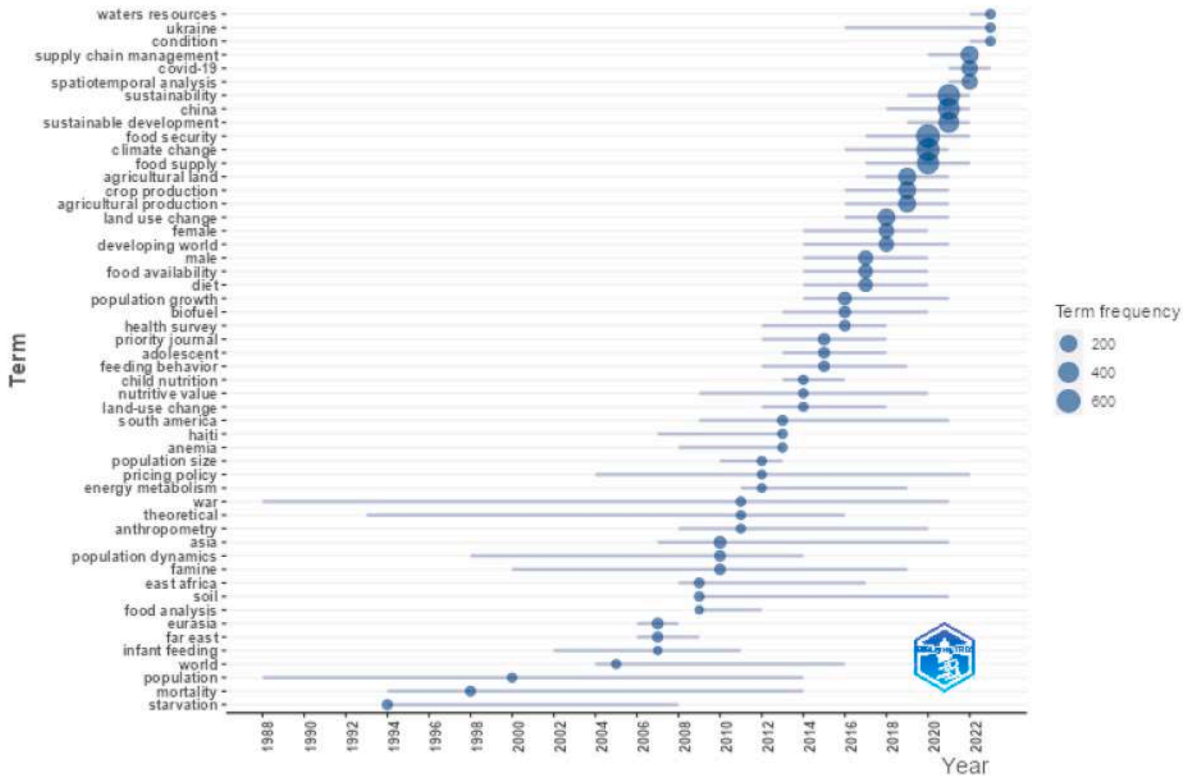

Fig. 3. Trending topics across the years.
Source: Authors elaboration using biblioshiny app

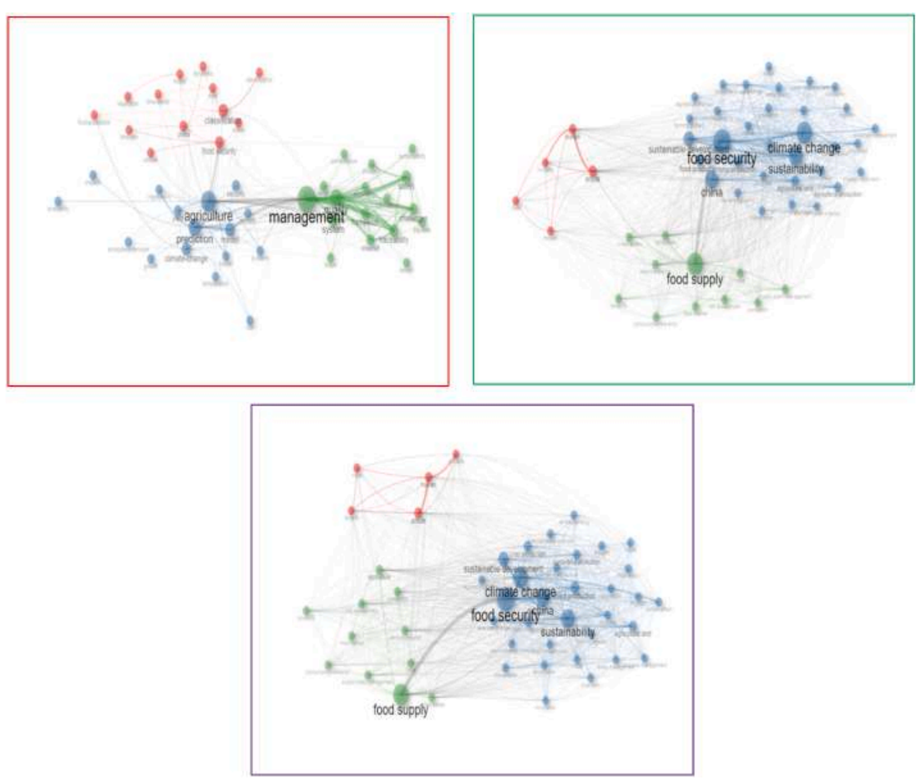

Fig. 4. Co-occurrence Word Network related to the use of AI and big data analytics to tackle food insecurity.
Source: Authors elaboration using biblioshiny app

value chains to tackle food insecurity related to the merged database. The table shows the frequency of each topic, as well as the year in which the topic was first highlighted by literature (year_q1 column 2 in Table 5), the median year (year_med column 3 in Table 5), and the year in which the topic appeared most recently (year_q3 column 4 in Table 5).

Based on Fig. 3 and Table 6, the most frequent topic (term) is food security, with a frequency of 617, with a median year for this topic equal to 2020, and it first appeared in the literature in 1994. The data suggest that food security is a relatively recent research topic, but it has become increasingly important in recent years. Based on Fig. 3 and Table 6, other frequently occurring topics include climate change, food supply, sustainability, China, and supply chain management. These topics are all related to food security, and they suggest that the research on this topic is focused on understanding the challenges posed by climate change, ensuring food availability, and developing sustainable food systems. The table also shows that some topics have become more important recently. For example, the topic of covid-19 first appeared in the literature in 2021, but it has already become a frequently occurring topic. They suggest that food security research is evolving to address the challenges posed by new and emerging threats. Also, the table shows that a global community of researchers conducts research on food security. The table includes papers from researchers in various countries, including the United States, China, the United Kingdom, India, and Brazil.

4.5. Comparative analysis of Co-occurrence Word Networks: insights from scopus, WoS, and the merged databases

Fig. 4 and Table 7 (see Appendix A2) show the co-occurrence of words in the literature on the use of AI and big data analytics to tackle food insecurity. The table shows the cluster to which each word belongs and the betweenness, closeness, and PageRank scores for each word.

The words food security, climate change, and sustainability are the most central words in the three databases. These words have high betweenness, closeness, and PageRank scores (see Table 7 in Appendix A2), which suggests that they are frequently used in the literature and are important for understanding the topic. Other important words in the network include China, agricultural land, crop production, land use change, and food production. These words also have high betweenness, closeness, and PageRank scores, which suggests they are important for understanding the topic. The analysis shows that the words food supply, supply chain management, decision-making, and agriculture are also important in the networks. These words suggest that the literature concerns the practical challenges of ensuring food security, such as managing food supply chains, the decision-making process, and the agricultural sector.

The comparative analysis among the three databases indicates some notable findings. Firstly, the merged database contains more words in the food security cluster than the individual databases, WoS and Scopus. Additionally, the merged database includes more words specifically related to the use of new technologies. On the other hand, WoS and Scopus have a greater number of words associated with the management of food supply chains and the development of sustainable food systems. This observation suggests that the literature on the topic of food security is increasingly concentrating on the application of new technologies to tackle the challenges in this field. The emphasis on new technologies indicates a growing interest and recognition of the potential of innovative approaches, such as AI and big data analytics, in enhancing food security. This suggests that the literature on this topic is becoming more focused on the use of new technologies to address the challenges of food security.

Therefore merging WoS with the Scopus table provides a more comprehensive overview of the literature on the use of AI and big data analytics to tackle food insecurity. The analysis shows that the literature on this topic is becoming more focused on using new technologies to address the challenges of food security while still maintaining a focus on the specific challenges of food security.

5. Discussion

The findings of this research indicate that harnessing AI and big data analytics could offer a viable solution to tackle the issue of food insecurity. The study revealed a growing prevalence of AI and big data analytics in the literature focused on food security. Key topics that surfaced prominently in this literature encompassed food security, sustainability, prediction, food supply, climate change, supply chain management and agriculture. Below, the study delves into the emerging themes found in the literature.

5.1. Identification of emerging themes

This bibliometric and scientometric analysis identified research themes that highlight the potential of AI and big data analytics in addressing food security challenges. The themes identified in this study include; the effects of COVID-19 on food supply chains, decision-making, and consumption behavior; achieving food security and sustainability amid climate change; leveraging predictive models in agriculture to assess supply chain risks; and understanding the impact of supply chain disruptions on food price volatility. Challenges involve ethical and policy implications, data availability, data privacy, and data quality. Despite obstacles, AI and big data promise to enhance global food security and sustainability.

5.1.1. The impact of COVID-19 on food supply chains decision making, and consumption behaviour

This theme explores the multifaceted effects of the COVID-19 pandemic on various aspects of the food industry, including food supply chains, decision-making processes, and consumption behaviors [149–154]. The pandemic's unprecedented challenges have necessitated risk assessments and adaptations within the food market to ensure sustained food security and address the evolving needs of consumers [15,155,156]. We establish through this theme that AI can be leveraged to manage the interplay between COVID-19, food supply dynamics, decision-making strategies, consumer behavior shifts, and the continual evaluation of potential risks to enhance supply chain resilience [11,11,157,158].

5.1.2. Achieving food security and sustainability in the face of climate change: optimizing agricultural land use and crop yield for sustainable food production

This theme explores the critical challenge of ensuring food security and sustainability in the context of climate change [159–164]. With a focus on agricultural practices, this theme explores strategies that can enhance agricultural productivity [165] and resilience and suitability of agricultural land [166] and crop yield [167]. Countries and industries aim to create a sustainable food production system capable of meeting the growing global demand for food while mitigating the adverse impacts of climate change. By investigating the interconnections between food security, sustainability, climate change, agricultural land management [168–170], and crop yield improvement, this theme devises innovative approaches and policies to address these complex and pressing issues to ensure a food-secure and sustainable future for all.

5.1.3. Leveraging predictive models in agriculture to assess the impacts and risks of supply chain disruptions on food security

This theme is centred around applying predictive models in agriculture to assess their impacts on food security and mitigate risks [171–173]. For example, cutting-edge techniques such as seasonal rainfall forecasting are used to predict and optimize agricultural outcomes, considering climate change, resource availability, and market dynamics [174,175]. By employing advanced models, authors seek to understand the potential risks and challenges that agriculture may face and identify strategies to enhance food security. The theme emphasizes the importance of evidence-based decision-making in food systems

[176] to ensure sustainable practices, increased productivity, and food security for global populations. Through this multidisciplinary approach, stakeholders can develop informed policies and innovative solutions to tackle current and future challenges in agriculture and secure a resilient and sustainable food system.

5.1.4. Impact of supply chain disruptions on food price volatility

Food prices have experienced a global surge due to a confluence of factors, including disruptions in the global supply chain, geopolitical conflicts, the outbreak of the coronavirus [177,178] and adverse climate events such as floods [179], heavy rains, wildfires, storms, droughts, as well as the escalation of energy prices [180]. A study carried out by Ref. [181] used a panel-VAR model to investigate the effect of oil price inflation on food prices and concluded that energy price surges lead to a negative impact on food security. These combined influences have exerted tremendous pressure on the availability and affordability of food products worldwide, contributing to the substantial increase in prices observed in recent times.

5.1.5. Risk assessment of global supply chains in the face of uncertainties

The increasing political, social, economic, and climatic shocks and uncertainties create a volatile and complex environment that can significantly impact supply chains and impede the flow of goods and services including food commodities [3,152,182–184]. This theme emphasizes the adoption of risk measures that will make supply chains resilient to shocks, for example the application of advanced Bayesian network methods [155]. Other authors have documented multilevel hierarchical structures in building resilience and facilitating risk assessment of disruptions in global food supply chains [185]. The failure mode and effect analysis approach has also been cited as a potential tool that can be used to manage the risks along supply chains [186]. The application of AI in combination with the pre-existing methods to identify and mitigate supply chain risks could lessen the burden of food insecurity by enabling firms, consumers and governments to plan in advance [187]. For example early warning technologies could be used by to mitigate risk and plan for uncertainties [92,94,188].

5.1.6. AI and big data analytics in food security: Lessons from Kenya for Africa's future

Within the context of AI and big data advances in food security, Kenya's contributions and initiatives stand out prominently. When we examine the most cited countries in this field of research, it becomes evident that Kenya has made significant strides in this area. In Table 4, Kenya emerges as a noteworthy player alongside global research leaders.

Kenya's presence among the top-cited countries underscores its active role in advancing AI and big data solutions for enhancing food security. This commitment to research and innovation positions Kenya as a valuable source of insights and best practices that can benefit not only its own food security efforts but also serve as a model for other African nations striving to address similar challenges. As Kenya continues to make significant contributions to this field, it sets a promising example for the broader African context, highlighting the potential of AI and big data to transform food security outcomes on the continent.

One of the notable advancements in Kenya's approach to food security has been the implementation of an AI-powered crop monitoring system. Developed by Agritech firm Agrivision, this innovative platform incorporates various features, including an interactive digital map, real-time analytics, crop monitoring, and rotation recommendations. Additionally, it plays a pivotal role in classifying key crops. This technology allows for enhanced precision in crop management and resource allocation, ultimately contributing to increased agricultural productivity [189,190].

In the pursuit of more accurate and timely food security forecasts, researchers in Kenya have explored the application of machine learning. Notably, studies have proposed leveraging high-frequency household survey data to predict transitions in the state of food security. By identifying key predictors of food security outcomes, these machine learning models have demonstrated the ability to generate forecasts with a lead time of up to four months into the future. This approach has the potential to significantly enhance the ability to allocate resources and implement targeted interventions to mitigate food insecurity [23,191,192].

Kenya has also taken significant strides in providing support to smallholder farmers through the deployment of AI platforms. A notable example is the UjuziKilimo platform,[2] which delivers agricultural data and insights to small-scale farmers. This initiative empowers farmers with real-time information on crop management, weather patterns, and market dynamics, enabling them to make informed decisions and optimize their agricultural practices. By embracing similar AI-driven solutions, other African nations can extend similar support to their smallholder farming communities, ultimately bolstering food security [193].

The experiences and successes of Kenya in the application of AI and big data analytics for food security analytics offer valuable lessons for other African nations. These countries can draw inspiration from Kenya's approach and consider implementing similar AI-powered crop monitoring systems to improve crop yields and reduce food insecurity. Moreover, the adoption of machine learning models for forecasting food security outcomes can aid in proactive policy formulation and resource allocation. Lastly, the development and deployment of AI platforms tailored to the needs of smallholder farmers can have a profound impact on food security efforts across the continent.

5.2. Research challenges regarding the use of AI and big data analytics to forecast disruptions in global value chains to tackle food insecurity

Research in the field of AI application in global food supply chains to mitigate food insecurity is likely to be confronted with several challenges. These challenges encompass ethical and policy implications arising from the integration of AI and big data analytics into food security research [194–198]. As these technologies become more prominent, it is crucial to address ethical concerns and establish robust policy frameworks concerning data collection, privacy, and algorithmic decision-making. Another critical challenge lies in data availability, particularly in certain countries where food security is a sensitive issue [20,199,200]. Researchers may face obstacles in accessing relevant and comprehensive data [201]. There is a need to develop open-access data sources, such as utilizing satellite imagery data (as seen in Ref. [202]) and exploring alternative data streams from search engines (Google Trends, Yahoo, Bing, and Baidu) and social media platforms [203].

The quality of data used in AI and big data analytics is paramount for producing reliable insights and solutions. To address this, researchers must develop robust techniques for filtering and cleaning large datasets to ensure their accuracy and validity, as concluded by Ref. [204]. Ensuring data quality is vital for making informed decisions and drawing meaningful conclusions from the analysis.

Additionally, data privacy emerges as a critical issue when utilizing AI and big data analytics to tackle food insecurity. The data employed to train these models often contain sensitive information about individuals, including their location, income, and health status. Proper protection and responsible data handling are imperative to prevent potential misuse or harm. Scholars like [205,206] have explored the ethical dimensions of data privacy in the context of AI applications.

Finally, while AI and big data analytics offer immense potential to improve food security by developing early warning systems, optimizing supply chains, and monitoring food safety, ethical implications must not be overlooked [207]. delved into ethical concerns within the agricultural industry, and [208] examined ethical aspects in the public health

[2] See https://www.ujuzikilimo.com/(accessed on September 17th, 2023).

sector. Considering these ethical dimensions ensures responsible and socially conscious implementation of AI-driven solutions to address global food insecurity.

Despite these challenges, the promising directions of using AI and big data analytics to tackle food insecurity are significant. These technologies could help enhance and promote food security for millions of people worldwide.

5.3. Future research directions

The 2030 agenda identifies that ending poverty and other deprivations must be coupled with policies that improve welfare while dealing with climate change and preserving oceans and forests. While some progress has been made, much still needs to be done. Due to the COVID-19 pandemic, generally, the share of countries that experienced high food prices decreased from 48.1 % in 2020 to 21.5 % in 2021 [26]. The figures in 2021 far outweigh the 15.2 % average for the 2015-19 period (pre-COVID period). The high food prices are mainly due to, *among other things*, increases in input (energy and fertilizer) costs, production shortfalls, and adverse weather. Sub-Saharan Africa and the least developed countries (LDCs) bear most of the brunt of the increase in food security induced by the high prices. Specifically, the proportion of countries experiencing high food prices for a second successive year in 2021—reaching 40.9 % for Sub-Saharan Africa and 34.1 % for LDCs [26]. These statistics highlight the need to be innovative in tackling food security. In fact, using artificial intelligence and big data analytics to forecast disruptions in global value chains to tackle food insecurity is a growing field of research. The United States, China, and the United Kingdom are the leading countries in this field of research, and the most cited topics in the field include food security, climate change, food supply, sustainability, and China. The field is becoming increasingly focused on understanding the challenges posed by climate change, ensuring food availability, and developing sustainable food systems. By understanding these challenges, researchers will provide hope for achieving the ambitious SDG goal number 2 of achieving “zero hunger” by 2030. Indeed, to achieve this goal, there is a need to transform food systems, invest in sustainable agriculture practices, and ease the impact of the COVID-19 pandemic and climate change on food security. Research avenues in this area are endless.

Future research could explore the impact of the use of AI and big data analytics to:

(a) Improve crop yields using spatial data, satellite imagery, and remote sensing data driven by AI-based machine learning and deep learning models.
(b) Optimize supply chains using different optimization AI algorithms.
(c) Monitor food safety using advanced machine learning techniques. Techniques like deep learning, reinforcement learning, and transfer learning can enhance prediction models, improve forecasting accuracy, and facilitate informed decision-making processes related to food security.
(d) Develop early warning systems for food insecurity using real-time data sensors.
(e) Improve the resilience of food systems to shocks and stresses.
(f) Addressing food insecurity in specific regions that suffer the most.
(g) Analyze food waste and related sustainability-connected studies made for the general public to pinpoint new development stream options for food waste reduction-related operations, strategies, and follow-up research option.
(h) Integration of multiple data sources such as government databases, social media platforms, spatial data, satellite imagery, remote sensing data, and open data repositories. This expansion will enhance the accuracy and depth of analysis in food security research.

6. Policy recommendations

In 2015, the United Nations member states formally adopted the 2030 Agenda for Sustainable Development, which consists of 17 goals aimed at fostering global development and addressing various challenges. One of these goals, SDG 2, specifically focuses on "zero hunger," aiming to achieve food security, improve nutrition, and promote sustainable agriculture. The research outcomes presented in this study will provide valuable insights and strategies for developing countries to develop strategies that enable them to pursue SDG 2, ensuring the eradication of hunger and malnutrition while fostering sustainable agricultural practices. This will involve fostering partnerships between developed and undeveloped nations, forging collaborative efforts to combat poverty and deprivations related to food insecurity.

The lesson for developing nations is to ensure that they take advantage of the potential of AI and big data analytics to address food insecurity challenges. Some of the policy implications include the following:

(a) Invest in R&D in the area of AI and big data analytics for food security. This will help develop new technologies to address food security challenges, such as predicting crop yields, optimizing supply chains, and monitoring food safety.
(b) Create an enabling environment for using AI and big data analytics in the food security sector. This includes providing access to data, training for farmers and other stakeholders, and developing regulations supporting AI and big data analytics.
(c) Support the development of regional and international partnerships to share experiences, this will ensure that the benefits of AI and big data analytics are available to all less developed countries, including African nations.
(d) Provide cash transfers and social security baskets to cushion the most vulnerable members of the population from price spikes during supply chain disruptions.

7. Conclusion

Our study investigated the research trends in AI applications in global food supply chains to mitigate food insecurity. With this objective in mind, we explored the publication trends, revealing insights into prolific authors, leading articles with significant impact, and the most productive institutions and countries in the field of AI applications to improve food security. Additionally, the study identified emerging themes, research gaps, and potential future research areas. We addressed the objectives and research questions by utilizing bibliometric and scientometric analysis. The analysis encompassed literature from both WoS and Scopus databases, providing wide coverage of research articles from the extensive time period spanning 1973 to 2023.

By employing this rigorous analysis approach, the study shed light on the progress and dynamics of research in food security. The findings presented valuable insights for researchers, policymakers, and stakeholders, aiding in a better comprehension of the advancements, challenges, and potential opportunities for utilizing AI to enhance global food supply chains and alleviate food insecurity.

Based on the merged dataset (Scopus and WoS), the annual growth rate of publications was 13.98 %. The trend of annual citations continued to show steady growth until 2022, which aligned with the increasing prominence and widespread adoption of big data. Moreover, the analysis indicated that the literature on this topic is experiencing a growing trend toward globalization. Researchers from various countries actively contribute to the field, reflecting a diverse and collaborative approach to addressing the challenges of AI application in global food supply chains and food security. The most cited countries in this field are the United States, China, and the United Kingdom showcasing their prominent roles in advancing research on AI applications in global food supply chains to mitigate food insecurity. The most frequent topics in the literature are food security, climate change, food supply, agriculture, sustainability, and supply chain management.

The analysis also reveals that the literature is becoming more focused on using new technologies to reduce food security challenges, highlighting its importance in the context of AI-driven solutions for food supply chains and the attainment of the SDG on zero hunger. With its profound impact on food systems, climate change stands out as a crucial keyword that researchers closely examine. Its influence on food production, distribution, and access is a pressing concern in the context of food security.

Additionally, the literature explored other keywords related to food supply, agriculture, sustainability, and supply chain management, as they are closely intertwined with the challenges and opportunities of food security, particularly in the context of global food supply chains and the SDG 2 of zero hunger. Harnessing the power of AI and big data analytics offers promising solutions to overcome the multi-dimensional challenges of food supply chains and create a more sustainable and secure food future. Moreover, AI has the potential to enhance crop yields, develop and implement early warning systems, optimize supply chains, manage supply and demand volatilities and price fluctuations, and monitor food safety from the farm to the fork hence contributing to a more resilient and efficient food system.

While bibliometric and scientometric analyses offer valuable advantages in evaluating research, it is essential to recognize certain limitations associated with these approaches. These limitations encompass the quality of the gathered data and the possibility of overlooking non-traditional forms of scholarly communication like social media interactions, expert interviews, or alternative publishing platforms. Additionally, the challenge of assessing research quality solely based on citation metrics is a noteworthy limitation, as it may not fully capture the true impact and significance of the research.

Moreover, these analyses might not fully capture the research's broader societal and economic impact, which is essential to understand scholarly work's real-world implications and relevance. Therefore, acknowledging and considering these limitations is crucial in ensuring a comprehensive and nuanced assessment of research activities, impact, and quality. By considering these factors, researchers and evaluators can adopt a more balanced and holistic approach to gauging the significance and value of scientific contributions.

Ethical approval

There are no human subjects used in this study, as such there is no need for ethical approval.

Consent to participate

The article does not contain any studies with human participants performed by any of the authors.

Consent to publish

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Availability of data and materials

The dataset used for this study is available upon request from the corresponding author.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A

Table 6
Trend topics across years

Terms	frequency	year_q1	year_med	year_q3
Starvation	14	1994	1994	2008
Mortality	14	1994	1998	2014
population	8	1988	2000	2014
World	7	2004	2005	2016
Eurasia	25	2006	2007	2008
far east	16	2006	2007	2009
infant feeding	5	2002	2007	2011
east africa	12	2008	2009	2017
Soil	10	2009	2009	2021
food analysis	5	2009	2009	2012
Asia	44	2007	2010	2021
famine	21	2000	2010	2019
population dynamics	21	1998	2010	2014
War	9	1988	2011	2021
anthropometry	7	2008	2011	2020
theoretical	7	1993	2011	2016
population size	8	2010	2012	2013
energy metabolism	6	2011	2012	2019
pricing policy	6	2004	2012	2022
south america	14	2009	2013	2021
Haiti	9	2007	2013	2013
anemia	8	2008	2013	2013
child nutrition	9	2013	2014	2016
land-use change	8	2012	2014	2018
nutritive value	8	2009	2014	2020

(continued on next page)

Table 6 (*continued*)

Terms	frequency	year_q1	year_med	year_q3
priority journal	37	2012	2015	2018
adolescent	25	2013	2015	2018
feeding behavior	21	2012	2015	2019
population growth	68	2014	2016	2021
biofuel	35	2013	2016	2020
health survey	23	2012	2016	2018
Male	106	2014	2017	2020
food availability	85	2014	2017	2020
Diet	81	2014	2017	2020
land use change	209	2016	2018	2021
Female	120	2014	2018	2020
developing world	112	2014	2018	2021
agricultural land	233	2017	2019	2021
crop production	220	2016	2019	2021
agricultural production	218	2016	2019	2021
food security	617	2017	2020	2022
climate change	576	2016	2020	2021
food supply	492	2017	2020	2022
sustainability	515	2019	2021	2022
China	477	2018	2021	2022
sustainable development	390	2019	2021	2022
supply chain management	221	2020	2022	2022
covid-19	152	2021	2022	2023
spatiotemporal analysis	141	2021	2022	2022
Ukraine	10	2016	2023	2023
waters resources	10	2022	2023	2023
Condition	9	2022	2023	2023

Source: Authors elaboration using biblioshiny app

Table 7
Co-occurrence Word Network related to the use of AI and big data analytics to tackle food insecurity literature

WoS					Scopus					Merged				
Node	Cluster	Betweenness	Closeness	PageRank	Node	Cluster	Betweenness	Closeness	PageRank	Node	Cluster	Betweenness	Closeness	PageRank
classification	#1	48,05	0,01	0,03	article	#1	10,40	0,02	0,03	article	#1	9,48	0,02	0,03
food security	#1	56,25	0,01	0,03	human	#1	5,81	0,02	0,03	human	#1	5,95	0,02	0,03
china	#1	46,47	0,01	0,03	female	#1	0,21	0,01	0,01	female	#1	0,23	0,01	0,01
identification	#1	0,55	0,01	0,01	humans	#1	1,03	0,01	0,02	humans	#1	1,08	0,02	0,02
water	#1	9,62	0,01	0,02	male	#1	0,16	0,01	0,01	male	#1	0,17	0,01	0,01
area	#1	1,93	0,01	0,02	food security	#2	35,19	0,02	0,06	food security	#2	35,10	0,02	0,06
dynamics	#1	0,00	0,01	0,01	climate change	#2	26,71	0,02	0,05	climate change	#2	25,53	0,02	0,05
modes	#1	3,67	0,01	0,01	sustainability	#2	13,68	0,02	0,04	sustainability	#2	13,19	0,02	0,04
time-series	#1	0,65	0,01	0,01	china	#2	11,65	0,02	0,04	china	#2	11,32	0,02	0,04
climate	#1	2,98	0,01	0,01	sustainable development	#2	7,89	0,02	0,03	sustainable development	#2	7,79	0,02	0,04
food-production	#1	0,33	0,01	0,01	food production	#2	4,64	0,02	0,03	food production	#2	4,75	0,02	0,03
land-use	#1	0,61	0,01	0,01	agricultural land	#2	1,91	0,02	0,02	agricultural land	#2	2,29	0,02	0,03
vegetation	#1	0,00	0,01	0,01	agricultural production	#2	2,25	0,02	0,02	crop production	#2	3,66	0,02	0,03
agriculture	#2	273,04	0,02	0,07	crop production	#2	3,69	0,02	0,03	agricultural production	#2	2,28	0,02	0,02
prediction	#2	123,09	0,01	0,05	land use change	#2	0,89	0,02	0,02	land use change	#2	1,07	0,02	0,02
model	#2	17,77	0,01	0,03	land use	#2	0,96	0,02	0,02	land use	#2	1,08	0,02	0,02
climate-change	#2	78,82	0,01	0,04	crop yield	#2	0,78	0,02	0,02	crop yield	#2	0,72	0,02	0,02
security	#2	5,49	0,01	0,02	smallholder	#2	1,31	0,02	0,02	smallholder	#2	1,31	0,02	0,02
systems	#2	1,00	0,01	0,01	spatiotemporal analysis	#2	1,11	0,02	0,02	spatiotemporal analysis	#2	1,01	0,02	0,02
yield	#2	22,48	0,01	0,03	innovation	#2	0,36	0,02	0,01	innovation	#2	0,32	0,02	0,01
impact	#2	3,28	0,01	0,02	remote sensing	#2	0,80	0,02	0,01	remote sensing	#2	0,79	0,02	0,01
models	#2	5,42	0,01	0,02	alternative agriculture	#2	0,52	0,02	0,02	alternative agriculture	#2	0,53	0,02	0,02
temperature	#2	2,17	0,01	0,01	cultivation	#2	0,61	0,02	0,02	cultivation	#2	0,67	0,02	0,02
impacts	#2	0,00	0,01	0,01	food consumption	#2	0,82	0,02	0,01	food consumption	#2	0,89	0,02	0,01
ecosystem services	#2	0,38	0,01	0,01	stakeholder	#2	0,64	0,02	0,01	stakeholder	#2	0,59	0,02	0,01
growth	#2	0,00	0,01	0,01	developing world	#2	1,25	0,02	0,01	developing world	#2	1,25	0,02	0,01
risk	#2	0,34	0,01	0,01	water management	#2	0,57	0,02	0,01	drought	#2	0,66	0,02	0,01
regression	#2	0,66	0,01	0,01	farming system	#2	0,59	0,02	0,01	irrigation	#2	0,61	0,02	0,02

(*continued on next page*)

Table 7 (*continued*)

WoS					Scopus					Merged				
Node	Cluster	Betweenness	Closeness	PageRank	Node	Cluster	Betweenness	Closeness	PageRank	Node	Cluster	Betweenness	Closeness	PageRank
availability	#2	0,00	0,01	0,01	climate effect	#2	0,53	0,02	0,01	water management	#2	0,42	0,02	0,01
management	#3	207,94	0,02	0,09	drought	#2	0,75	0,02	0,01	farming system	#2	0,58	0,02	0,01
quality	#3	13,17	0,01	0,04	irrigation	#2	0,67	0,02	0,02	maize	#2	0,64	0,02	0,01
system	#3	22,05	0,01	0,03	regression analysis	#2	1,13	0,02	0,01	climate effect	#2	0,47	0,02	0,01
safety	#3	9,60	0,01	0,03	maize	#2	0,71	0,02	0,01	regression analysis	#2	1,05	0,02	0,01
challenges	#3	6,31	0,01	0,03	adaptive management	#2	0,53	0,02	0,01	adaptive management	#2	0,46	0,02	0,01
food	#3	22,60	0,01	0,02	environmental impact	#2	0,60	0,02	0,01	crops	#2	0,78	0,02	0,02
framework	#3	10,10	0,01	0,03	water supply	#2	1,06	0,02	0,02	biodiversity	#2	0,58	0,02	0,01
internet	#3	1,49	0,01	0,03	crops	#2	0,88	0,02	0,02	environmental impact	#2	0,58	0,02	0,01
traceability	#3	7,57	0,01	0,04	strategic approach	#2	0,49	0,02	0,01	food supply	#3	41,18	0,02	0,06
big data	#3	5,65	0,01	0,02	food supply	#3	42,87	0,02	0,06	agriculture	#3	4,03	0,02	0,02
technology	#3	5,93	0,01	0,02	supply chain management	#3	1,14	0,02	0,02	supply chain management	#3	0,93	0,02	0,02
products	#3	1,04	0,01	0,02	decision making	#3	2,83	0,02	0,02	decision making	#3	2,52	0,02	0,02
information	#3	2,73	0,01	0,02	agriculture	#3	3,70	0,02	0,02	covid-19	#3	0,29	0,02	0,01
sustainability	#3	0,31	0,01	0,01	covid-19	#3	0,34	0,01	0,01	united states	#3	2,85	0,02	0,01
design	#3	0,39	0,01	0,01	united states	#3	2,90	0,02	0,01	consumption behavior	#3	0,76	0,02	0,01
future	#3	2,96	0,01	0,02	consumption behavior	#3	0,76	0,02	0,01	india	#3	1,30	0,02	0,01
performance	#3	1,10	0,01	0,01	india	#3	1,33	0,02	0,01	risk assessment	#3	1,23	0,02	0,01
					risk assessment	#3	1,25	0,02	0,01	perception	#3	1,38	0,02	0,01
					perception	#3	1,40	0,02	0,01	food market	#3	0,61	0,02	0,01
					food market	#3	0,67	0,02	0,01					

Source: Authors elaboration using biblioshiny app

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