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Mapping the Global Research Landscape: Bibliometric Analysis of Agri-food Systems and Nutritional Security

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ABSTRACT

The study examined the evolution of research on the linkages between agri-food systems and nutritional security globally using bibliometric analysis of 1057 documents listed in SCOPUS database from 1984 to May 2023. The study identified major keywords in the literature, such as food security, India, nutrition, and climate change, establishing their significance in the field. The analysis of co-occurrence networks identified a prominent cluster named "sustainable agri-food systems for achieving food and nutritional security," emphasising sustainable approaches in agriculture and food systems to ensure both food and nutritional security. Evolution of themes in the 21st Century was analysed in this study under three-time spans. During 2000-10, there was a global emphasis on food security focusing on Asian and African countries, nutritional security received little attention during this span. The second time slice (2011-19) witnessed the emergence of research on nutritional security, which included a variety of topics such as gender, dietary diversity, breeding, and food security. The third time slice (2020-23) was largely concerned with establishing measures for mitigating climatic change, abiotic stresses, and the impacts of the Covid-19 pandemic on nutritional security. These research efforts contributed to a better understanding of the complex interplay between food security, nutritional security, and the challenges posed by the Covid-19 pandemic. The study emphasised on the futuristic research ensuring interdisciplinary collaboration, technological advancements, holistic approach to achieve long-term food and nutritional security, climate adaptation, biodiversity, and ensuring equitable access to nutritious food.

Keywords: Agri-food system, nutritional security, bibliometric analysis, Covid-19, climate change

JEL: Q18, Q54, Q01, I15, I38

1

INTRODUCTION

The research on nutritional security is of paramount importance in addressing issues related to hunger and malnutrition. The nutritional security research focus is consistent with SDG 2 on Zero Hunger, which seeks to eradicate hunger, provide food and nutritional security, and promote sustainable agriculture by 2030. The undernutrition, micronutrients deficiencies, and the increasing prevalence of weight gain and obesity in both children and adults continue to pose significant challenges on global health and nutrition. The World Health Organisation (WHO) estimates that roughly 2 billion persons suffer from micronutrient deficiencies, while 1.9 billion adults are overweight or obese. While there has been some progress in addressing these issues, the latest estimates reveal persistent problems. For instance, the prevalence of low birthweight decreased modestly from 2000 to 2015, but still affected 14.6 per cent of newborns (WHO, 2019). Similarly, while the prevalence of stunting in children under the age of five has declined from 33.1 per cent in 2000 to 22.0 per cent in 2020, there has been a slight increase in the prevalence of wasting

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and overweight among children. Maternal anemia and obesity have also shown an upward trend (FAO, 2022). Furthermore, the affordability of a healthy diet remains a significant challenge, with approximately 3.1 billion people lacking the financial resources to afford it in 2020 (FAO, 2022). The Covid-19 pandemic has exacerbated these issues, highlighting the vulnerabilities and inequalities in agri-food systems and societies worldwide. These challenges necessitate a closer examination of agri-food systems and their role in achieving nutritional security.

In this context, the global research agenda has focused on sustainable production and consumption systems, gender dynamics, markets, income, climate resilience, institutions, and global uncertainties leading to better nutritional outcomes. The strategic focus has encouraged nutritionally rich crops, dietary diversity, reducing post-harvest losses, and enhancing value-addition to improve the nutritional outcomes. The role of institutions, policy and governance in ensuring healthy food systems is also investigated. While previous studies have touched upon various aspects of the field, a systematic trajectory of available information and an unabridged scope of nutritional food security are yet to be established. This study systematically reviewed the global research literature on nutritional security and presents the research landscape based on comprehensive bibliometric analysis. This study merges qualitative and quantitative approaches to examine the existing literature, identify research gaps, and provide a roadmap for future research pathways.

Bibliometric analysis offers a valuable tool for analysing the scientific literature and in understanding the publication patterns. The accessibility of electronic texts and internet-based abstract services have facilitated the use of bibliometric techniques to study the structure and methodology of scientific communication (Morris *et al*., 2002; Patra *et al*., 2006; McBurney and Novak, 2002; Borgman and Furner, 2002). These methods allow for statistical analysis of publication productivity, citation patterns, and the flow of information across disciplines, organisations, and nations (Kurtz and Bollen, 2010). The study endeavours to provide valuable insights into the research landscape of agri-food systems and nutritional security, identify gaps in knowledge, and offer directions for future research efforts. The key research questions are:

Research Question 1 (RQ1): What are the major keywords, trending topics, and relationships in the field of nutritional security?

Research Question 2 (RQ2): How have the research and research themes evolved over time?

Research Question 3 (RQ3): What are the research gaps and potential topics for further research?

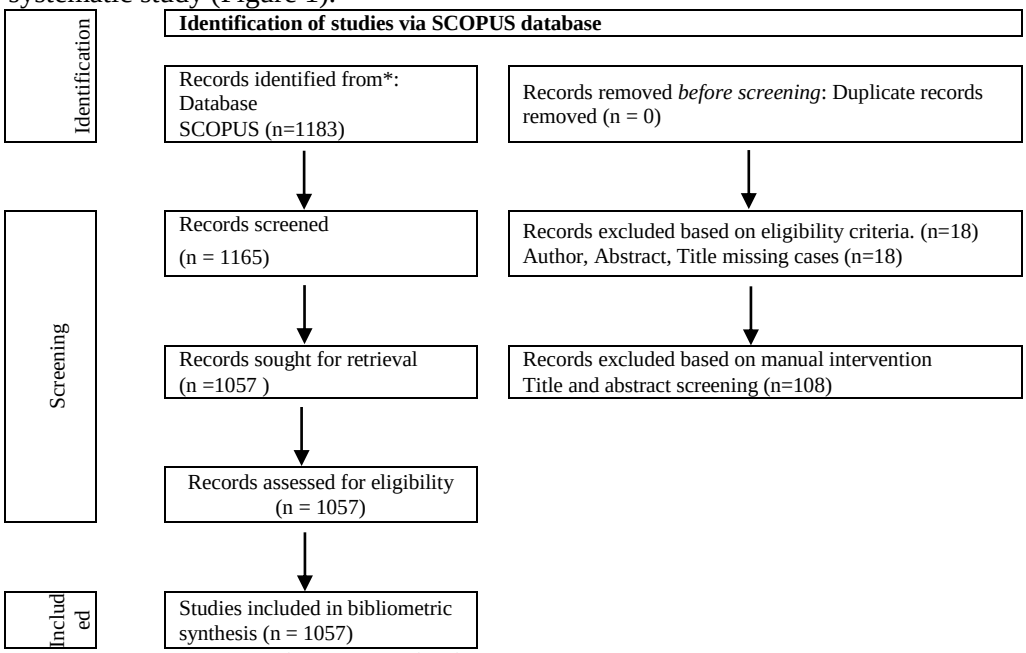
II

METHODOLOGY

Using a bibliometric approach, this study synthesises the global research on nutritional security. The SCOPUS database search was carried out with keyword search ("Agri" OR "food") and ("nutritional security") to identify the relevant publications. SCOPUS database is considered as one of the largest and best claimed databases in extant literature (Zhao and Strotmann, 2015; Montero-Navarro *et al.,* 2021; Perez-Vega *et al.,* 2022), and being reviewed as high-quality standard database (Low and Siegel, 2020). The SCOPUS database with keywords "Agri" OR "Food" AND "Nutrition security" OR "Food security" resulted in a total of 44451 global studies till May 2023. When the search was narrowed down specifically to 'nutritional security', it resulted in only 1,183 studies till May 2023. Data based on the advance query search criteria resulted in raw data of 1183 documents. The following search string was used to obtain the data from SCOPUS-

(TITLE-ABS-KEY(("agri" OR "food") AND "nutritional security") AND (LIMIT-TO (SUBJAREA,"AGRI") OR LIMIT-TO (SUBJAREA,"ENVI") OR LIMIT-TO (SUBJAREA,"ECON") OR LIMIT-TO (SUBJAREA,"SOCI") OR LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"ARTS")) AND (LIMIT-TO (LANGUAGE,"English")))

The screening was performed using SCOPUS filters as 1) language: English only, 2) Subject area: Agri and biological sciences, economics and econometrics, environmental science, social sciences and art and humanities. PRISMA approach was used to screen the document for much clarity in the systematic study (Figure 1).



Note: * Reported the number of records identified from SCOPUS search

Figure 1. PRISMA 2020 Flow Diagram

The retrieved SCOPUS database was cleaned manually by the authors as it may contain impurities and may not be exclusively envisioned to produce bibliometric analysis (Briones-Bitar *et al.,* 2020, Donthu *et al.,* 2021). As a result, 1057 documents were found relevant for further analysis. Biblioshiny programme, an open source software of 'RStudio' was used in this study for quantitative research particularly for science mapping analysis (Agbo *et al.*, 2021).

III

RESULTS AND DISCUSSION

This section focuses on the outcomes and discussion related to the research objectives outlined earlier. It involves conducting a bibliometric analysis, encompassing various aspects starting from keyword analysis to thematic evolution of research in this domain. Additionally, this section provides an overview of potential avenues for future research and proposes a framework to achieve them.

Keywords Analysis

In the context of bibliometric analysis, word clouds serve as a visual representation to depict frequently appearing terms or keywords within a collection of research publications. This visualisation technique offers valuable insights into the prevalent research topics and themes. Figure 2 illustrates a word cloud presenting the most frequently mentioned words derived from the authors' keywords in the literature. The figure highlights prominent keywords such as food security, India, nutrition, and climate change, indicating their significance within the reviewed literature.

Figure 2. Word Cloud of Author's Keywords

Word clouds can serve as an initial exploration tool to identify the most significant terms, while to delve more inside the data, the results of keyword analysis were categorized into different groups (Table 1). "Food quality and nutrition" had the highest frequency (with 28 per cent of total keywords used by the authors),

followed by "climate change and sustainability". In "Food quality and nutrition" category, 'nutrition' term was given prime importance, followed by 'nutritional value', 'food supply', 'diet', 'malnutrition', etc. In the "climate change and sustainability" group, 'food security' term was observed most frequently followed by 'climate change' and 'sustainable development', etc. While studying the "Geography" group, it was observed interestingly that 'India' appeared with highest frequency, followed by 'Africa', 'Brazil' and 'developing world'.

TABLE 1. FREQUENCY DISTRIBUTION OF AUTHORS' KEYWORDS

Food quality and nutrition (1)			Climate change and sustainability (2)			Anthrofauna (3)		
Keyword	Frequency	%	Keyword	Frequency	%	Keyword	Frequency	%
Nutrition	63	4.96	Food security	117	9.21	Animal	44	3.46
Nutritional value	48	3.78	Climate change	40	3.15	Human	84	6.61
Food supply	46	3.62	Sustainable development	35	2.75	Nonhuman	20	1.57
Nutritional status	43	3.38	Sustainability	19	1.49	Adult	14	1.10
Diet	30	2.36	Biodiversity	15	1.18	Male	16	1.26
Malnutrition	27	2.12	Carbon dioxide	13	1.02	Female	23	1.81
Nutrients	21	1.65	Total	239	18.80	Total	201	15.81
Catering service	17	1.34						
Food	15	1.18						
Iron	15	1.18						
Food consumption	14	1.10						
Zinc	13	1.02						
Total	352	27.69						

Geography (4)			Sectors and commodities (5)			Disciplines (6)		
Keyword	Frequency	%	Keyword	Frequency	%	Keyword	Frequency	%
India	64	5.04	Crops	57	4.48	Agriculture	47	3.70
Africa	16	1.26	Fruit	20	1.57	Crop production	45	3.54
Brazil	15	1.18	Fish	19	1.49	Plant breeding	28	2.20
Developing world	12	0.94	Vegetable	17	1.34	Genetics	19	1.49
Total	107	8.42	Plants (botany)	16	1.26	Soil	15	1.18
			Fabaceae	15	1.18	Review	15	1.18
			Zea mays	14	1.10	Physiology	13	1.02
			Food article	32	2.52	Total	182	14.32
			Total	190	14.95			

Note: Total frequency of keywords is 1271.

Co-Occurrence Network

The co-occurrence network analysis was conducted to categorise the literature on "nutritional security" into different research themes. The analysis utilised the "Walktrap" clustering algorithm, the algorithm is very often used in previous bibliometric studies and found one of the best community structures (Camarasa *et al.*, 2019). In this algorithm, the clusters are identified based on citation pattern of listed

database, which resulted in six clusters (Figure 3 and Table 2). The first cluster consists of keywords such as "drought" and "salinity," indicating a strong co-occurrence and association between the two. The second cluster connects keywords like "abiotic stress" and "biotechnology." These keywords are closely related and frequently appear together in scholarly publications, indicating a shared research focus on managing and addressing abiotic stresses in the context of crops. Improving crop resilience under challenging conditions, such as drought, stress, and other abiotic stresses, can contribute to achieving more stable crop yields, mitigate the food shortages and enhances access to nutritious food. The third cluster includes keywords like genetic diversity, conservation, and agrobiodiversity; and highlights the importance of agrobiodiversity in maintaining ecosystems, and the role of genetic conservation in environmental sustainability.

The fourth cluster connects nodes containing keywords like biofortification, malnutrition, micronutrients, millets, hidden hunger, rice, iron, and zinc. The publications in this cluster revolve around the interrelated topics of nutrition, biofortification, and addressing malnutrition, and suggests a focus on improving the nutritional content of crops to combat malnutrition and address micronutrient deficiencies. The fifth cluster indicates a focus on plant breeding techniques, genetic improvement, or crop selection strategies to develop varieties with improved nutritional qualities.

The sixth cluster is the largest cluster among all. The presence of keywords like food security, nutritional security, sustainability, sustainable agriculture, sustainable development goals, and food systems suggests a concern for ensuring sustainable food production systems for achieving sustainable development goals. The inclusion of additional keywords such as climate change, nutrition, crop improvement, fish, yield, gender, health, livelihood, and Covid-19 indicates a broader perspective encompassing various dimensions of agriculture and food systems. These dimensions include, the impact of climate change on food production, the nutritional aspects of food security, crop improvement techniques for enhancing yields, the role of fish and aquatic resources in food security, the gender dimensions of agriculture, the health implications of food systems, livelihood opportunities in agriculture, and the challenges posed by the Covid-19 pandemic.

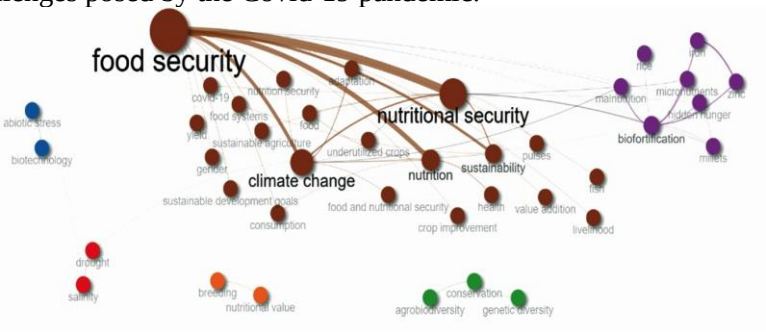


Figure 3. Co-Occurrence Network

TABLE 2. CLUSTERS IN THE RESEARCH DOMAIN OF NUTRITIONAL SECURITY

Cluster 1	Cluster 2	Cluster 3	
Drought Salinity	Abiotic stress Biotechnology	Genetic diversity Conservation Agrobiodiversity	
Cluster 4	**Cluster 5**	**Cluster 6**	
Biofortification Malnutrition Micronutrients Millets Hidden hunger Rice Iron Zinc	Breeding Nutritional value	Food security Nutritional security Climate change Nutrition Sustainability Food and nutritional security Yield Food Crop improvement Nutrition security Fish Pulses	Sustainable agriculture Sustainable development goals Value addition Adaptation Consumption Covid-19 Gender Health Livelihood Underutilized crops Food systems

Trend Topic Chart

Bibliometric analysis utilises trend topic charts to gain insights into the changing research landscape within a particular field. These charts depict the frequency or popularity of specific research topics or keywords over time. By setting the minimum word frequency at 5 and considering 3 words per year, it was discovered that the term "food security" appeared as most frequently used term in the literature (Figure 4). After the onset of the Covid-19 pandemic in 2020, research on global nutritional security focused on "food security," "India," "climate change," "agriculture," "nutrition," and "anemia."

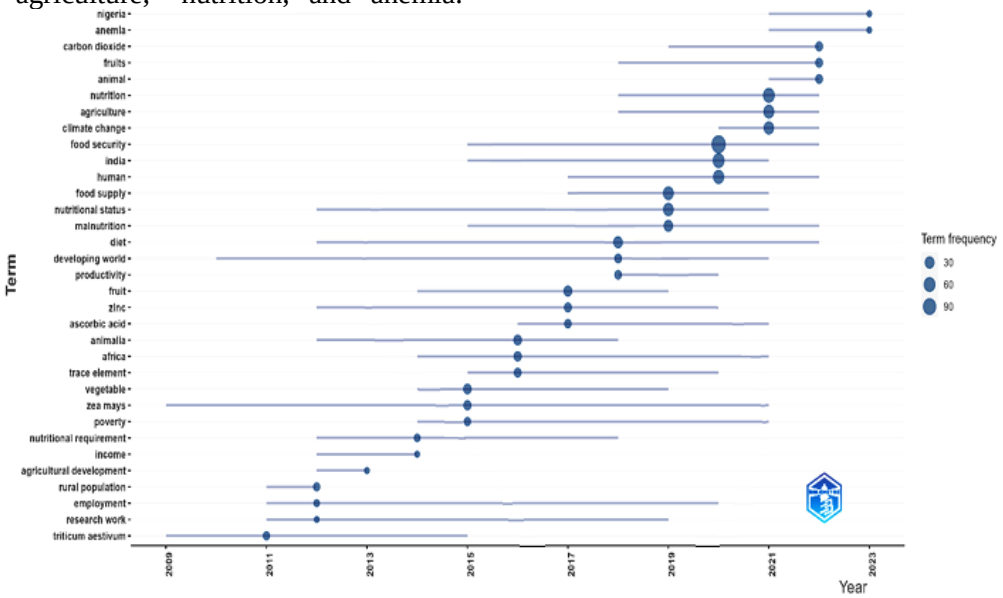


Figure 4. Trend Topics Chart

Thematic Evolution

The analysis of historical developments in the research domain of the 'agri-food systems and nutritional security' begins with a comprehensive examination of thematic evolution (Figure 5), which utilises authors' keywords and an inclusion index weighted by word occurrence. The analysis employed a parameter of a minimum cluster frequency (per thousand docs) at 10, number of words to be used in the analysis at 5000, and number of labels (for each cluster) at 2.

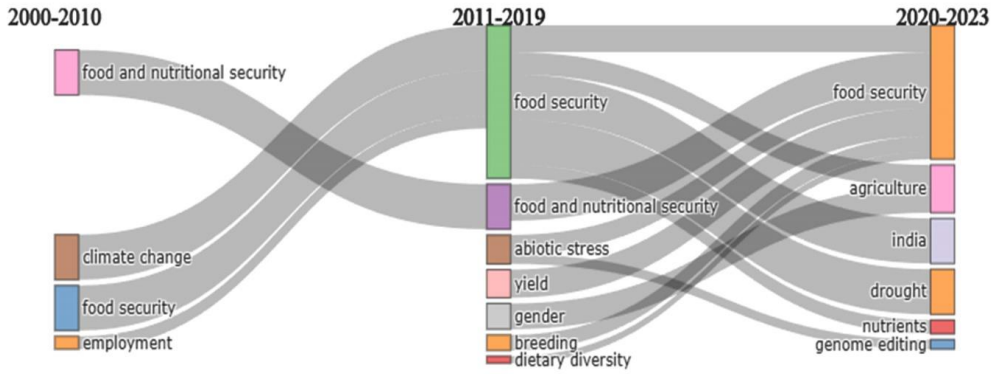


Figure 5. Thematic Evolution in the Area of Nutritional Security

The progression of research themes on nutritional security has emerged according to the global and national priorities. The first time segment (2000-10) represents an early evolution of the concept. This phase witnessed global emphasis on food security in Asian and African countries with a little attention to the nutritional security. Notably, the first paper in 21st Century, addressing the linkages between nutrition and agriculture was published in 2000 in the Food and Nutrition Bulletin, which highlighted the efforts by the Norwegian Ministry of Agriculture to promote consumers' interests and their participation in setting agricultural policy goals to enhance food and nutritional security (Eide, 2000). As the concerns emerged, the researchers in developing countries too started giving due emphasis to nutritional security. A study conducted by Hussain *et al.* (2006) in Pakistan gained popularity. The study emphasised the potential of new quality protein maize (QPM) hybrids with high yield and better quality to contribute to food, feed, and nutritional security, thereby helping alleviate poverty among resource-poor farmers in the country. Another important contribution by Kawarazuka and Béné (2010) identified the pathways for household food and nutritional security through fish farming.

During the second time slice (2011-19), there was a notable emergence of research field focused on gender, dietary diversity, breeding, food, and nutritional security. Notably, a research article garnered substantial attention among researchers, emphasizing the role of crop improvement programmes in lentils for ensuring a food-

secure world (Erskine *et al.,* 2011). Numerous studies were conducted to analyse the role of millets in promoting food and nutritional security (Siqueira *et al.,* 2011; Vanaja *et al.,* 2011; Mavlyanova, 2013; Sood *et al.,* 2015; Kumar *et al.,* 2016). A number of studies provided insights into the crop improvement programmes for millets on a global scale (Vinoth and Ravindhran, 2017; Mirza and Marla, 2019). The most cited study during this time span focused on human health and sustainable food production for ensuring food and nutritional security (Foyer *et al.,* 2016). These endeavours collectively advanced the understanding of how various crops and breeding programmes could play a crucial role in enhancing food and nutritional security.

The recent time slice (2020-23) witnessed many global challenges posed by climate change, nutrient management, abiotic stresses, and Covid-19 pandemic. Due emphasis was given on high-yielding cultivars and biofortification to ensure nutritional security (Rhowell *et al.,* 2021; Roorkiwal *et al.,* 2021; Selvakumar and Kalia, 2022). The global research agenda gave India sufficient attention because of its significant focus on transforming into a nutritionally secured nation. The studies in the Indian context highlighted that the current nutritional status of Indian households remains below the optimal level (Srivastava *et al.,* 2023) and implementing non-economic intervention strategies, viz., raising awareness about healthy dietary behaviour such as fortified food, emphasising hygiene and disease prevention could be successful for ensuring nutritional security (Chand and Jumrani, 2013; Dev and Pandey, 2022). Jumrani (2023) further established that increasing income still remains a crucial means of eliminating undernutrition, particularly among the impoverished populations in low- and middle-income nations like India.

A review by Malhi *et al.* (2021) describing the impact of climate change on agriculture, garnered significant citations and recognition. Similarly, another study by by Lal (2020) describing the role of home gardening and urban agriculture for promoting food and nutritional security during the onset of Covid-19 pandemic, received substantial attention. Similarly, numerous researchers also examined the impacts of the Covid-19 pandemic on food and nutritional security (Alvi and Gupta, 2020; Amorim *et al.,* 2020; Cassol *et al.,* 2020; Ankrah *et al.,* 2021; Mandal *et al.,* 2021; Nchanji and Lutomia, 2021; Alam *et al.,* 2022; Shahbaz *et al.,* 2022).

Future Research Pathways

Research on nutritional security needs in depth exploration of drivers of nutrition and associated health outcomes. The future research pathways for the context of 'agri-food systems and nutritional security' are summarised in Table 3. Research programmes must integrate various disciplines like crop genetics, soil improvement, effective irrigation mechanisms including the impact of climate change to improve agricultural productivity and ensuring sustainable food production systems. Research on food access and distribution must examine the factors affecting

access to nutritious food, proximity to markets, transportation infrastructure, and food distribution networks. Nutritional diets create positive impacts on health outcomes. The impacts of different dietary patterns may be studied on chronic illness, micronutrient deficiencies, wasting, stunting, and obesity along with interventions to improve nutrition, such as fortification and supplementation.

Effective policies and governance influence the nutritional security (Beveridge *et al.*, 2013; Pingali, 2015; Gillespie *et al.*, 2019; Wang *et al.*, 2022). Policy research must emphasise the effectiveness of food policies, social safety nets, and trade agreements, in addressing nutritional security. Nutritional security may be significantly impacted by gender discrepancies in access to and control over resources such as land, water, seeds, credit, and technology. Studies may address how improved nutritional outcomes are directly impacted by women's economic empowerment. Peri-urban agriculture has the potential to have a substantial impact on nutritional security by boosting local food systems, providing fresh and diversified food alternatives, and empowering people. What kind of enabling environment would be essential for sustainable peri-urban agriculture practices in terms of investment, infrastructure, capacity, and promote supporting policies?

The researches related to market access and value chains may focus on how infrastructure improvement can ensure supply-chain efficiency and reduce post-harvest losses. It may also be highlighted how reduction/alteration in trade policies like tariffs and quotas, can ensure nutritional and dietary diversity. Value-addition through processing, packaging, and effective marketing can increase the market penetration (Wood *et al.*, 2021). Further, the research must focus on how promoting inclusive value chains involving smallholder farmers, women, and marginalized groups, can ensure equitable access to resources, and information. Market research is required to understand the demand of nutritional food and its drivers. The impacts of traceability systems and certification schemes may also be highlighted. Evidences are also required on how food policies address specific forms of malnutrition, such as stunting, wasting, micronutrient deficiencies, obesity and diet-related chronic diseases.

Digitalisation may be crucial in addressing nutritional security (Masiero, 2015; Dev and Pandey, 2022). It is important to ascertain how early warning systems can identify possible food shortages (Rembold *et al.*, 2019), malnutrition hotspots, or climate-related problems using satellite images, remote sensing, and data analytics (Usha and Singh, 2013; UNCTAD, 2017; von Braun *et al.*, 2023). Blockchain, the Internet of Things (IoT), and cloud-based platforms are examples of technologies that may track and monitor the flow of food from production to consumption (Misra *et al.*, 2022). Insights are critical on how the resilience of food systems may be increased by promoting climate-smart agricultural practices such conservation agriculture, and efficient water management.

TABLE 3. POTENTIAL AREAS OF RESEARCH AND FRAMEWORK FOR 'AGRI-FOOD SYSTEMS AND NUTRITIONAL SECURITY'

Theme	Dimensions	Research Approach	Selected readings
Sustainable Food Production Systems and Nutritional Quality	• Explore the relationship between sustainable agricultural systems and nutritional outcomes. Focus on organic food consumption, regenerative agriculture, biodiversity, soil health, and the production of nutrient-rich crops • Potential for improving nutritional outcomes from indigenous and traditional food systems. • Innovation and technological change in promoting nutritious foods	Food Systems Analysis, Cost-Benefit Analysis, Health Belief Model, Diffusion of Innovations Theory	Rosenstock *et al.*, 1988; Rogers, 2003; Brent, 2006; Johnston *et al.*, 2014
Peri-urban Agriculture and Nutrition	• Examine the potential of peri-urban agriculture in improving access to fresh, diverse and nutritious foods • Evaluating the nutritional benefits, upscaling, and implications of urban agriculture initiatives.	Nutritional Ecology	Oftedal,1991
Market Access, Value Chains and Nutrition	• Role of different actors in agri-food value chains in shaping nutritional outcomes. • How value chain dynamics influence the nutritional quality and availability of food products. • Impact of marketing strategies (e.g., price promotions, product labeling, advertising) on consumers' perceptions of nutritious food products and their willingness to pay for them	Supply Chain Governance, Value Chain Dynamics, Market Research	IFPRI, 2015; Nandi, 2015; Miquel Vidal and Castellano-Tejedor, 2022
Food Losses and Wastages	• Impact of food losses and wastages on nutrition • Impact of interventions in post-harvest handling, storage, transportation, value-addition in enhancing the availability of nutritious food.	Impact Assessment	Chen *et al.*, 2020
Agri-food Policies and Nutritional Outcomes	• Impact of agricultural and food policies on nutritional outcomes. • How policy decisions related to subsidies, trade, pricing, and food safety regulations influence the availability and affordability of nutritious foods. • Role of certification and standards, traceability and transparency, and supply chain resilience	Impact Assessment through Economic Surplus and Functional Analysis	Madan *et al.*, 2005
Climate Change and Nutrition	• Impact of climate change on the agri-food system and implications for nutritional security • How climate aberrations in terms of extreme weather conditions like temperature, precipitation, and extreme weather events affect crop yields, nutrient content, and food availability, particularly for vulnerable populations.	Life Cycle Assessment, Ecological Footprint Analysis, Social-Ecological Systems framework	Wackernagel and Rees, 1998; Geneva, 2006; Ostrom, 2009
Gender and Nutrition	• Examine gender dimensions of the agri-food system and its impacts on nutritional outcomes. • How gender mainstreaming in access to land, resources, and decision-making power in agriculture can be instrumental in promoting gender equity and improve nutrition.	Behavioral Economics	Thaler and Sunstein, 2009
Digitalization and Nutrition	• Examine the potential of digital technologies (mobile applications, remote sensing, and blockchain) in enhancing nutritional outcomes • How digital technologies can improve information dissemination, market access, supply chain transparency, and awareness about nutritious foods.	Use of Blockchain Technology	Ben Fekih and Lahami, 2020

IV

CONCLUSION

The study synthesised the global research on 'agri-food systems and nutritional security' using bibliometric analysis. "Food security", "India", "nutrition", and "climate change" were prominent keywords used in the literature. "Food quality and nutrition" category shared the highest frequency of keywords. The co-occurrence network analysis placed highest emphasis on 'sustainable agri-food systems for achieving food and nutritional security'. The thematic progression placed emphasis on mitigation strategies to counter the impact of climate change, abiotic stress and most importantly the Covid-19 pandemic on nutritional security in the recent time slice. These research efforts collectively contributed to a better understanding of the complex interplay between food security, nutritional security, and the challenges posed by the Covid-19 pandemic. The paper further discusses the future research pathways in the context of agri-food systems and nutritional security, as they are crucial for finding innovative and sustainable solutions to feed a growing global population, climate adaptation, protect biodiversity, and ensure equitable access to nutritious food. It requires interdisciplinary collaboration, technological advancements, and a holistic approach that considers both environmental and social dimensions to achieve long-term food security and sustainability.

REFERENCES

Agbo, F.J. S.S Oyelere, J. Suhonen and M. Tukiainen (2021), "Scientific Production and Thematic Breakthroughs in Smart Learning Environments: A Bibliometric Analysis." Smart Learning Environments, Vol. 8, No. 1, pp. 1–25. https://doi.org/10.1186/s40561-020-00145-4

Alam, G.M., M.N.I. Sarker, M. Gatto, H. Bhandari and D. Naziri (2022), "Impacts of COVID-19 on the Fisheries and Aquaculture Sector in Developing Countries and Ways Forward." Sustainability, Vol. 14, No. 3, pp. 1071.

Alvi, M. and M. Gupta (2020), "Learning in Times of Lockdown: How Covid-19 is Affecting Education and Food Security in India." Food Security, Vol. 12, No. 4, pp. 793-796.

Amorim, A.L.B.D., J.R.S. Ribeiro Junior, and D.H. Bandoni (2020), "National School Feeding Program: Strategies to Overcome Food Insecurities during and after the COVID-19 Pandemic." Revista de Administração Pública, Vol. 54, pp. 1134-1145.

Ankrah, D.A., A. Agyei-Holmes and A. A. Boakye (2021), "Ghana's Rice Value Chain Resilience in the Context of COVID-19." Social Sciences & Humanities Open, Vol. 4, No. 1, pp. 100210.

Ben Fekih, R. and M. Lahami (2020), "Application of blockchain technology in healthcare: a comprehensive study". In The Impact of Digital Technologies on Public Health in Developed and Developing Countries: 18th International Conference, ICOST 2020, Hammamet, Tunisia, June 24–26, 2020, Proceedings 18 (pp. 268-276). Springer International Publishing.

Beveridge, M.C.M., S.H. Thilsted, M. J. Phillips, M. Metian, M. Troell and S.J. Hall (2013), "Meeting the Food and Nutrition Needs of the Poor: The Role of Fish and the Opportunities and Challenges Emerging from the Rise of Aquaculturea." Journal of Fish Biology, Vol. 83, No. 4, pp. 1067–1084. https://doi.org/https://doi.org/10.1111/jfb.12187

Borgman, C.L. and J. Furner (2002), "Scholarly Communication and Bibliometrics." Annual Review of Information Science and Technology, Vol. 36, No. 1, pp. 1–53.

Brent, R.J. (2006), "Applied Cost–Benefit Analysis" (Second Edition). Edward Elgar Publishing, number 3477.

Briones-Bitar, J., P. Carrión-Mero, N. Montalván-Burbano and F. Morante-Carballo (2020), "Rockfall Research: A Bibliometric Analysis and Future Trends." Geosciences (Switzerland), Vol. 10, No. 10, pp. 1–25. https://doi.org/10.3390/geosciences10100403

Camarasa, C., C. Nägeli, Y. Ostermeyer, M. Klippel and S. Botzler (2019), "Diffusion of Energy Efficiency Technologies in European Residential Buildings: A Bibliometric Analysis." Energy and Buildings, 202, 109339. https://doi.org/https://doi.org/10.1016/j.enbuild.2019.109339

Cassol, A., L.P. Vargas and M.D. Canever (2020), "Territorial Development, Covid-19 and the New Strategies of Production, Commercialization and Food Consumption of Family Farming in the Southern Region of Rio Grande Do Sul." Revista Brasileira de Gestao e Desenvolvimento Regional, pp. 374-387.

Chand, R. and J. Jumrani (2013), "Food Security and Undernourishment in India: Assessment of Alternative Norms and the Income Effect." Indian Journal of Agricultural Economics, Vol. 68, No. 902-2016-66815, pp. 39-53.

Chen, C., A. Chaudhary and A. Mathys (2020), "Nutritional and Environmental Losses Embedded in Global Food Waste." Resources, Conservation and Recycling, Vol. 160, pp. 104912.

Dev, S.M. and V.L. Pandey (2022), "Dietary Diversity, Nutrition and Food Safety." In: Chand, R., P. Joshi and S. Khadka (Eds.) *Indian Agriculture Towards 2030,* India Studies in Business and Economics. Springer, Singapore. https://doi.org/10.1007/978-981-19-0763-0_3

Donthu, N., S. Kumar, D. Mukherjee, N. Pandey and W.M. Lim (2021), "How to Conduct a Bibliometric Analysis: An Overview and Guidelines." Journal of Business Research, Vol. 133, pp. 285–296. https://doi.org/10.1016/J.JBUSRES.2021.04.070

Eide, W.B. (2000), "Agriculture for Consumers: Experiences from Norway." Food and Nutrition Bulletin, Vol. 21, No. 4, pp. 542-546.

Erskine, W., A. Sarker and S. Kumar (2011), "Crops that Feed the World: Investing in Lentil Improvement Toward a Food Secure World. Food Security, Vol. 3, pp. 127-139.

Food and Agriculture Organization of the United Nations (FAO) (2022), *The State of Food Security and Nutrition in the World 2022: Repurposing Food and Agricultural Policies to Make Healthy Diets More Affordable*, Rome. https://doi.org/10.4060/cc0639en

Foyer, C.H., H.M Lam, H.T. Nguyen, K.H.M. Siddique, R.K. Varshney, T.D. Colmer, W. Cowling, H. Bramley, T.A. Mori, J.M. Hodgson, J.W. Cooper, A.J. Miller, K. Kunert, J. Vorster, C. Cullis, J.A. Ozga, M.L. Wahlqvist, Y. Liang, H. Shou, …. M.J. Considine (2016), "Neglecting Legumes has Compromised Human Health and Sustainable Food Production." Nature Plants, Vol. 2, No. 8, pp. 16112. https://doi.org/10.1038/nplants.2016.112

Geneva, S. (2006), "Environmental Management–Life Cycle Assessment–Principles and Framework." International Organization for Standardization (ISO), ISO 14040:2006. Geneva, Switzerland.

Gillespie, S., M. Van Den Bold and J. Hodge (2019), "Nutrition and the Governance of Agri-food Systems in South Asia: A Systematic Review." Food Policy, Vol. 82, pp. 13–27.

Hussain, M., S.R. Chughtai, H.I. Javed, H.N. Malik and M.H. Munawwar (2006), "Performance of Locally Constituted Quality Protein Maize Hybrids: A Fortune for Malnourished People and Feed Industry in Pakistan." Asian Journal of Plant Science, Vol. 5, No. 2, pp. 385-389.

International Food Policy Research Institute (IFPRI) (2015), "Value Chain and Nutrition: A Framework to Support the Identification, Design, and Evaluation of Interventions." IFPRI Discussion Paper 01413, Washington, DC.

Johnston, J.L., J.C. Fanzo and B. Cogill (2014), "Understanding Sustainable Diets: A Descriptive Analysis of the Determinants and Processes That Influence Diets and Their Impact on Health, Food Security, and Environmental Sustainability", in Advances in Nutrition (Vol. 5, Issue 4, pp. 418–429). American Society for Nutrition. https://doi.org/10.3945/an.113.005553

Jumrani, J. (2023), "How Responsive are Nutrients in India? Some Recent Evidence." Food Policy, Vol. 114, pp. 102379. https://doi.org/10.1016/j.foodpol.2022.102379

Kawarazuka, N. and C. Béné (2010), "Linking Small-Scale Fisheries and Aquaculture to Household Nutritional Security: An Overview", *Food Security*, Vol. 2, No. 4, pp. 343–357. https://doi.org/10.1007/s12571-010-0079-y

Kumar, A., M. Metwal, S. Kaur, A.K. Gupta, S. Puranik, S. Singh, ... and R. Yadav (2016), "Nutraceutical Value of Finger Millet [Eleusine coracana (L.) Gaertn.], and their Improvement using Omics Approaches", *Frontiers in Plant Science*, Vol. 7, pp. 934.

Kurtz, M. and J. Bollen (2010), "Usage Bibliometrics", Vol. 44, Medford, NJ: Information Today. Inc.

Lal, R. (2020), "Home Gardening and Urban Agriculture for Advancing Food and Nutritional Security in Response to the COVID-19 Pandemic", *Food Security*, Vol. 12, No. 4, pp. 871-876.

Low, M.P. and D. Siegel (2020), "A Bibliometric Analysis of Employee-Centred Corporate Social Responsibility Research in the 2000s", *Social Responsibility Journal*, Vol. 16, No. 5, pp. 691–717. https://doi.org/10.1108/SRJ-09-2018-0243

Madan, M.S., A. Gowda, S.J. Ramana, M. KV and J. Nagendra (2005), *Using the Economic Surplus Model to Assess Returns on Research Investment: A Case Study of Developing Soil Water Conservation Measures for Cardamom*, Indian Institute of Spices Research, Calicut–673012, Kerala.

Malhi, G.S., M. Kaur and P. Kaushik (2021), "Impact of Climate Change on Agriculture and its Mitigation Strategies: A Review", *Sustainability*, Vol. 13, No. 3, pp. 1318.

Mandal, S.C., P. Boidya, M.I.M. Haque, A. Hossain, Z. Shams and A.A. Mamun (2021), "The Impact of the COVID-19 Pandemic on Fish Consumption and Household Food Security in Dhaka city, Bangladesh", *Global Food Security*, Vol. 29, pp. 100526.

Masiero, S. (2015), "Redesigning the Indian Food Security System through E-Governance: The Case of Kerala", World Development, Vol. 67, pp. 126–137. https://doi.org/10.1016/j.worlddev.2014.10.014

Mavlyanova, R. (2013), "Strategic Approaches for Research and Promotion of Underutilized Vegetable Crops for Food Security in Central Asia and the Caucasus." in II International Symposium on Underutilized Plant Species: Crops for the Future-Beyond Food Security, June 27-July 1 2011, Malaysia.

McBurney, M.K. and P.L. Novak (2002), "What is Bibliometrics and Why Should You Care?", Proceedings of IEEE International Professional Communication Conference, pp. 108–114.

Miquel Vidal, M. and C. Castellano-Tejedor (2022), "Identification of Marketing Strategies Influencing Consumers' Perception of Healthy Food Products and Triggering Purchasing Decisions", *Businesses*, Vol. 2, No. 4, pp. 410-422.

Mirza, N. and S.S. Marla (2019), "Finger Millet (Eleusine coracana L. Gartn.) Breeding", Advances in Plant Breeding Strategies: Cereals, Vol. 5, pp. 83-132.

Misra, N.N., Y. Dixit, A. Al-Mallahi, M.S. Bhullar, R. Upadhyay and A. Martynenko (2022), "IoT, Big Data, and Artificial Intelligence in Agriculture and Food Industry." IEEE Internet of Things Journal, Vol. 9, No. 9, pp. 6305–6324. https://doi.org/10.1109/JIOT.2020.2998584

Montero-Navarro, A., T. Gonz Alez-Torres, J.E.-L. Rodr Iguez-S Anchez, R. Gallego-Losada, U. Rey and J. Carlos (2021), "A Bibliometric Analysis of Greenwashing Research: A Closer Look at Agriculture, Food Industry and Food Retail", *British Food Journal*, Vol. 123, No. 13, pp. 547–560. https://doi.org/10.1108/BFJ-06-2021-0708

Morris, S., C. DeYong, Z. Wu, S. Salman and D. Yemenu (2002), "DIVA: A Visualization System for Exploring Document Databases for Technology Forecasting", *Computers and Industrial Engineering*, Vol 43, No. 4, pp. 841–862.

Nandi, R. (2015), "Organic Food Market in India: Supply Chain Governance and Consumer Behavior", Verlag Dr Koester.

Nchanji, E.B. and C.K. Lutomia (2021), "COVID-19 Challenges to Sustainable Food Production and Consumption: Future Lessons for Food Systems in Eastern and Southern Africa from a Gender Lens", *Sustainable Production and Consumption*, Vol. 27, pp. 2208-2220.

Oftedal, O.T. (1991), "The Nutritional Consequences of Foraging in Primates: The Relationship of Nutrient Intakes to Nutrient Requirements." Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, Vol. 337, No. 1270, pp. 161–170.

Ostrom, E. (2009), "A General Framework for Analyzing Sustainability of Social-Ecological Systems." Science, Vol. 325, pp. 419-422. https://doi.org/10.1126/science.1172133

Patra, S.K., P. Bhattacharya and N. Verma (2006), "Bibliometric Study of Literature on Bibliometrics." DESIDOC Bulletin of Information Technology, Vol. 26, No. 1, pp. 27–32.

Perez-Vega, R., P. Hopkinson, A. Singhal and M.M. Mariani (2022), "From CRM to Social CRM: A Bibliometric Review and Research Agenda for Consumer Research." Journal of Business Research, Vol. 151, pp. 1–16. https://doi.org/10.1016/j.jbusres.2022.06.028

Pingali, P. (2015), "Agricultural Policy and Nutrition Outcomes – Getting Beyond the Preoccupation with Staple Grains." Food Security, Vol. 7, No. 3, pp. 583–591. https://doi.org/10.1007/s12571-015-0461-x \

Rembold, F., M. Meroni, F. Urbano, G. Csak, H. Kerdiles, A. Perez-Hoyos, G. Lemoine, O. Leo and T. Negre (2019), "A New Global Early Warning System to Detect Anomaly Hot Spots of Agricultural Production for Food Security Analysis and Agricultural Systems", Vol. 168, pp. 247–257, https://doi.org/10.1016/j.agsy.2018.07.002

Rhowell Jr, N.T., A.R. Fernie and N. Sreenivasulu (2021), "Meeting Human Dietary Vitamin Requirements in the Staple Rice via Strategies of Biofortification and Post-Harvest Fortification", *Trends in Food Science & Technology*, Vol. 109, pp. 65-82.

Rogers, E.M. (2003), *Diffusion of Innovations* (Fifth Edition), Simon and Schuster.

Roorkiwal, M., S. Pandey, D. Thavarajah, R. Hemalatha and R.K. Varshney (2021), "Molecular Mechanisms and Biochemical Pathways for Micronutrient Acquisition and Storage in Legumes to Support Biofortification for Nutritional Security", *Frontiers in Plant Science*, Vol. 12, pp. 682842.

Rosenstock, I.M., V.J. Strecher and M.H. Becker (1988), "Social Learning Theory and the Health Belief Model", Health Education Quarterly, Vol. 15, No. 2, pp. 175–183.

Selvakumar, R. and P. Kalia (2022), "Profiling of Flavonoid Compounds in Tropical Indian Cultivars and their Hybrids in Carrot (Daucus carota)", In XXXI International Horticultural Congress (IHC2022): International Symposium on Breeding and Effective Use of Biotechnology (pp. 337-344).

Shahbaz, P., S.U. Haq, U.B. Khalid and I. Boz (2022), "Gender-based Implications of the COVID-19 Pandemic on Household Diet Diversity and Nutritional Security in Pakistan", *British Food Journal*, Vol. 124, No. 3, pp. 951-967.

Siqueira, R.L.D., D.D.A. Fonseca, M.N. Viana, T.D.S. Junqueira, R.D.C.L. Ribeiro and R.M.M. Cotta (2011), "Food and Nutritional Security Council: Analysis of the Social Control over the Food and Nutritional Security State Policy in the State of Espírito Santo", Saúde e Sociedade, Vol. 20, pp. 470-482.

Sood, S., R.K. Khulbe, A.K. Gupta, P.K. Agrawal, H.D. Upadhyaya and J.C. Bhatt (2015), "Barnyard Millet–A Potential Food and Feed Crop of Future." Plant Breeding, Vol. 134, No. 2, pp. 135-147.

Srivastava, S.K., D. Kolady and S. Paul (2023), "Changing Food Consumption Pattern and Its Implications on Achieving Zero Hunger in India (SDG-2)", in Narula, S.A. and S.P. Raj (Eds), *Sustainable Food Value Chain Development.* Springer, Singapore. https://doi.org/10.1007/978-981-19-6454-1_9

Thaler, R.H. and C.R. Sunstein (2009), *Nudge: Improving Decisions About Health, Wealth, and Happiness*, Penguin.

UNCTAD (2017), "The Role of Science, Technology and Innovation in Ensuring Food Security by 2030", United Nations Conference on Trade and Development (UNCTAD) Report, Geneva, Switzerland.

Usha, K. and B. Singh (2013), "Potential Applications of Remote Sensing in Horticulture—A Review." Scientia Horticulturae, Vol. 153, pp. 71–83. https://doi.org/https://doi.org/10.1016/j.scienta.2013.01.008

Vanaja, M., P. Raghu Ram Reddy, N. Jyothi Lakshmi, S.K. Yadav, A. Narasimha Reddy, M. Maheswari and B. Venkateswarlu (2011), "Yield and Harvest Index of Short and Long Duration Grain Legume Crops under Twice the Ambient CO2 Levels." Indian Journal of Agricultural Sciences, Vol. 81, No. 7, pp. 666.

Vinoth, A. and R. Ravindhran (2017), "Biofortification in Millets: A Sustainable Approach for Nutritional Security." Frontiers in Plant Science, Vol. 8, pp. 29.

Von Braun, J., K. Afsana, L.O. Fresco and M.H.A. Hassan (2023), "Science for Transformation of Food Systems: Opportunities for the UN Food Systems Summit." In: Von Braun, J., K. Afsana, L.O. Fresco and M.H.A. Hassan (eds). Science and Innovations for Food Systems Transformation. Springer, Cham. https://doi.org/10.1007/978-3-031-15703-5_50

Wackernagel, M. and W. Rees (1998), "Our Ecological Footprint: Reducing Human Impact on the Earth." New Society Publishers.

Wang J., X. Ding, H. Gao and S. Fan (2022), "Reshaping Food Policy and Governance to Incentivize and Empower Disadvantaged Groups for Improving Nutrition." Nutrients, Vol. 14, No. 3, pp. 648. https://doi.org/10.3390/nu14030648

WHO (2019), "UNICEF-WHO Low Birthweight Estimates: Levels and Trends 2000-2015." (No. WHO/NMH/NHD/19.21). World Health Organization, Geneva, Switzerland.

Wood, B., O. Williams, V. Nagarajan and G. Sacks (2021), "Market Strategies used by Processed Food Manufacturers to Increase and Consolidate their Power: A Systematic Review and Document Analysis." Globalization and Health, Vol. 17, No. 1, pp. 1-23.

Zhao, D. and A. Strotmann (2015), *Analysis and Visualization of Citation Networks*, Morgan & Claypool Publishers. https://doi.org/10.1007/978-3-031-02291-3