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SUSTAINABLE FOOD SYSTEMS AND NUTRITIONAL SCIENCE IN INDIA: A SCIENTOMETRIC APPROACH TO UNDERSTANDING RESEARCH PATTERNS

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Abstract

This study applies a scientometric approach to analyze global research trends in sustainable food systems and nutritional science from 2000 to 2023. The data, drawn from the Scopus database, examines publication growth, collaboration networks, and emerging research themes. Tools such as VOSviewer and CiteSpace were employed to visualize co-authorship, citation networks, and thematic developments.

Key findings reveal significant growth in publications, particularly between 2020 and 2023, reflecting an increasing global focus on food security and sustainability. India emerged as a major contributor to the field, with the Indian Council of Agricultural Research and the ICAR-Indian Agricultural Research Institute leading publication output. Additionally, India has developed strong international research collaborations, especially with the United States, United Kingdom, Australia, and China.

The analysis identifies food security, climate change, and sustainable agriculture as dominant themes, while keywords like controlled study and male are underrepresented, indicating potential research gaps. Leading contributors include Varshney R.K., Jat M.L., and Siddique K.H.M., with highly cited publications shaping the discourse in sustainable food systems.

The study concludes that while progress is evident, there are notable gaps, particularly in areas like precision agriculture, gender studies, and underrepresented regions. Future research should focus on these gaps to ensure a more comprehensive understanding of sustainable food systems and nutritional science, supporting global efforts toward food security and sustainability.

Keywords

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Sustainable food systems, nutritional science, scientometric analysis, research patterns, bibliometrics, sustainability, food security

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1. INTRODUCTION

1.1. Background and Rationale

Sustainable food systems offer a holistic solution to the complex challenges of food security, environmental sustainability, and nutritional health. As defined by Garnett (2014), these systems ensure that food is produced in ways that are economically sustainable, environmentally sound, and socially equitable. This approach recognizes the critical need to balance human health, ecological preservation, and economic sustainability, particularly as global food demand intensifies, driven by climate change and malnutrition (FAO, 2018). Nutritional science is integral to this effort, moving beyond the biological aspects of food to address broader health determinants influenced by dietary patterns. Tilman and Clark (2014) emphasize that nutritional security extends beyond calorie sufficiency, requiring access to safe, diverse, and nutrient-dense foods produced sustainably. Addressing the widespread issues of malnutrition, including obesity and micronutrient deficiencies, necessitates aligning nutrition policies with sustainability principles (Pingali, 2012).

Scientometric analysis offers a quantitative approach to mapping research trends within sustainable food systems and nutritional science (Aria & Cuccurullo, 2017). It provides critical insights into influential studies, emerging themes, and collaboration networks, particularly in interdisciplinary fields like food systems. By analyzing research production, scientometrics can inform policy decisions, identify research gaps, and guide collaborative efforts across disciplines such as agriculture, public health, and environmental science. Furthermore, scientometric evaluations aid in assessing the impact of current policies and innovations, providing a foundation for strategic interventions in sustainable food and nutrition systems (Mingers & Leydesdorff, 2015).

1.2. Objectives of the Study

1. To examine the global research trends in sustainable food systems and nutritional science.
2. To analyse collaboration networks, key contributors, and influential publications.
3. To identify gaps and emerging trends in the field.

2. LITERATURE REVIEW

2.1. Sustainable Food Systems

Sustainable food systems are increasingly recognized as central to tackling global issues related to food security, climate change, and the responsible use of resources. According to the Food and Agriculture Organization (FAO, 2018), a sustainable food system (SFS) is one that ensures food security and nutrition for all, without compromising the economic, social, and environmental foundations necessary to provide for future generations. Such systems encompass the entire food supply chain, including production, processing, distribution, consumption, and waste management, while simultaneously promoting environmental care, social equity, and economic viability (FAO, 2018).

Transitioning to sustainable food systems requires overcoming numerous challenges, such as reducing environmental impacts, promoting biodiversity, cutting greenhouse gas emissions, and improving the efficiency of resource use. These pressures are exacerbated by population

growth, urbanization, and changing dietary preferences, particularly the increasing demand for resource-intensive foods like meat and dairy (Godfray et al., 2010). Such trends significantly contribute to environmental degradation, including deforestation, water depletion, and biodiversity loss, posing critical threats to long-term sustainability (Garnett, 2014).

Beyond environmental considerations, sustainable food systems must also address social dimensions, including fair access to nutritious food, equitable labor practices, and the preservation of cultural food traditions. Inequities in food access disproportionately affect marginalized populations (Pingali, 2012). Achieving sustainable food systems thus requires a holistic approach, integrating technological innovations, policy reforms, and community-based strategies to enhance food production while safeguarding ecosystems and promoting social justice (FAO, 2018).

2.1.1. Nutritional Science and Its Intersection with Sustainability and Food Security

Nutritional science plays an essential role in sustainable food systems, particularly at the intersection of human health and environmental sustainability. Research by Tilman and Clark (2014) emphasizes the dual challenge of meeting the nutritional needs of a growing global population while mitigating the environmental impacts of food production. Nutritional science advocates for diets that are both health-promoting and environmentally sustainable, with plant-based diets being an example of lower carbon footprint alternatives to meat-based diets (Tilman & Clark, 2014).

Sustainability in nutrition extends beyond environmental concerns to encompass food security, defined as ensuring that everyone has access to sufficient, safe, and nutritious food for an active and healthy life (Godfray et al., 2010). Food insecurity remains a persistent global challenge, compounded by factors such as climate change, political instability, and economic inequality. Nutritional science contributes to identifying and promoting sustainable diets that are both accessible and environmentally sound (Garnett, 2014).

A shift towards sustainable diets also involves diversifying food production to enhance resilience against climate-related disruptions. Research has shown that adopting diverse, locally adapted crops can increase food system resilience and ensure nutritional adequacy (Tilman & Clark, 2014). Thus, nutritional science not only informs individual dietary choices but also influences broader food system policies aimed at sustainability. This integration of nutrition and sustainability is essential for addressing global challenges in food security and health.

2.2. Scientometric Analysis in Food and Nutritional Sciences

2.2.1. The Evolution of Scientometric Methods in Research Analysis

Scientometric methods have evolved significantly, becoming critical tools for quantitatively analyzing scientific literature. Mingers and Leydesdorff (2015) outline the importance of these methods in evaluating research outputs, citation patterns, and collaboration networks. These approaches go beyond basic bibliometric indicators, offering sophisticated tools for visualizing and mapping the structure of scientific knowledge. Scientometric methods enable researchers to track trends, identify influential publications, and explore the evolution of

ISSN PRINT 2319 1775 Online 2320 7876
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thematic areas in a field.

A significant advancement in scientometrics is network analysis, which has transformed the study of collaborations and co-authorship patterns. This method reveals key authors, institutions, and countries shaping a research field, providing insights into knowledge dissemination and accumulation. According to Mingers and Leydesdorff (2015), tools like VOSviewer and CiteSpace allow for the visualization of these networks, enhancing the mapping of research trends.

In food and nutritional sciences, scientometric methods are used to assess the growing body of literature on sustainable food systems, public health, and nutrition security. Such analysis highlights dominant research themes and emerging interdisciplinary areas where nutritional science intersects with environmental sustainability and food production systems. Scientometric analysis is crucial for tracking the development of research in this domain, offering evidence-based insights for policymakers and scholars.

2.2.2. Previous Scientometric Studies in Food and Nutritional Science: Key Findings and Limitations

Wang et al. (2018) conducted a comprehensive scientometric study in food and nutritional sciences, uncovering significant trends, collaboration networks, and thematic developments. Their analysis revealed an increasing focus on food security, malnutrition, and sustainable agricultural practices. However, research on sustainable food systems remains underdeveloped compared to other nutritional science areas, particularly in integrating environmental and public health considerations.

While scientometric studies provide valuable insights, there are limitations. For instance, relying on citation-based metrics may overlook smaller, innovative studies that are less frequently cited. Additionally, the focus on English-language publications may exclude research from non-English-speaking regions, potentially biasing the analysis. Future studies should address these gaps for a more comprehensive understanding of the research landscape in food and nutritional sciences.

3. METHODOLOGY

3.1. Data Sources

This study employed data from the Scopus database, which was selected due to its comprehensive coverage of peer-reviewed literature across diverse fields. The search was conducted using the key terms “sustainable food systems,” “nutritional science,” and “food security” to ensure a focused and relevant dataset.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

"sustainable food systems" OR "nutritional science" OR "food security") AND PUBYEAR > 1999 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "AGRI") OR LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ENVI") OR LIMIT-TO (SUBJAREA , "MEDI")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (SRCTYPE , "j") OR LIMIT-TO (SRCTYPE , "p")) AND (LIMIT-TO (AFFILCOUNTRY , "India"))

The search was restricted to publications from 2000 to 2023, with the objective of identifying trends and emerging themes over the last two decades. The search query was further refined to include only research articles, reviews, and conference papers, excluding book chapters, editorials, and other forms of non-peer-reviewed literature.

3.2. Screening Process

A total of 3,700 records were initially retrieved from the Scopus database. The inclusion criteria for the study required that the articles explicitly address issues related to sustainable food systems, nutritional science, and food security. Articles that did not fall within these topics, as well as those that focused exclusively on technical aspects of agriculture without connection to sustainability or nutrition, were excluded. Additionally, only publications in English were considered, which is a limitation but was necessary to maintain consistency in analysis.

3.3. A three-step screening process was employed to refine the dataset:

➢ ***Title and Abstract Screening***: After the initial retrieval, 1,100 records were excluded based on the title and abstract, as these did not align with the research focus.
➢ ***Full-Text Review***: Out of the remaining 2,600 records, 450 publications were excluded after a full-text review. The main reasons for exclusion were: lack of focus on sustainability (210 records), nutritional outcomes not being addressed (140 records), or duplication (100 records).
➢ ***Data Extraction and Quality Check***: A further 80 articles were excluded after data extraction due to poor data quality or irrelevance to the study objectives, bringing the final dataset to 2,070 articles.

3.4. PRISMA Flow Diagram

Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines, the flow of information through the different phases of the study is depicted as follows:

➢ Records identified from Scopus: 3,700.
➢ Records excluded during title/abstract screening: 1,100.
➢ Full-text articles assessed for eligibility: 2,600.
➢ Full-text articles excluded with reasons: 450 (non-relevance to sustainability/nutrition or duplication)
➢ Final articles included in the analysis: 2,070.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

3.5. Data Analysis

The final dataset was exported into CSV format and analyzed using VOSviewer and CiteSpace for bibliometric and scientometric analyses. These tools were used to map citation networks, co-authorship networks, and keyword co-occurrence. The key indicators evaluated included publication growth, co-authorship patterns, keyword trends, and collaboration networks. This methodological approach ensured a rigorous screening and selection process, enabling a comprehensive analysis of global research trends in sustainable food systems and nutritional science. The final dataset of 2,070 publications provides a robust foundation for identifying gaps, emerging themes, and key contributors in the field.

3.5.1. Research Trends in Sustainable Food Systems and Nutritional Science.

Table 1: Research Trends in Sustainable Food Systems and Nutritional Science.

Year	Publications	Percentage (%)	Cumulative Frequency
2000	13	0.4	13
2001	18	0.55	31
2002	12	0.37	43
2003	13	0.4	56
2004	13	0.4	69
2005	16	0.49	85
2006	16	0.49	101
2007	25	0.76	126
2008	31	0.95	157
2009	47	1.44	204
2010	56	1.71	260
2011	62	1.9	322
2012	81	2.48	403
2013	78	2.38	481
2014	89	2.72	570
2015	135	4.13	705
2016	132	4.04	837
2017	162	4.95	999
2018	184	5.63	1183
2019	204	6.24	1387
2020	263	8.04	1650
2021	450	13.76	2100
2022	506	15.47	2606
2023	665	20.33	3271

The table 1 reveals an important upward trend in the number of publications from 2000 to 2023. Starting with 13 publications in 2000, the count increases to 665 by 2023, reflecting a substantial annual increase. The percentage of total publications also grows clearly, from just 0.4% in 2000 to 20.33% in 2023. This rapid growth became particularly pronounced from

2010 onward, with especially notable spikes between 2020 and 2023. The cumulative frequency, which tracks the total number of publications up to each year, reached 3,271 by 2023, indication a growth and accelerating trend in publication output over the years.

3.5.2. Table 2 for Annual Growth Rate

Table 2: Annual Growth Rate

Year	Publications	Previous Year Publications	Annual Growth Rate (%)
2000	13	-	-
2001	18	13	38.46
2002	12	18	-33.33
2003	13	12	8.33
2004	13	13	0
2005	16	13	23.08
2006	16	16	0
2007	25	16	56.25
2008	31	25	24
2009	47	31	51.61
2010	56	47	19.15
2011	62	56	10.71
2012	81	62	30.65
2013	78	81	-3.7
2014	89	78	14.1
2015	135	89	51.69
2016	132	135	-2.22
2017	162	132	22.73
2018	184	162	13.58
2019	204	184	10.87
2020	263	204	28.92
2021	450	263	70.34
2022	506	450	12.44
2023	665	506	31.34

To calculate the annual growth rate for each year, you can use the formula:

$$\text{Growth Rate} = \frac{\text{Number of Publications in Current Year} - \text{Number of Publications in Previous Year}}{\text{Number of Publications in Previous Year}} \times 100$$

Table 2 shows the annual growth rates in the number of publications which shows a clear trend of increasing growth over time, with some fluctuations. In the early on years, from 2000 to 2009, the growth rates diverse, with important increases and rare declines. A growth rate of -33.33% in 2002 means that the number of publications in 2002 was 33.33% lower than in 2001. However, starting around 2010, the growth rates began to rise more consistently, reaching significant peaks such as a 70.34% increase in 2021. This indicates a strong increase in publication output, particularly in the most recent years. Although the growth rates have begun to stabilize somewhat recently, the overall trend reflect a strong and ongoing expansion in the number of publications.

3.5.3. Double Timing of Research Growth

Table 3: Double Timing of Research Growth

Year	Annual Growth Rate (%)	Doubling Time (Years)
2001	38.46	1.82
2003	8.33	8.4
2005	23.08	3.04
2007	56.25	1.24
2008	24	2.92
2009	51.61	1.36
2010	19.15	3.65
2011	10.71	6.53
2012	30.65	2.28
2014	14.1	4.96
2015	51.69	1.35
2017	22.73	3.08
2018	13.58	5.15
2019	10.87	6.44
2020	28.92	2.42
2021	70.34	0.99
2022	12.44	5.63
2023	31.34	2.23

The "Rule of Seventy" is a useful heuristic for estimating the time required for a quantity to double, particularly in contexts like publication growth rates. This rule states that dividing 70 by the annual growth rate provides an approximate number of years for doubling (Troughton, 1968).

$$\text{Doubling Time} = \frac{70}{\text{Annual Growth Rate}}$$

In the doubling time, table 3 shows how quickly the number of publications is expected to double, based on the annual growth rates. In the early years, doubling times were relatively

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

longer, indicating slower growth, such as 8.40 years in 2003. As time progressed, particularly from around 2010, the doubling times became shorter, reflecting faster growth rates. For instance, in 2021, the doubling time was only about 0.99 years, highlighting an exceptionally rapid growth phase. Recent years generally show shorter doubling times, indicating that the number of publications is increasing at a faster rate. Overall, the data illustrates a trend of accelerating publication growth, with increasingly frequent doubling of the number of publications.

3.5.4. Top 10 Authors with Highest Number of Publications

Table 4: Top 10 Author with Highest Number of Publications

Author	Publications	Percentage (%)
Varshney, R.K.	26	17.81
Jat, M.L.	20	13.7
Siddique, K.H.M.	19	13.01
Aggarwal, P.K.	14	9.59
Das, A.	14	9.59
Babu, S.	14	9.59
Sharma, P.C.	13	8.9
Kumar, A.	13	8.9
Singh, G.P.	12	8.22
Vadez, V.	12	8.22

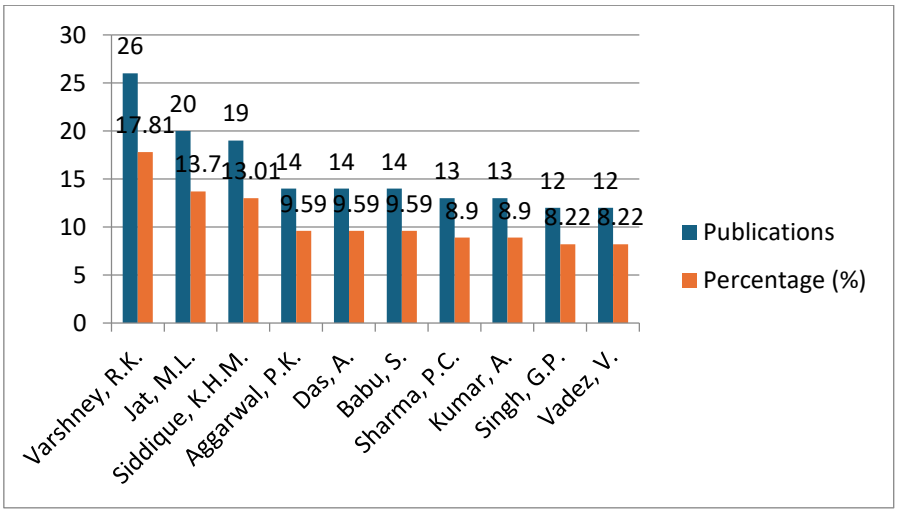


Figure 1: Top 10 Author in India

The top 10 author by number of publications shows in table 3.3.4. With 17.81% of the total publications, Varshney, R.K. has the most, followed by Jat, M.L. with 13.70% and Siddique, K.H.M. with 13.01%. With 9.59% of the total, the next three authors Agarwal, P.K., Das, A., and Babu, S.have comparable levels of contribution. Of the total publications, Sharma, P.C. and Kumar, A. account for 8.90%, while Singh, G.P. and Vadez, V. each make up 8.22%.

Overall, the distribution demonstrates that the leading authors Varshney, R.K. being the most well-known have contributed significantly, while the other authors' output levels are more similar.

3.5.5. Top 10 Institute in India

Table 5: Top 10 Institute from India

Institution	Publications	Percentage (%)
Indian Council of Agricultural Research	237	12.09
ICAR - Indian Agricultural Research Institute, New Delhi	200	10.21
International Crops Research Institute for the Semi-Arid Tropics	125	6.37
Banaras Hindu University	106	5.4
Jawaharlal Nehru University	86	4.38
Punjab Agricultural University	80	4.08
Indian Institute of Technology Kharagpur	69	3.51
University of Delhi	67	3.41
International Food Policy Research Institute	61	3.11
CCS Haryana Agricultural University	51	2.6

In table 3.3.5, the Indian Agricultural Research Institute, New Delhi (ICAR) comes in second with 10.21% of publications, and the Indian Council of Agricultural Research is first with 12.09%. The International Crops Research Institute for the Semi-Arid Tropics and Banaras Hindu University have made significant contributions, with 6.37% and 5.40%, respectively. The contributions from other universities, like Jawaharlal Nehru University and Punjab Agricultural University, range from 4% to 3.51%, with the rest universities contributing lower amounts. This distribution illustrates the varied contributions made by others while highlighting a few top universities.

3.5.6. Top 10 Journal in India

Table 6: Top 10 Journal in India

Journal	Publications	Percentage (%)
Economic And Political Weekly	61	13.56
Frontiers In Plant Science	59	13.11
Indian Journal of Agricultural Sciences	51	11.33
Sustainability Switzerland	48	10.67
Food Security	45	10
Indian Journal of Agricultural Economics	41	9.11
Science Of the Total Environment	36	8

Frontiers In Sustainable Food Systems	35	7.78
Journal Of Rural Development	31	6.89
Frontiers In Microbiology	24	5.33

The table 3.3.6 reveals that the leading journals, Frontiers in Plant Science and Economic and Political Weekly, account for 13.11% and 13.56% of publications, respectively, according to table 3.3.6. The Indian Journal of Agricultural Sciences (11.33%) and Sustainability Switzerland (10.67%) are two more significant contributors. The proportions of Food Security and a few other periodicals are lower, ranging from 5.33% to 10.00%. This demonstrates an emphasis on publications in a small number of top journals, with a more widespread distribution in the others.

3.5.7. Top 10 Authors with Highest Citations in India

Table 7: Top 10 Authors with Highest Citations in India

Author	Documents	Citations	Total Link Strength
Varshney, Rajeev K.	21	1943	19
Kumar, Vinod	9	1795	7
Kim, Ki-Hyun	7	1743	6
Rai, Prabhat Kumar	12	1320	5
Kumar, Pradeep	24	1290	8
Pathak, H.	9	1283	9
Jat, M.L.	18	1268	28
Kumar, Sandeep	6	1189	4
Kumar, Rakesh	12	800	9
Kamle, Madhu	6	717	20
Bohra, Abhishek	11	698	15
Kumar, Vijay	6	677	4
Siddique, Kadambot H. M.	14	652	18
Kumar, Anjani	18	646	16
Sapkota, Tek B.	6	583	11
Kumar, Anil	10	547	-
Kumar, Arun	5	509	-
Agrawal, Madhoolika	7	481	-
Mishra, Ashok K.	7	480	-
Mahato, Dipendra Kumar	5	473	-

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

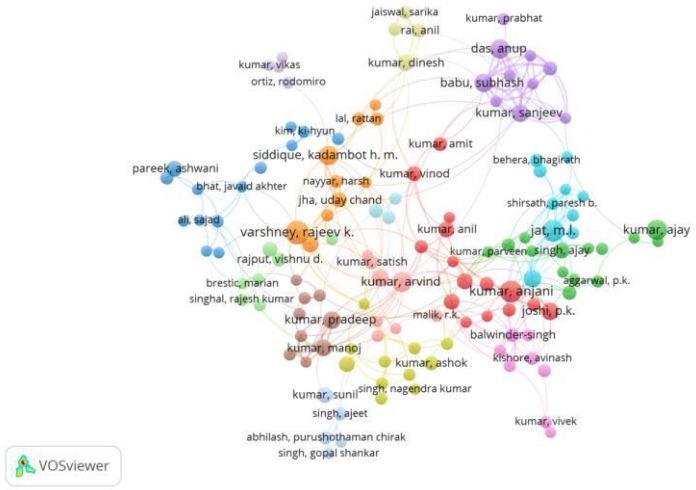


Figure 2: Top 10 Author in India

Figure 2 and Table 7 list authors who have had a major influence on research. Rajeev K. Varshney is in first place with the most citations (1943) and a robust link strength of 19. Kim, Ki-Hyun and Kumar, Vinod both have lower link strengths but higher citation counts (1795 and 1743). Pradeep Kumar has a large number of citations (1290) and an 8 link strength. Jat, M.L. has the greatest link strength (28), and a high citation count (1268). While the citation counts of other authors such as Kamle, Madhu, and Bohra, Abhishek, are important, their link strengths differ, indicating different levels of collaboration and research impact.

3.5.8. Mostly Occurrence Keywords with Total Collaboration

Table 8: Mostly Occurrence Keywords with Total Collaboration

Keyword	Occurrences	Total Link Strength
Food Security	1334	14805
India	843	9887
Food Supply	649	9813
Human	364	7717
Article	327	7284
Humans	253	5672
Nonhuman	254	5590
Climate Change	449	5256
Agriculture	362	5134
Review	176	3862
Crops	209	3536
Female	135	3210
Rice	221	3102
Crop Production	166	2835
Controlled Study	109	2750
Male	104	2633

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

Sustainable Development	166	2598
Crop	120	2580
Crop Yield	185	2579
Catering Service	103	2473

Food Security leads in terms of both occurrences (1334) and link strength (14805), showing substantial collaboration. Table 3.3.8 lists the top 20 keywords in the dataset. While keywords like Human, Article, and Climate Change have strong links despite fewer occurrences, India and Food Supply also have high levels of collaboration. While still important, agricultural terminology like "crops" and "rice" are less collaborative. Terms like "caterer service" and "controlled study" are less essential. Overall, the data shows good cooperation on important topics, especially in agriculture and food security, with minor gaps in specialized fields.

3.5.9. Highly Occurrence Keywords

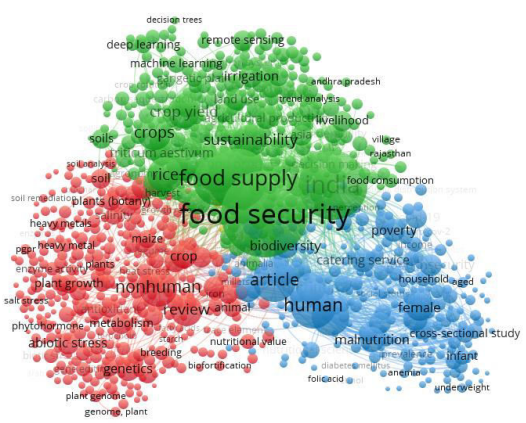
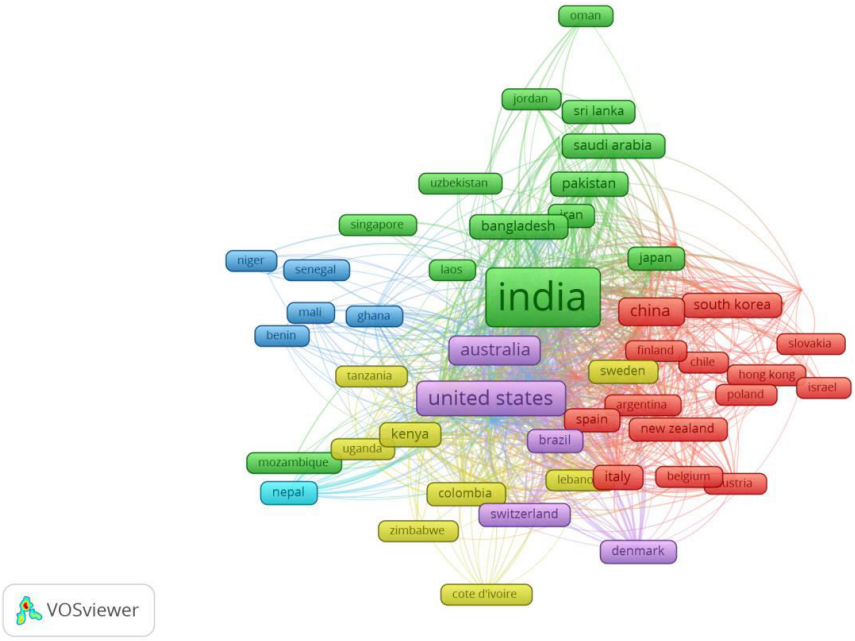


Figure 3: Highly Occurrence Keywords

The figure 3 highlights the top 20 keywords and their collaboration strength within the dataset. Food security is the most important topic in the research, as seen by its high occurrences and strong relationship. Significant relevance is also shown by India and Food Supply. High link strengths are indicative of strong integration of keywords such as "human," "article," and "climate change" in the dataset. Although they have somewhat weaker link strengths, other important themes like agriculture, crops, and rice are nonetheless noteworthy. Moderately contributing keywords include "controlled study" and "sustainable development," whereas the least common keyword among the top keywords is "catering service." The main themes and how they work together in the context of the research are shown by this analysis.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

3.5.10. Top Collaborative Countries



India is the country with the highest level of collaboration with the United States, followed by

Figure 4: Top Collaborative Countries

the United Kingdom, Australia, and China, according to figure 4 from the visual analysis of the VOSviewer program. This suggests that in the fields of nutritional science and sustainable food systems, Indian scholars collaborate with these nations on a regular basis. These partnerships imply that India is actively participating in international research initiatives, utilizing resources and knowledge from other countries to tackle issues related to food security. The close connections to the US and other top nations suggest that such relationships will probably promote information sharing, technological advancement, and wider research effects. It also represents India's increasing contribution to conversations about agricultural sustainability and global food security, matching with global research goals and encouraging international collaboration.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

3.5.11. Major Gap Occurrence Areas

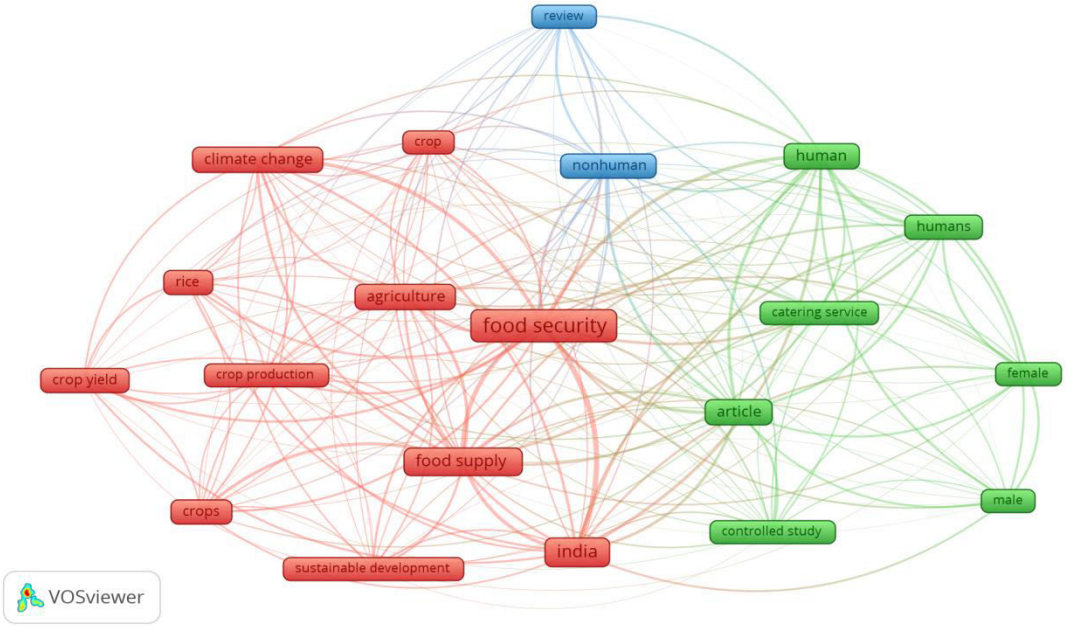


Figure 5: Major Gap Occurrence Areas

The analysis of the top 20 keywords reveals several gaps. Keywords with lower occurrences and link strengths, such as *Catering Service*, *Controlled Study*, and *Male*, indicate less centrality and connectivity within the dataset. Additionally, the dataset may lack coverage of certain relevant areas, such as *Nutrition*, *Sustainability Practices*, or specific regional studies, which might be underrepresented. Emerging trends like *Precision Agriculture* or *Genetic Modification* also appear to be missing, suggesting that the dataset may not fully capture the latest advancements in the field. These gaps highlight opportunities for expanding research focus and incorporating newer, relevant topics into the dataset.

3.5.12. Year wise Gap Occurrence

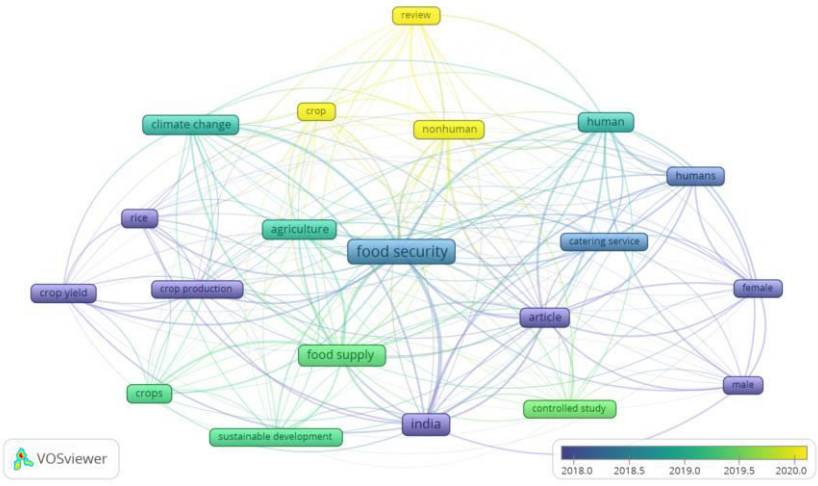


Figure 6: Gap occurrence with year

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, 2022

From 2020 onwards, the keywords *Crop*, *Nonhuman*, and *Review* show a clear decline in occurrences, indicating that these topics have received less attention in recent research. This trend suggests that either fewer studies are being conducted in these areas, or the focus has shifted toward other emerging topics. The reduced frequency of these keywords implies that research on *Crops* and *Nonhuman* subjects, as well as comprehensive *Reviews*, may have diminished, potentially pointing to gaps or a shift in research priorities in the field during this period.

4. RESULTS AND DISCUSSION

4.1. Publication Trends and Growth

The data reveals an important rise in publications on sustainable food systems and nutritional science between 2000 and 2023. The number of publications increased from 13 in 2000 to 665 in 2023, with a significant increase in publishing production after 2010, particularly between 2020 and 2023. This rapid growth reflects the growing worldwide emphasis on food security and sustainability. The Indian Council of Agricultural Research (12.09%) and the ICAR-Indian Agricultural Research Institute, New Delhi (10.21%) make significant contributions.

4.2. Geographical Analysis

In terms of geographical collaboration, India has developed significant international relationships, particularly with the United States, which is India's most frequent collaborator. The United Kingdom, Australia, and China come next. These agreements demonstrate India's active participation in global research networks, which enables the flow of information and innovation to address global food security and sustainability concerns.

4.3. Collaboration Networks

Co-authorship analysis demonstrates extensive collaboration among leading authors and institutions. Varshney, R.K. (17.81%) is the leading author contributor, followed by Jat, M.L. (13.70%). Collaboration networks, as measured by total link strength, demonstrate strong institutional links, particularly between Indian and foreign research groups. Major centers include the International Crops Research Institute for the Semi-Arid Tropics and Banaras Hindu University, which have made substantial contributions to the discipline.

4.4. Citation and Influence Analysis

Highly cited authors include Varshney, Rajeev K. (1943 citations), Kumar, Vinod (1795 citations), and Kim, Ki-Hyun (1743 citations), reflecting their significant impact on the field. Influential journals such as *Economic and Political Weekly* and *Frontiers in Plant Science* are leading platforms for publishing impactful research. These citations underscore the critical contributions of authors and journals in shaping discussions around food systems and nutritional science.

4.5. Thematic Evolution and Research Hotspots

Keyword analysis reveals *Food Security*, *India*, and *Food Supply* as dominant themes, with strong linkages and frequent occurrences. Thematic evolution shows growing attention to climate change and agricultural practices, although areas such as *Crops*, *Nonhuman*, and *Review* have seen a decline in focus since 2020. This suggests a shift towards newer research priorities, such as sustainable development and precision agriculture.

4.6. Gaps and Challenges

The research reveals underexplored areas like *Controlled Study*, *Catering Service*, and *Male*, suggesting that these topics have received less attention. There are also emerging trends, such as genetic modification and precision agriculture, that are not fully captured. Geographic disparities in research contributions, with stronger focus on India and lesser representation from other regions, may have implications for global food security and equitable research development. Addressing these gaps could improve the comprehensiveness of research in sustainable food systems and nutrition.

5. LIMITATIONS AND RECOMMENDATIONS

5.1. Limitations

This study is based on data collected from the Scopus database, which, while extensive, may not capture all relevant research from local or non-indexed journals. The analysis focuses solely on publications from India, excluding global perspectives that could provide broader insights into sustainable food systems and nutritional science. Furthermore, only publications from 2000 to 2023 are considered, potentially missing earlier foundational research and trends. The study also relies on keyword co-occurrence analysis, which may not fully reflect emerging research areas. As a result, there may be gaps in understanding newer topics like precision agriculture, nutrition, and genetic modification.

5.2. Recommendations

To gain a more comprehensive understanding, future research should incorporate a wider geographic range, especially including publications from other countries involved in food security research. Notably, India is highly collaborative with the United States, followed by the United Kingdom, Australia, and China. Expanding the analysis to include these countries would provide a global view of research trends. Additionally, data from other research databases, such as Web of Science or Google Scholar, should be integrated to cover a broader range of publications. Focused funding and research initiatives could also address underexplored areas like precision agriculture and sustainable practices, encouraging growth in these critical fields.

6. CONCLUSION

This study provides a comprehensive overview of publication trends, collaboration networks, and thematic key area in sustainable food systems and nutritional science, based on Scopus data from 2000 to 2023. India emerges as a key area, with significant collaborations, particularly with the United States, the United Kingdom, Australia, and China. Institutions like the Indian Council of Agricultural Research lead the field in publication output. Thematic analysis highlights *Food Security*, *India*, and *Food Supply* as dominant research areas, while topics like *Crops* and *Nonhuman* have seen reduced focus since 2020. Despite the study's insights, limitations include its focus on India and reliance on a single database. Expanding research to include other countries and emerging topics will provide a more comprehensive view of global trends in food security and sustainable agriculture.

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