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The role of traditional knowledge in sustainable food systems: A temporal and thematic analysis

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Abstract: Traditional knowledge (TK) encompasses the skills, knowledge, practices, beliefs and insights passed through generations by the traditional or local communities. These knowledge systems are crucial for enhancing food security and preserving the cultural practice. This study aims to provide a comprehensive knowledge mapping and portray the publication trends in the use of TK for sustainable food systems and food security. The data were obtained through the Scopus database using the key terms ("indigenous knowledge" OR "traditional knowledge" OR "local knowledge") AND ("food security" OR "sustainable food"). A total of 989 documents published in English in between 1992 and 2024 were considered for the analysis, excluding 2025 (Date acquisition: 30th July 2025). For relevance, the data were analyzed across 11-year intervals (1992-2002, 2003-2013, 2014-2024). The Vosviewer tool and Excel were used for data visualizing. The period between 1992-2002 displays relatively limited keyword diversity and less interconnection between clusters, indicating the foundational stage of attention towards TK and food security. Apart from the interconnected clusters, an outlier cluster was also visible in this period. During the second phase (2003-2013) “food security” is highlighted as the core theme, while other topics clustered around climate adaptation, agricultural innovation and spatial geographic expansion. This period stands as a transitional stage in the related research. The period between 2014- 2024 marks a high complexity of themes, indicating the field has evolved significantly in multi-dimensional aspects. Food security, TK and Climate change are tightly interconnected, while attention to sub-themes like health, policy and technology has evolved significantly. Overlay visualization highlights the areas of high research concentration and emerging interest, enabling researchers to engage with trending topics and contribute to the ongoing development of the domain. Overall, the study provides valuable insights into the evolving research landscape, highlighting that TK has shifted from a peripheral role to a central pillar in sustainable food systems research. The key challenge is to integrate it with innovation and policy to enhance local resilience and global sustainability.

Keywords: bibliometric analysis; food security; indigenous knowledge; sustainability; traditional knowledge.

Introduction

Traditional Knowledge (TK) or indigenous knowledge refers to the knowledge, practices, skills, beliefs, insights, and worldviews that are passed down through generations within indigenous, local, and traditional communities [1]. It is the cumulative body of knowledge, practices, innovations, and beliefs that are developed, sustained, and passed down through. It is closely tied to cultural identity, local environments, and resource use. TK often includes agricultural practices [2], ethnomedicine, ecological management [3], food preparation [1, 4], oral traditions [5], and spiritual beliefs [6].

TK is highly valued in sustainability and food systems research because it embodies place-based knowledge adapted to local ecosystems [7], and importantly contributes to biodiversity conservation and resilience [8]. On the other hand, practices of TK support sustainable resource management [9], supporting food security for large populations [10]. All these finally strengthen the cultural heritage and community identity [11] brings together with food.

The Green revolution (1940s–1970s) introduced high-yield crop varieties, chemical fertilizers, and irrigation technologies. The revolution boosted short-term food production while it also led to the erosion of local crop diversity, increased dependency on external inputs, contributed to soil degradation and water stress. This sparked recognition that modern agriculture alone could not ensure long-term sustainability, but the traditional knowledge systems was needed to restore balance.

The Brundtland report "Our Common Future" in 1987 stressed sustainable development and provided the most widely cited definition of sustainable development as 'meeting the needs of the present without compromising the ability of future generations to meet their own needs [12]. Next, the 1992 Rio Earth Summit, which is also known as the United Nations Conference on Environment and Development (UNCED) marked a turning point in mainstreaming sustainability at the global level [13]. It introduced key frameworks, including Agenda 21 as an action plan for sustainable development, the Convention on Biological Diversity, and the United Nations Framework Convention on Climate Change (UNFCCC), which collectively laid the foundation for global environmental governance and sustainable development practices.

Giving limited recognition, the Millenium Development Goals (2000-2015) treated hunger as an outcome of poverty, not as part of a complex system [14]. Food and Agriculture Organization [15] highlights the need of stronger coordination of short-, medium-, and long-term actions for sustainable use and conservation of food and agricultural resources amid rapid social, environmental, and climate change. Further, complementary and alternative food system developments are urgently required and lessons from traditional indigenous peoples' food systems are crucial for jointly developing resilient food systems [16]. However, Sustainable Development Goals (2015-2030) explicitly link food security, biodiversity, and indigenous knowledge. Importantly, SDG 2 (Zero hunger) and SDG 15 (Life on land) address the need of TK in food practices. It highlights that the food systems need to operate within planetary boundaries to be sustainable, and the need to ensure food nutrition and security for all [16]. Meanwhile, concepts of sustainability emphasize the importance of balancing present benefits with the responsibility of safeguarding resources and values for future generations.

The main objective of the study is to portray the publication trends and development of literature on the use of traditional knowledge (TK) for sustainable food systems based on the academic literature. Specific objectives are to analyze the temporal evolution of research on traditional knowledge and sustainable food systems while identifying major trends and growth patterns over time; To identify thematic clusters within the literature by highlighting the dominant research themes and subfields associated with traditional knowledge and food systems; To assess the intersections between traditional knowledge and key dimensions of sustainability (ecological, social and economic) within food systems; and to derive implications for future research and policy,

In order to achieve these objectives, the study seeks to answer the following research questions,

1. How has the research on TK and SFS evolved over time?
2. What are the main themes, clusters and subfields that emerged in this domain?
3. What are the themes that TK and SFS contribute to the sustainability?
4. What are the present and future research directions for strengthening the role of TK in SFS research and policy?

Materials and methods

Source of data. This study used refined data from the Scopus database, which indexes millions of multidisciplinary records such as journals, books, chapters, and conference proceedings and also serves as a citation index [17]. The following is the retrieval strategy.

Search terms- ("indigenous knowledge" OR "traditional knowledge" OR "local knowledge") AND ("food security" OR "sustainable food")

Document type- All document types

Publication Stage- Final

Language- English

Scopus displays documents in the selected domain starting from 1992; therefore, all records from 1992 onward were included to analyze the growth in the field, while documents from 2025 were excluded as the year is not yet complete. Accordingly, a total of 989 documents were refined on 30th July 2025.

Table 1: Types of Documents Used in the Study

Document Type	Count
Journal Article	673
Book	22
Book chapter	131
Conference paper	48
Letter	3
Review	94
Conference review	1
Data paper	1
Editorial	5
Note	8
Short survey	2
Total	989

Source: Created by Authors, 2025

Methods used

For the graphical representation of bibliometric mapping, the VOSviewer tool was used [18]. Co-occurrence of author keywords was mapped into three-time spans depending on the availability of the data in the Scopus database. Each time span included 11-year intervals, 1992–2002, 2003–2013, and 2014–2024 for the analysis. The co-occurrences of author keywords were mapped according to time intervals to study the diversity of bibliometric data temporally.

In the network analysis, nodes represent keywords, while the size of the node depends on the frequency of the keyword in the dataset. Each keyword cluster brings a group of closely related terms, while keywords that appear together are closer more often. Cooccurrence links are shown by the lines connecting the key words. Thicker lines show the stronger relationships. The density maps show the hotspots in related research.

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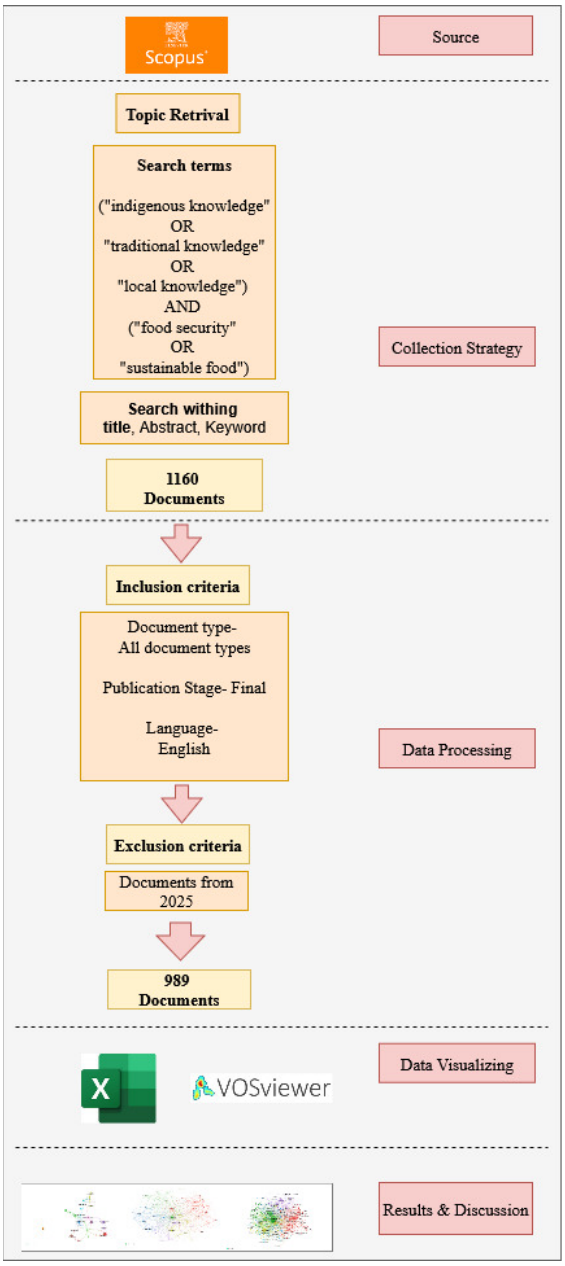
Figure 1: Methodology



Source: Created by Authors, 2025

Bibliometric analysis is considered a quantitative research method [19]. In this analysis, internal biases were mitigated by adopting a systematic and replicable data collection process. Data for the study were sourced from a reputable indexing database to minimize biases. A well-defined search strategy (specific keywords, time frames, and inclusion/exclusion criteria) was employed to ensure accuracy and consistency. Duplicate records were removed through manual reading and standardized cleaning procedures.

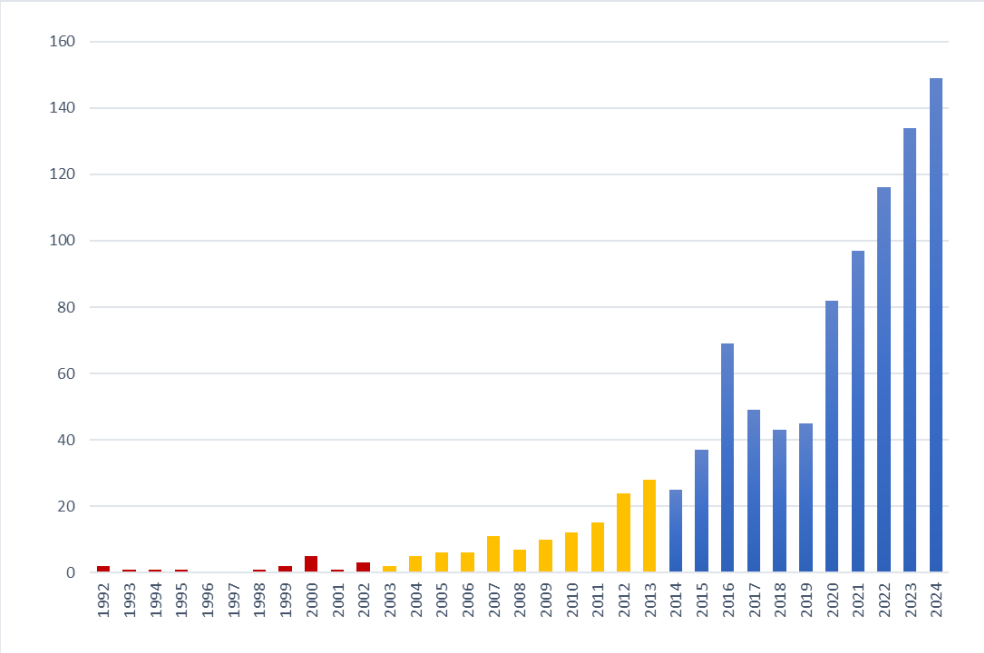
Results

The sample size used in this study was determined by the total number of publications retrieved from the Scopus databases based on the defined search terms, time period, inclusion and exclusion criteria. Since bibliometric research aims to map the full scope of existing literature, the sample size reflects the entire body of relevant, indexed publications available on the topic in the selected database. This approach ensures that the analysis captures all

keywords, networks and thematic trends necessary for reliable knowledge mapping. Therefore, the sample size is inherently aligned with the analytical objective of representing the complete research landscape on the role of traditional knowledge in sustainable food systems.

Temporal evolution. To define the evolutionary nature of the publications, we have refined the number of publications annually (Figure 2). Accordingly, clear growth can be seen in the related literature with most of it produced after 2007. No production records occurred between 1996 and 1997. According to the time interval taken in the study, 1992-2002 depicts the early phase of research, while 2003-2013 represent the intermediate and expansion period. The growth of the publications depicts the emerging interest in the field. Research in this domain has gained significant growth during the recent history between 2014-2024. The three-time spans are represented by distinct colors in Figure 2.

Figure 2: Year-wise production of literature



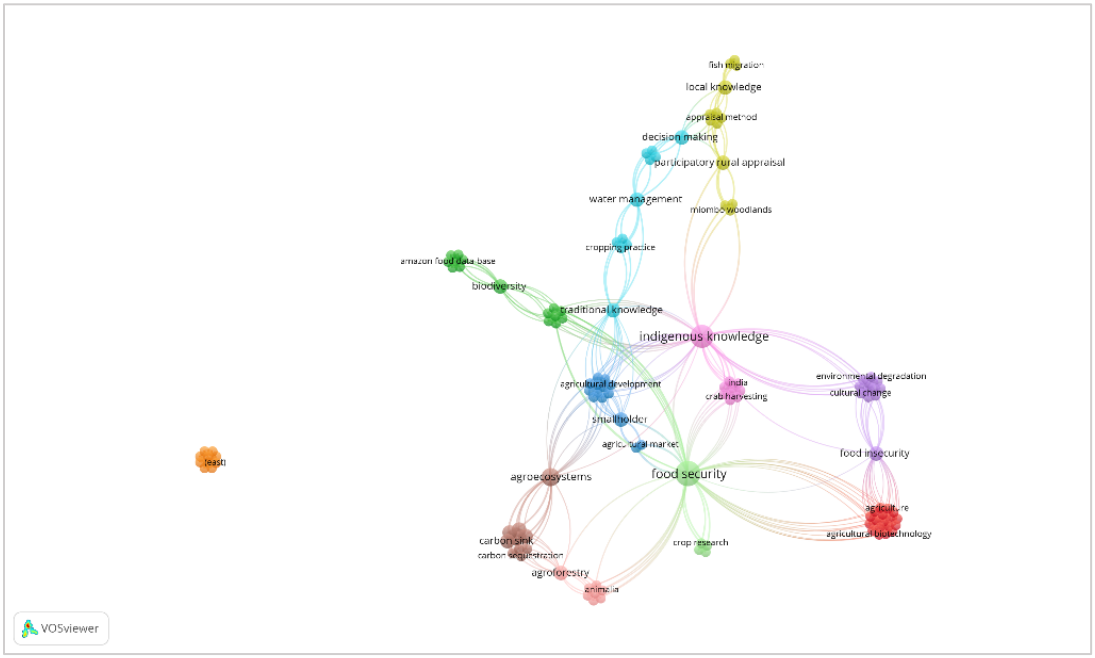
Source: Created by Authors, 2025

Thematic evolution. The period between 1992 and 2002 displays relatively limited keyword diversity and less interconnection between clusters, indicating the initial stage of attention towards indigenous knowledge and food security (Figure 3). The brown cluster visualizes the link between agricultural development to food security with the key themes like agroecosystems, carbon sink and agroforestry. It was not only plant-based agriculture that received attention; the keyword "animalia" indicates that animal husbandry was also recognized as an important aspect of food security. Environmental degradation and cultural change are also connected with indigenous knowledge and food security, depicting their interconnectedness. Themes related to water management, traditional knowledge and cropping practices also gained scholarly attention. Apart from the interconnected clusters, an outlier cluster was also visible in this period, representing the scarcity of research related to the node.

Basically, the research during this phase was foundational. Each node developed equally in this era.

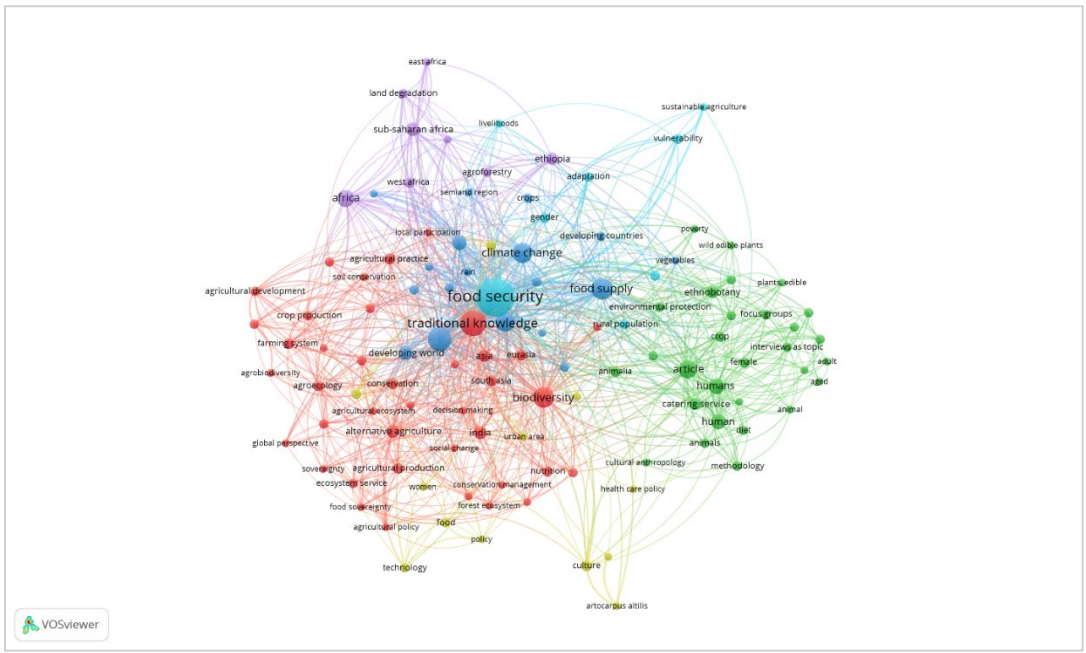
Next page

Figure 3: Network Visualization between 1992-2002



Source: Created by the Authors using the VOSviewer tool, 2025

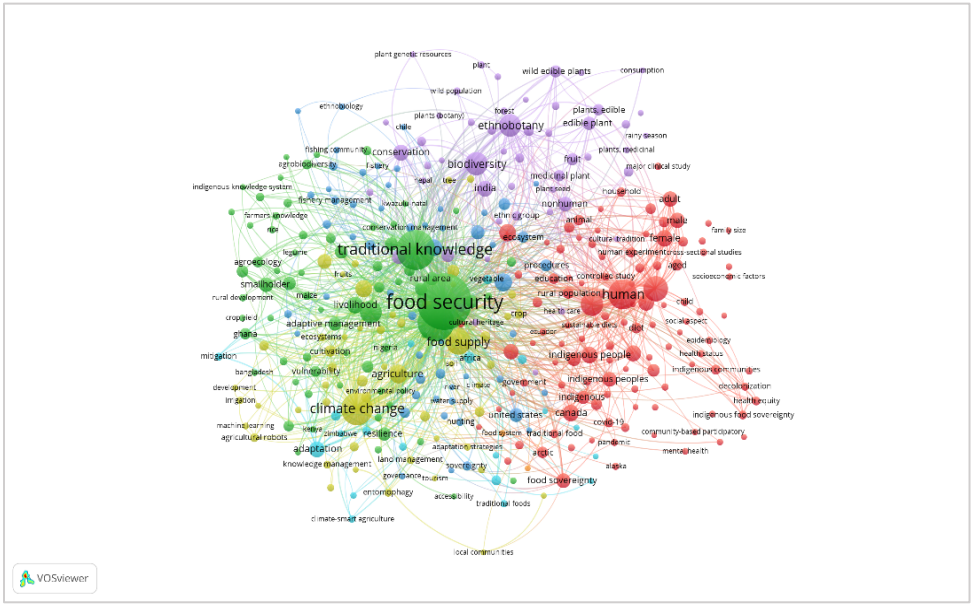
Figure 4: Network Visualization between 2003-2013



Source: Created by the Authors using the VOSviewer tool, 2025

Themes have become more diverse and developed when coming to the second phase (2003-2013) (Figure 4). Notably, "food security" is highlighted as the core theme, with all other key words directly or indirectly connected to it by this period. Meanwhile, "traditional knowledge", "food supply", "climate change" and "biodiversity" nodes have significantly developed, depicting the increase of research related to these nodes. 6 main clusters are visible in this period. The appearance of the African region (Africa, Sub-Saharan Africa, West Africa) is highlighted in the purple cluster, interconnected with the traditional knowledge. Further, Asia, Eurasia, India, South Asia and Ethiopia appeared highlighting the attention paid to the geographical significance of food security and indigenous knowledge. Green cluster, clustered around agricultural systems and biodiversity. Blue cluster addresses regional and development contexts. Red cluster addresses human, cultural and nutritional aspects while the yellow cluster traces the food supply chain and adaptation. Meanwhile, the light blue cluster is gathered around food security and vulnerability. No distinct outlier clusters emerged during this period, indicating that all clusters remained interconnected.

Figure 5: Network Visualization between 2014-2024



Source: Created by the Authors using the VOSviewer tool, 2025

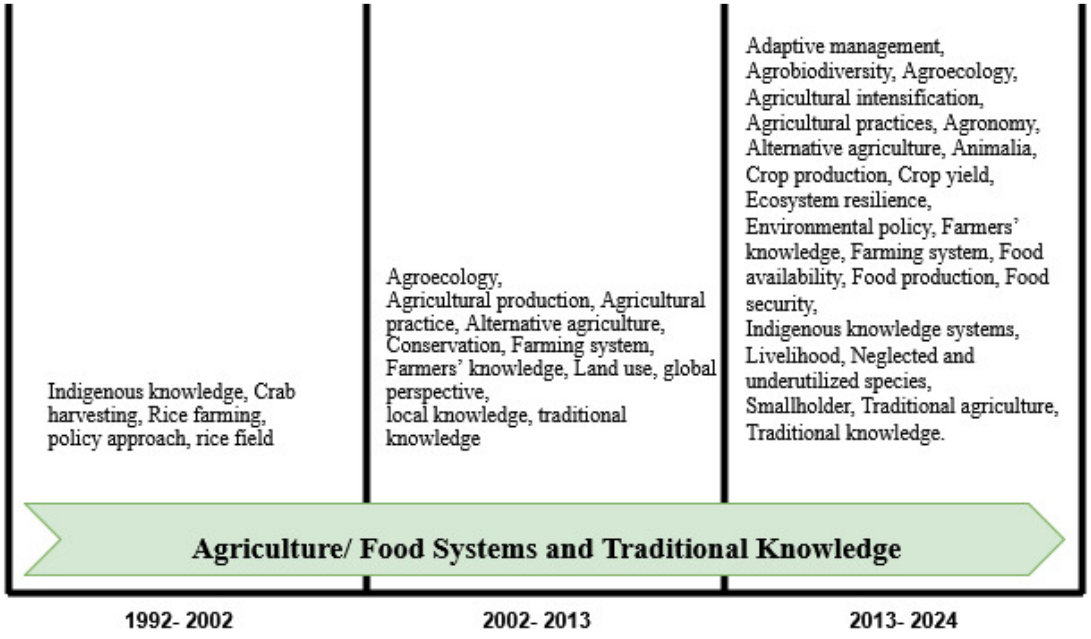
The period between 2014- 2024, marked high complexity and richness of keywords, indicating the field has evolved significantly in multi-dimensional aspects (Figure 5).

During the 2014-2024 period, the green cluster was the most prominent. It carries the research related to traditional knowledge and its link to food security, highlighting local farming practices, smallholder farmers, and adaptive agricultural strategies. Yellow cluster highlighted themes like climate change, adaptation, resilience and vulnerability, focusing on the impacts of climate change and adaptation strategies for food security. Further, keywords like machine learning, agricultural robots and knowledge management show the attention towards technology-driven adaptation strategies during this period. Purple cluster focuses on biodiversity conservation and ethnobotanical practices, particularly how traditional plants contribute to diets and healthcare. Specially this cluster depicts the strong intersection between traditional ecological knowledge and modern ethnoscience, emphasizing the importance of wild and medicinal plants in food systems. The red cluster incorporates socio-cultural and public health dimensions, emphasizing food sovereignty and community-based approaches of indigenous peoples. It also includes pandemic-related research terms, such as COVID-19. Research relevant to the rural population and livelihoods are presented by the blue cluster. The light blue cluster is a small but distinct cluster on food sovereignty movements and the rights of communities to control food systems.

Using the author keywords, we derived main themes from keyword clusters. Figures 6–11 illustrate the evolution of keyword clusters through the integration of newly emerging terms. Over time, certain themes evolved directly into advanced clusters. From the outset, these clusters exhibited a clear demarcation of keywords, reflecting strong thematic orientations related to food systems and traditional knowledge. The agriculture and food systems theme

initially emerged with a limited set of keywords, such as rice farming, crab farming, and traditional knowledge. Over time, however, it expanded into a large cluster encompassing aspects of agroecology, agronomy, and crop yield, and further advanced into sustainability-oriented themes such as ecosystem resilience and adaptive management. Figures 6 and 7 illustrate themes that exhibited strong development from the outset, ultimately consolidating into a single large cluster.

Figure 6: Thematic Development of Keyword cluster 01



Source: Created by the Authors using the Keywords Clusters derived from VOSviewer tool, 2025

Figure 7: Thematic Development of Keyword cluster 02

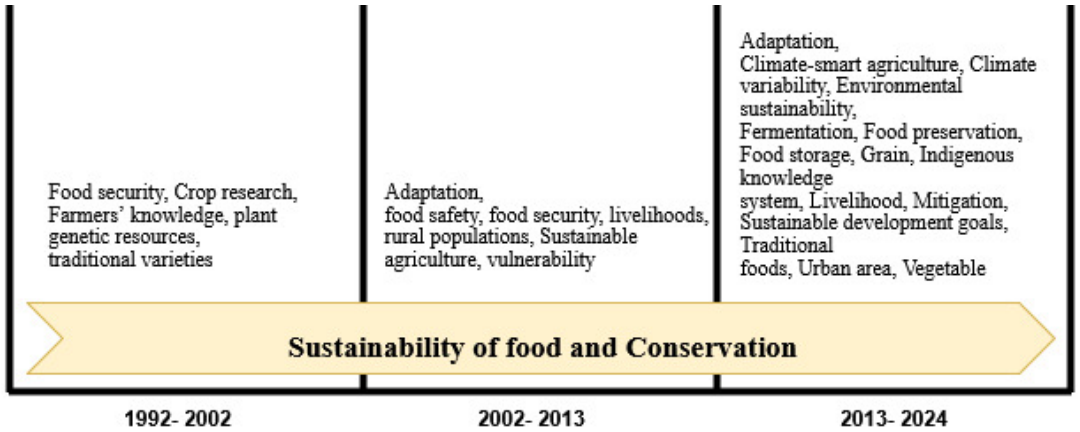


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Figure 8: Thematic Development of Keyword cluster 03

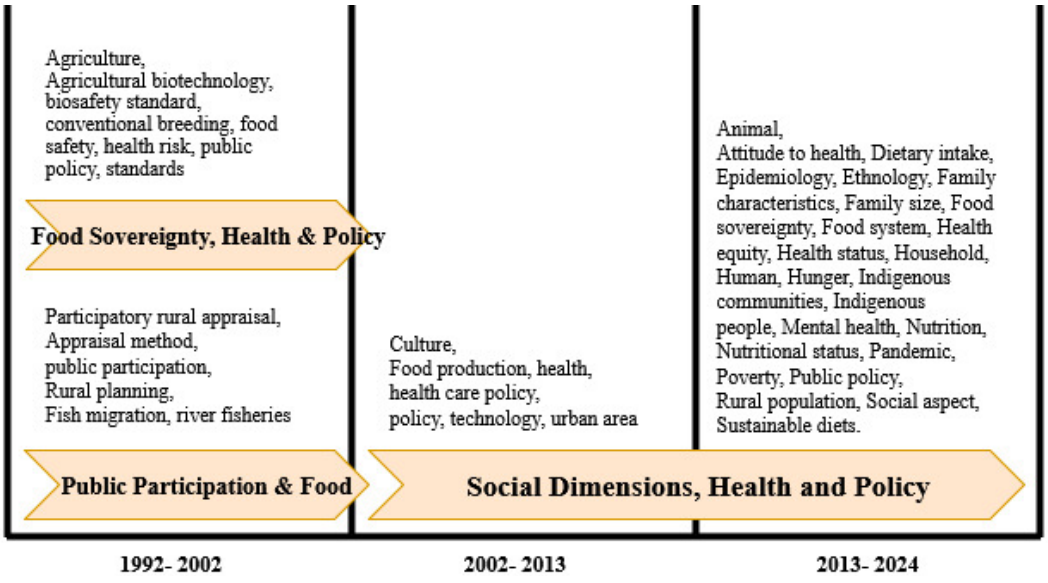

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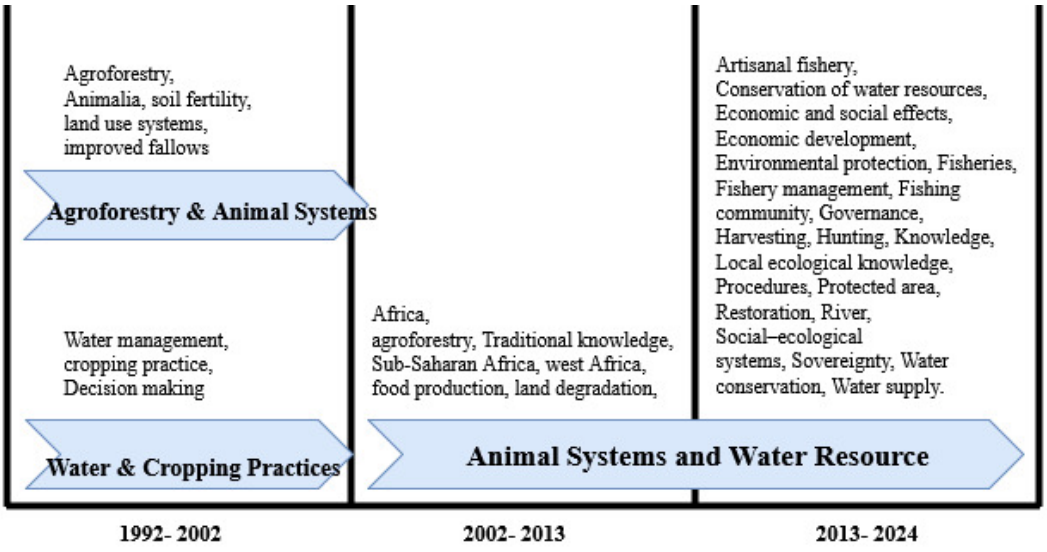
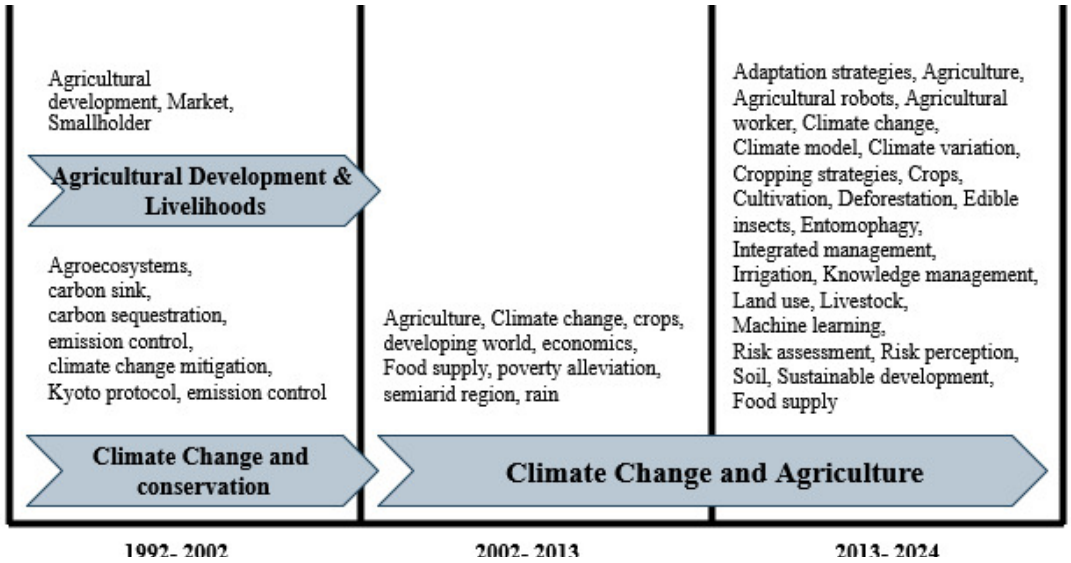
Figure 9: Thematic Development of Keyword cluster 04



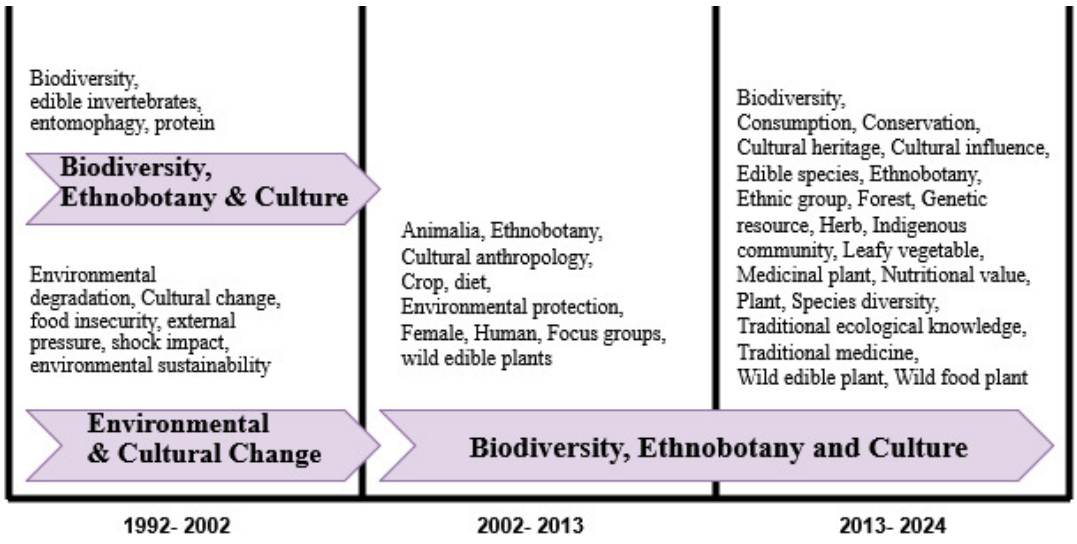
Source: Created by the Authors using the Keywords Clusters derived from VOSviewer tool, 2025

Figure 10: Thematic Development of Keyword cluster 05



Source: Created by the Authors using the Keywords Clusters derived from VOSviewer tool, 2025

Figure 11: Thematic Development of Keyword cluster 06



Source: Created by the Authors using the Keywords Clusters derived from VOSviewer tool, 2025

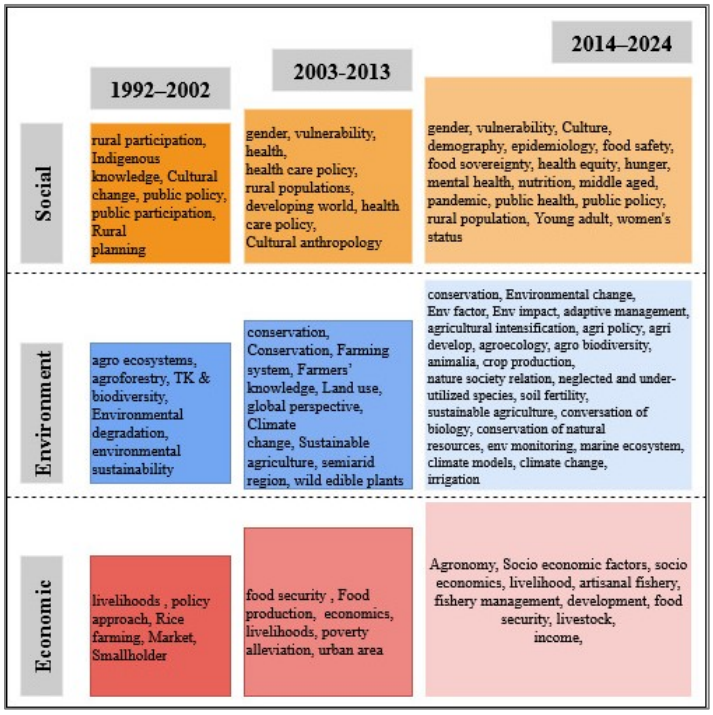
Meanwhile, some thematic clusters gradually merged over time, forming new clusters characterized by more advanced, meaningful, and contextually relevant keywords, reflecting the influence of global research trends. Figures 8, 9, 10 and11 depict the merging of these thematic clusters and their evolution into new advanced clusters.

Alignment with sustainability measures. The evaluation of any concept and its associated impacts become incomplete unless examined through the lens of sustainability practices. Between 1992 and 2002, research related to agriculture and traditional knowledge reflected the early stages of sustainability thinking, which had not yet been formally structured into the widely recognized ecological, social, and economic pillars. During this period, scholars

often employed terms such as "conservation," "agroecosystems,", "biodiversity," "rural participation", and "livelihoods" which can now be considered precursors to contemporary sustainability concepts. These themes closely aligned with the first wave of sustainability discourse triggered by the 1992 Rio Earth Summit, highlighting a growing global awareness of the need to integrate environmental stewardship, community engagement, and resource management into agricultural and rural development practices.

During 2003–2013, research began to adopt a clearer sustainability framing, reflecting the growing global emphasis on development and equity in post 2000, particularly in line with the Millennium Development Goals (MDGs) (Figure 12). Themes such as conservation, gender, vulnerability, food security, and issues specific to the Global South became prominent, indicating a shift from purely ecological or technical concerns toward broader social, economic, and equity considerations. This period represents a transitional phase in which sustainability thinking became more structured and multidimensional, integrating human and environmental dimensions in research on agriculture and traditional knowledge. Research from the period between 2014-2024, explicitly adopts the language of sustainability, directly aligning with global frameworks such as the Sustainable Development Goals (SDGs). Studies increasingly emphasize themes such as climate-smart agriculture, environmental sustainability, and food sovereignty, reflecting a shift toward integrating resilience, equity, and long-term resource management into agricultural and food systems research. This explicit framing marks the consolidation of sustainability as a central paradigm, where traditional knowledge and scientific innovation are examined not only for their immediate benefits but also for their contribution to global sustainability targets and local community resilience.

Figure 12: Development of keywords along the pillars of sustainability

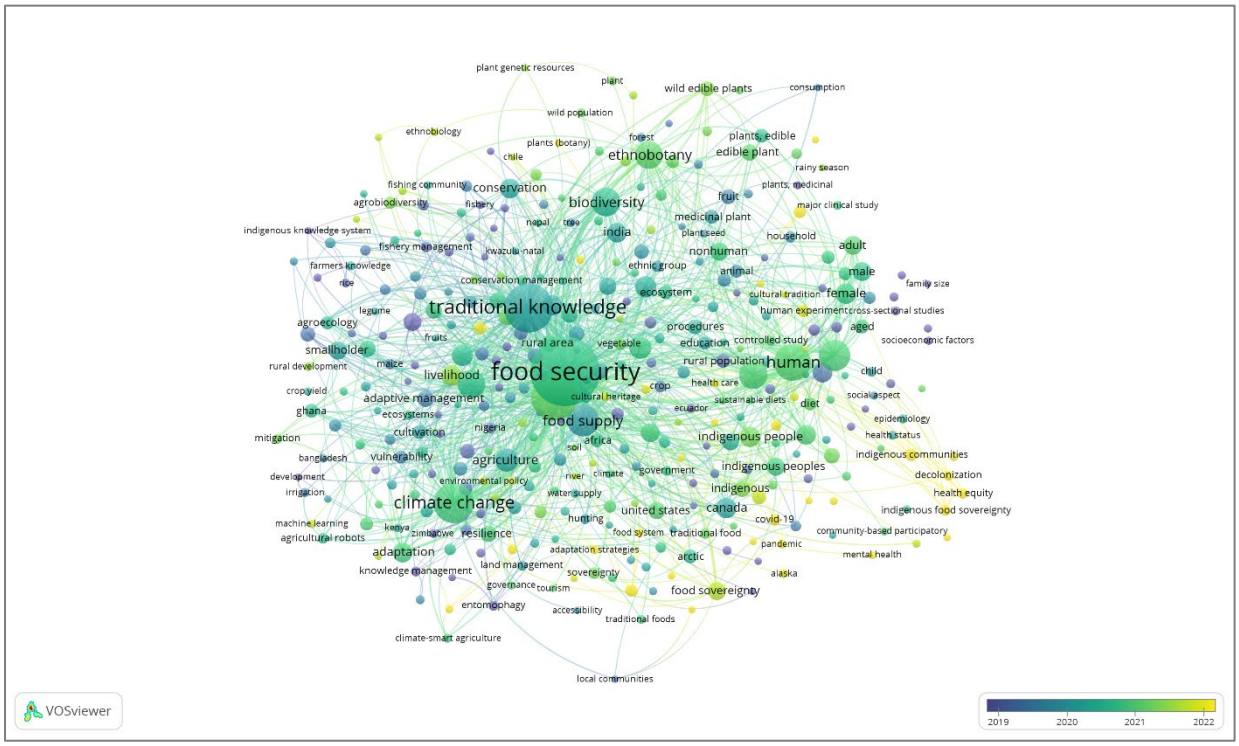


Source: Created by the Authors using the Keywords Clusters derived from VOSviewer tool, 2025

Present and future research directions. Focusing on the overlay visualization map of 2014-2024 (Figure 13), food security, traditional knowledge, food supply, agriculture and climate change remain green, depicting the stable core and consistent research themes. Keywords appear in blue- purple, such as traditional agricultural systems, biodiversity conservation, and ethnobotanical approaches, were identified as the key terms established earlier (2019-2020) in the field. Terms in greenish blue such as, machine learning, agricultural robots and knowledge management, entered the field by 2020, indicating the transition phase where technical interventions began to be explored and research for food security. Food sovereignty, decolonization, indigenous food sovereignty, health equity, mental health, pandemic, community-based participatory research which are highlighted in yellow are newer, emerging research frontiers,

showing the shift towards social justice, equity, and resilience debates in food security research. Key terms appeared green such as human, adult, child, diet, epidemiology and health status reflect the integration of public health, demography and nutrition research into food security-related research around 2020. Further, Covid-19, SARS-CoV-2, severe acute respiratory syndrome, pandemic, prevention and control are also recognized as new dimensions in this domain.

Figure 13: Overlay visualization map of 2014-2024



Source: Created by the Authors using the VOSviewer tool, 2025

Learning algorithms, carbon sequestration, climate variability, systems thinking, urban farmers, indigenous resurgence, first nation, prevention and control, digital health, citizen science, health equity, community academic partnership, dietetics, wild vegetable, underutilized plants, food heritage, gained visibility within the literature around 2023, reflecting their increasing relevance and capacity to open new directions for future research. Referring to the overlay map, it is visible that core nodes such as food security, TK and Climate change remain strong across years. While the focus was primarily on agriculture and biodiversity, and emphasis had shifted towards themes such as food sovereignty, technological innovation by 2022 onwards.

Paying attention to keywords we suggest, exploring how traditional knowledge can be combined with modern tools like machine learning, precision agriculture, and robotics to enhance food security. Further research should emphasize the importance of embedding justice, sovereignty, and community perspectives into food policy, while also recognizing the value of linking food systems with health and nutrition outcomes. Developing robust frameworks for integrating traditional knowledge (TK) into national and international food security strategies and sustainability agendas remains a critical priority. In addition, greater attention should be given to protecting biodiversity and ethnobotanical knowledge, both of which are essential for building resilient and adaptive food systems.

Discussion

The analysis demonstrates that research on traditional knowledge (TK) and sustainable food systems has undergone a clear evolution in scope, complexity, and integration over the past three decades. In the earliest phase (1992–2002), scholarship was exploratory and fragmented, primarily addressing foundational links between agriculture [20], food security [21], and environmental stewardship. The diversity of loosely connected clusters during this period reflects a

knowledge base still in formation, shaped by localized studies and the initial wave of sustainability discourse following the Rio Earth Summit.

The intermediate period (2003–2013) represents a transitional stage marked by thematic consolidation around food security, biodiversity, and climate change [22, 23], while also expanding geographically to include Africa, Asia, and other regions of the Global South. Integrating traditional knowledge has become a key concern [24]. This shift corresponds to the global policy climate influenced by the Millennium Development Goals (MDGs), where concerns of vulnerability, equity, and gender became more pronounced. The disappearance of isolated clusters during this period signals that TK-related research was becoming more interconnected and aligned with broader development priorities.

The most recent phase (2014–2024) reveals a mature and multidimensional research landscape. Six highly integrated clusters highlight the embedding of TK within food security debates alongside contemporary challenges such as climate resilience, biodiversity conservation, health equity, and technological innovation. Notably, the entry of machine learning, robotics, and digital health illustrates a growing intersection between traditional practices and modern technological interventions. At the same time, the rise of themes such as food sovereignty [25], decolonization [26, 27], and pandemic resilience [28] reflects a strong socio-political and justice-oriented turn in food systems research. TK emerges here not just as a cultural legacy, but as a dynamic, adaptive knowledge system positioned at the heart of sustainability, resilience, and community empowerment.

From a sustainability perspective, the field has moved from implicit environmental framing (1990s) [29] to structured multidimensional approaches (2000s) and, most recently, to explicit alignment with the Sustainable Development Goals (SDGs) [30]. Research now consistently integrates ecological, social, and economic dimensions, positioning TK as both a scientific resource and a political tool for equity, sovereignty, and resilience.

Looking forward, the overlay visualization suggests that while core themes (food security, TK, climate change) remain central, new directions are rapidly emerging. These include the integration of advanced technologies with traditional practices, the recognition of ethnobotanical and underutilized plant knowledge, and the embedding of food systems within public health and mental health frameworks. This indicates that future scholarship should prioritize interdisciplinary approaches, combining technology, equity, and traditional knowledge to develop adaptive strategies for global food security [1, 31, 32].

Conclusions

Temporal analysis highlights evolving research trends, from early descriptive studies to recent interdisciplinary approaches integrating ecology, social sciences, and technology. The consistent research themes such as food security, traditional knowledge, food supply, agriculture and climate change across the period remain the foundational backbone of the field, with sustained scholarly attention. It grows along with many different aspects such as technology, culture, equity, health and resilience.

Further, TK intersects strongly with the three pillars of sustainability (ecological, social, and economic) demonstrating its relevance for resilient and sustainable food systems. In this manner, we can identify that TK has become an essential part of sustainable food systems and human health, including community resilience. This bibliometric study provides an evidence-based foundation for understanding how concepts such as sustainability, traditional knowledge, and food security have developed over time and across disciplines. Findings suggest directions for future research and policy, emphasizing integration of TK into modern food security strategies, conservation efforts, and community-based interventions.

In this study analytical procedures were conducted using established bibliometric tools, which limited researcher subjectivity in identifying patterns and clusters. Validity of the conclusions was cross-checked with the relevant literature which collectively strengthened the reliability of the findings and supported robust conclusions about the contribution of traditional knowledge to sustainable food systems.

In summary, TK has transitioned from being perceived as peripheral or supplementary knowledge to a central pillar in sustainable food systems research. The challenge ahead lies in operationalizing this integration—ensuring that TK is not only preserved but also dynamically combined with innovation and policy frameworks to strengthen both local resilience and global sustainability.

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