What 50 Years of Food Systems Transformation Research Reveal: Key insights from bibliometric review of manuscripts from 1972 through 2024

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Technical Report

Contents

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Introduction

Food systems are the networks through which food is grown, processed, distributed, and shared—linking farmers, markets, ecosystems, and communities (Stefanovic, Freytag-Leyer, & Kahl, 2020). They shape not only what people eat, but the stability of economies, the health of populations, and the resilience of societies (Benton, Bieg, Harwatt, Pudasaini, & Wellesley, 2021). Yet these systems are under growing strain. Accelerating climate change, biodiversity loss, soil degradation, shifting dietary patterns, and disruptions in supply chains have exposed deep vulnerabilities across production, distribution, and consumption (Benton et al., 2021; Branca et al., 2019; Fan & Swinnen, 2020). As these pressures intensify, global conversation has broadened to integrate questions of yield and productivity along with questions of sustainability, justice, and long-term resilience. Calls for food systems transformation (FST) have underscored that incremental improvements are not adequate to sustain people or the planet. Without deeper structural change, progress toward global goals such as ending hunger, improving health, and addressing climate change will continue to stall (Willett et al., 2019).

Although the term "food systems transformation" has gained prominence in the past decade, its intellectual roots extend much further. The modern arc began during the Green Revolution, when high-yield crop varieties, synthetic fertilizers, and new irrigation technologies dramatically reshaped global agriculture (Evenson & Gollin, 2003; Pingali, 2012). These innovations reduced hunger in several regions but introduced new challenges: soil depletion, biodiversity loss, water stress, and widening inequities between farmers and nations. By the 1980s, scholars and practitioners across fields began questioning whether productivity alone could ensure food security. This shift gave rise to agroecology and sustainable agriculture — approaches that emphasized ecological balance, local knowledge, and social justice (Altieri, 2000). In the 1990s and early 2000s, global trade expansion, market liberalization, and policy integration further transformed food environments, heightening interdependence across regions and exposing new vulnerabilities (Ingram, 2011). By the 2010s, researchers increasingly used "transformation" to describe the depth of systemic change needed to address climate risks, nutrition transitions, ecological degradation, governance failures, and socioeconomic inequality simultaneously (von Braun, Afsana, Fresco, & Hassan, 2023; Zurek et al., 2018).

Studies have shown that FST globally can result in substantial economic returns, amounting to approximately $10 trillion annually (*2024 Global Food Policy Report: Food Systems for Healthy Diets and Nutrition*, 2024). Systematic attention to FST has gone beyond agricultural policy reforms (Fan & Swinnen, 2020; Ruben, Cavatassi, Lipper, Smaling, & Winters, 2021). Specific components of the FST, for instance, climate resilience crops, food loss and waste (Alexander et al., 2017), technological innovation (von Braun et al., 2023), adequate biosafety levels (Wielinga & Schlundt, 2014; Wu, Elliott, & Wu, 2021), and healthy consumption patterns (Ruben et al., 2021), to name a few, have received substantial inquiry. At a holistic level, topical issues such as systems thinking (Zhang et al., 2018), funding, multi-sectoral collaboration (Herens, Pittore, & Oosterveer, 2022), economic incentives, market externalities, and monitoring & evaluation have received deeper attention (Diaz-Bonilla, 2023). At both specific and holistic levels, there is a rightful urgency to expedite transformation in food systems globally. Today, FST serves as a wide-reaching framework for connecting environmental, nutritional, economic, technological, and justice-oriented concerns. There has been a significant increase in publications on FST over the years, spanning multiple academic disciplines and geographical settings. Thus, over the past two decades, research using FST has surged, spanning agriculture, nutrition, economics, technology, public health, and social justice. Yet despite its popularity, "transformation" remains an unsettled concept, and is defined in multiple—and sometimes conflicting—ways. Understanding this fragmentation is crucial for interpreting the field's evolution: which disciplines have shaped dominant narratives, which remain peripheral, how debates have unfolded over time, and what conceptual tensions continue to impede coherence.

Researchers have done commendable systematic reviews on FST (Juri, Terry, & Pereira, 2024; van Bers et al., 2019). However, systematic reviews, despite their own inherent merits, fall short in reviewing an objective inventory of the main scientific trends, patterns, and gaps across time and geographical settings. There is no comprehensive analysis on FST, which has analyzed publications, citations, authorships, and keywords to examine the intellectual structure, trends of publications, and future directions. To address this continued gap in the FST literature and particularly to offer a bird's eye-view of the scope and trends of the FST research, this study therefore conducts a large-scale bibliometric analysis of FST scholarship from 1972, when the study of sustainable food systems emerged, through 2024.

Study objective

The overall objective of this study is to examine the evolution of the research landscape of food system transformation. Specifically, the key goals are: 1) To analyze the contributions and collaborative networks of countries, institutions, authors, and journals for FST, and to highlight the most influential manuscripts, 2) To unpack dominant thematic structures, topics, trends in FST literature, using keywords analysis, and 3) To isolate key gaps emerging in

FST literature.

Methods

Study design

We conducted a large-scale bibliometric analysis of FST spanning more than five decades of research to scientifically map global research network for an overview of existing knowledge, unpack high-impact areas, and inform decision-making. Rather than reviewing individual studies, bibliometric analyses map the structure of an entire field, revealing dominant themes, influential institutions, geographic concentrations, and patterns of collaboration across thousands of publications. Bibliometric analyses reveal conceptual clusters, geographic patterns, institutional concentrations, collaborative networks, and thematic trajectories, while simultaneously highlighting gaps in the field. We analyzed manuscripts (written in English) published between 1972 and 2024 (both inclusive), which were indexed in three major scientific databases—Scopus, Web of Science, and PubMed. Since FST is a field that has a critical mass of both academic researchers and field practitioners, we examined diverse indexed entries including peer-reviewed articles, reports, commentaries, conference proceedings, book chapters, op-eds, and editorials, to list a few.

Search Strategy

Three databases, Scopus, Web of Science, and PubMed were used for this bibliometric analysis. These specific databases capture a comprehensive and extensive set of research outputs that explore FST within the established time frame. Importantly, they are largely compatible with each other and merged to create a singular bibliometric data file for analysis. Data from other relatively smaller databases including Embase, AGRICOLA, Agriculture and Environmental Science Database, and JSTOR were also scoured. However, the output from these databases got omitted from the final list due to duplication with the three primary databases (Scopus, Web of Science, and PubMed).

The search string, (“food* system*”) OR (“food* system* transformation*”) OR (“ transformation* of food* system*”) OR (“food* value chain transformation*”) OR (“food* system* transition*”) OR (“transition* of food* system*”) OR (“food* value chain transition*”), is intentionally broad to capture the breadth of how transformation has been discussed over time. This string was applied to article titles, abstracts, and keywords in Scopus and Web of Science, and just titles and abstracts in PubMed, which does not offer a keyword search. The search ranged from 1972, when FST as a concept was first introduced, through 2024. Additional filters include peer reviewed, English language to ensure the analysis is in one language, and the removal of retracted articles. Final counts for the database exports were Scopus (23,257), Web of Science (18,305), and PubMed (5,899). Post de-duplication among these three databases, a final dataset of 24847 entries was obtained. Using biblioshiny package (Ab Rashid, 2023; Büyükkıdık, 2022) in R version 4.5.1, we analyzed the final dataset (in a .txt format) to explore the intellectual landscape of food systems transformation. To the best of our knowledge, there is no other bibliometric review in the current literature that explores over 50 years of research on FST, and with such in-depth analyses. By mapping more than fifty years of research activity across disciplines, this study provides an empirical foundation for understanding how food systems transformation has evolved and where future scholarships must go to support more efficient, coherent, and just food systems.

Analysis Plan

The biblioshiny package in R provides exhaustive portfolio of analytical measures. First, we conducted a trend analysis of research output and authors across key institutions, countries, and journals. Second, we did network analyses to examine and visualize the co-occurrence of key items including terms, authors, and institutions. Third, we analyzed the intellectual structure, evolution, and co-occurrence of key terms of the FST with top 500 most frequent keywords used. Finally, we examine the collaboration network of top 50 countries with most FST output in the database.

Methodological Limitations

It is important to note that there was slight variation among the search strategies across databases. The search string runs through Scopus and Web of Science identified terms in the title, abstract, or keywords. PubMed does not have a comparable keyword option, so the search was set to just title and abstract. Additionally, there is a lack of reference data in Web of Science and Pubmed, which severely hinders the analysis of citation networks, co-citation analysis, and bibliographic coupling, and identifying seminal works.

Results

Our objective was to provide a comprehensive scope and reach of the intellectual structure of FST from 1972-2024, highlight key themes and gaps presented in the literature. The studies included depict a strong negative skew, illustrated in figure 1, which demonstrates the recent growth in the FST field of study. This figure depicts the number of articles produced each year from 1972 to 2024. FST was introduced in 1972 when a total of 7 studies were conducted. In 2024 the number jumps to 2489 studies in a year, following the peak of 3243 in 2023. Although there has been a slight drop in annual production recently, the trend skews upward. We discuss our specific findings below, that are responsive to the three specific goals of this study that were discussed earlier.

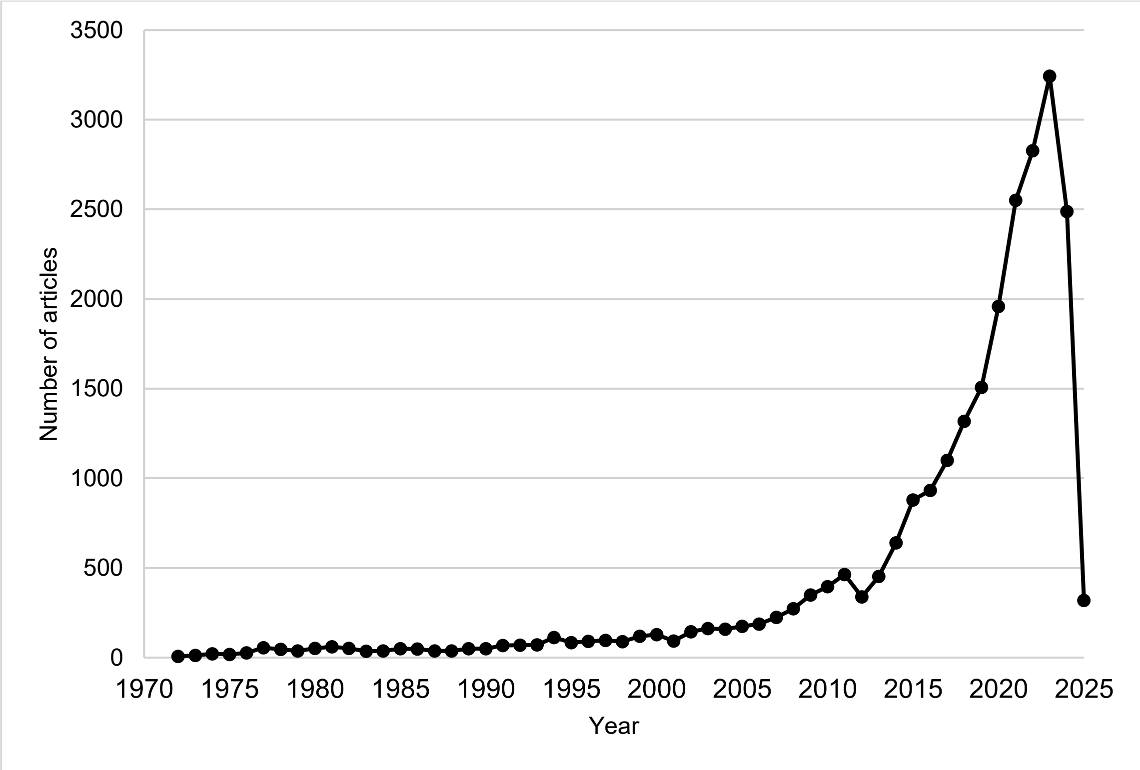

Figure 1: No. of articles produced per year.

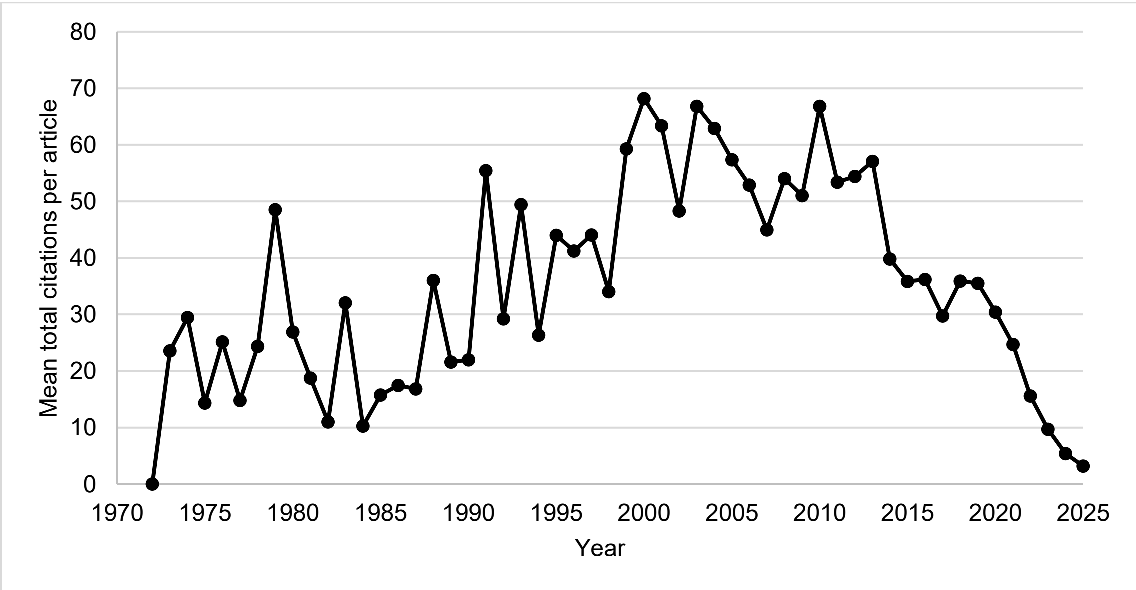

Figure 2: Mean total citations per article per year.

Figure 2 illustrates the mean total citations per article by publication year in the FST literature. Articles published between the mid-1990s and early 2010s exhibit the highest average citation counts, reflecting both increased visibility of the field during this period and sufficient time for citations to accumulate. Earlier years show lower and more variable citation averages, likely due to smaller publication volumes. However, a marked decline in mean citations per article is observed for more recent publication years, particularly after 2015. This pattern is consistent with citation lag, as recently published articles have had less time to accrue citations. Overall, the figure highlights temporal dynamics in citation accumulation rather than changes in the intrinsic impact of FST research.

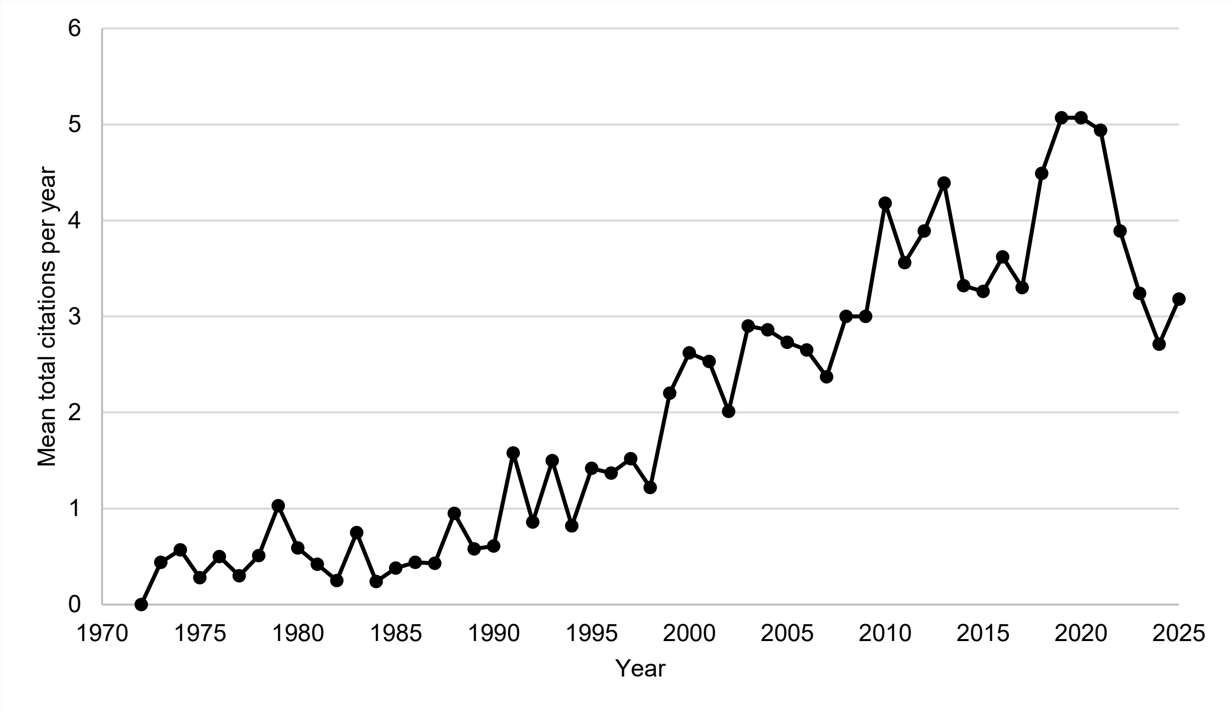

Figure 3: Mean total citations per year.

Figure 3 presents the mean total citations per article per year by publication year in the FST literature. As shown in figure 3, there is a gradual increase in citation rates from the 1970s through the early 2000s, indicating growing visibility and scholarly engagement with FST research over time. Citation rates per article rise more sharply from the late 1990s onward, peaking in the late 2010s. A modest decline in mean citations per year is observed in the most recent publication years, which is likely attributable to the rapid expansion of literature and insufficient time for newer articles to reach stable citation rates. Overall, the trend suggests that FST research has gained increasing annual citation momentum over time, reflecting the maturation and growing influence of the field.

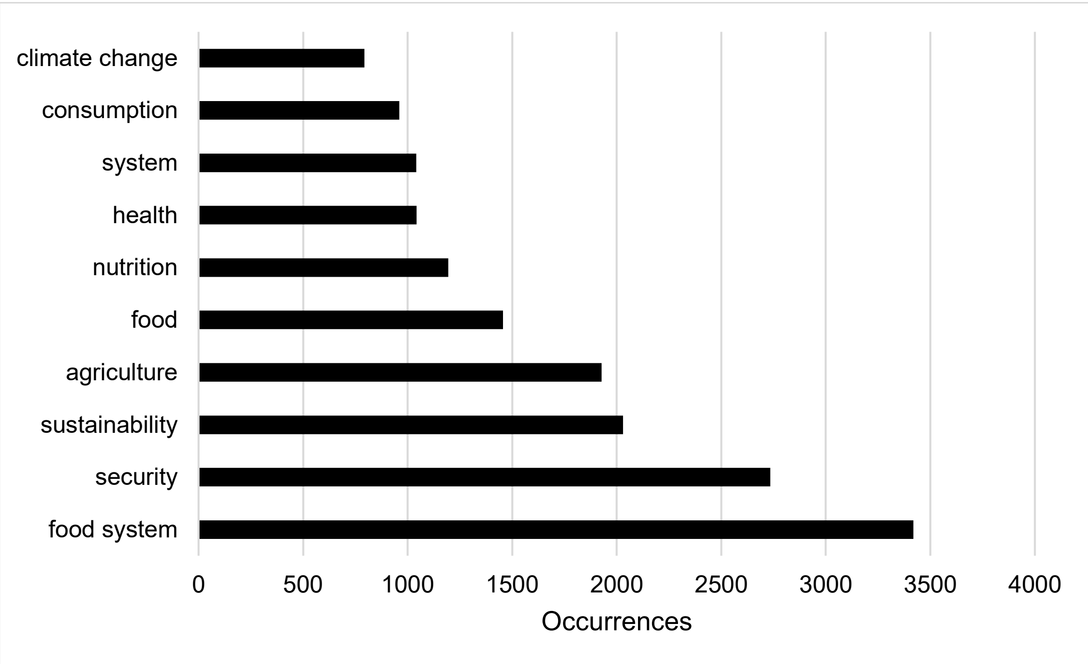

Figure 4: Top ten most frequent keywords

Figure 4 shows the top 10 most frequently mentioned keywords. “All keywords” were used with minor alterations. Food systems and food system were merged, along with human and humans, and system and systems. NA, article, and study were removed from the analysis. It could be observed that these keywords cluster into two key themes: 1) food systems and human consumption (food systems, agriculture, food, nutrition, health, systems, consumption) and 2) global networks and security (climate change, sustainability, security).

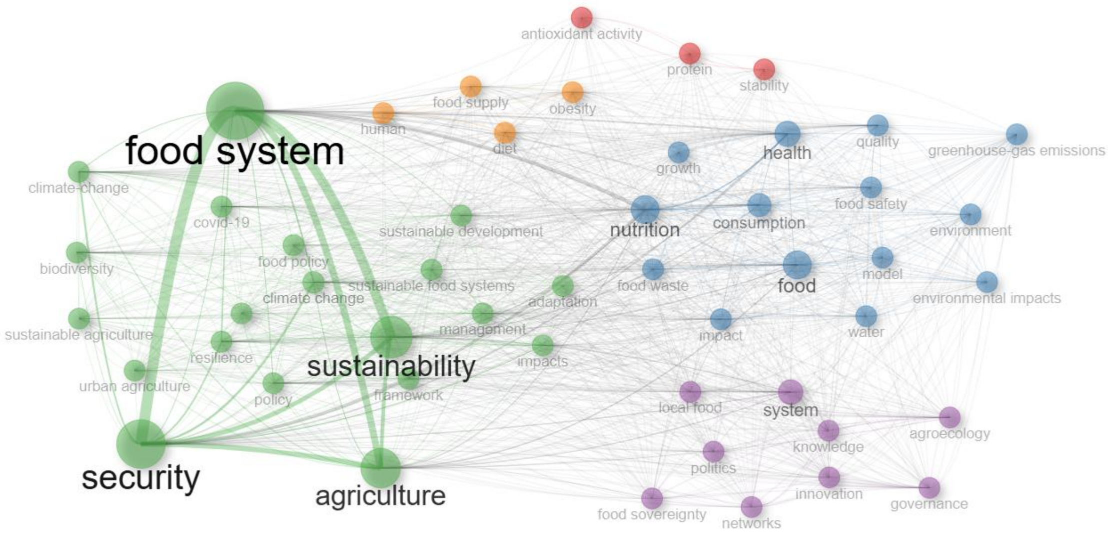

Figure 5: Co-occurrence network of top 50 most frequent keywords with minimum 2 edges and above

The co-occurrence network of top 50 most frequent keywords reveals the relationships between keywords, where the node size indicates its frequency and the edges (lines) connecting them represent co-occurrence. Thicker lines indicate more frequent association. We used the Walktrap algorithm to identify structure and patterns of identified keywords, represented by different colors, and they clearly suggest distinct but related themes in the FST literature. Keywords in the green cluster show research connecting agricultural practices with environmental sustainability and food security. However, the presence of COVID-19 suggests the cluster also investigated the relationship between food system and recent global crisis. The blue cluster revolves around nutritional aspects of food, its impact on human health and on the environment. Research in this community likely explores links between diet, health outcomes, and the environment. The purple cluster emphasizes on the systemic view of food systems – power, policy, governance, and the role of knowledge and innovation in transforming food systems. The inclusion of "food sovereignty" suggests an emphasis on local control and rights over food production. The orange cluster is a connector between food production and human health by focusing on issues related to diet and its impact on obesity. Finally, the small red cluster shows natural sciences research focusing on the nutritional composition of food, specifically regarding protein, and its stability and preservation, possibly linking to food processing and safety. Food system enjoys the highest centrality and connects multiple clusters integrating different aspects of the food system, such as production, nutrition, governance, and environment. Overall, the co-occurrence network of keywords reveals a hierarchical thematic structure within the FST literature, wherein food systems, sustainability, security, and agriculture forming a densely interconnected core. While health- and nutrition-focused research is strongly linked to this core, governance-, sovereignty-, and food science–oriented themes appear weakly integrated, occupying peripheral yet distinct conceptual spaces. FST research is organized around a dominant sustainability–security nexus, with other thematic areas contributing in more segmented ways.

Figure 6 is a thematic map plotted based on two key metrics, centrality and density. The centrality (relevance degree) indicates the importance of a theme within the research field. Higher centrality suggests the theme is strongly connected to other distinct themes and is therefore considered more central to the overall research landscape. Density (development degree) represents the degree of internal development of a theme. High density suggests that the theme is well-researched with strong connections among articles of largely similar fields. The motor themes of food systems, security and sustainability are high in centrality and high density. These are the driving forces of the research field, which are presently well-developed both within and across other topical areas. On the contrary, the niche themes include food, quality, and stability are low centrality but high density. These are highly specialized themes that are well-developed within their own specific area and have limited connections to the broader research field. The emerging or declining themes of human, food safety, and food supply are low centrality and low density, meaning these themes are either emerging or losing prominence in the research fields. Lastly, the basic themes of nutrition, health and consumption are high centrality but low density, meaning these are important themes but require further exploration.

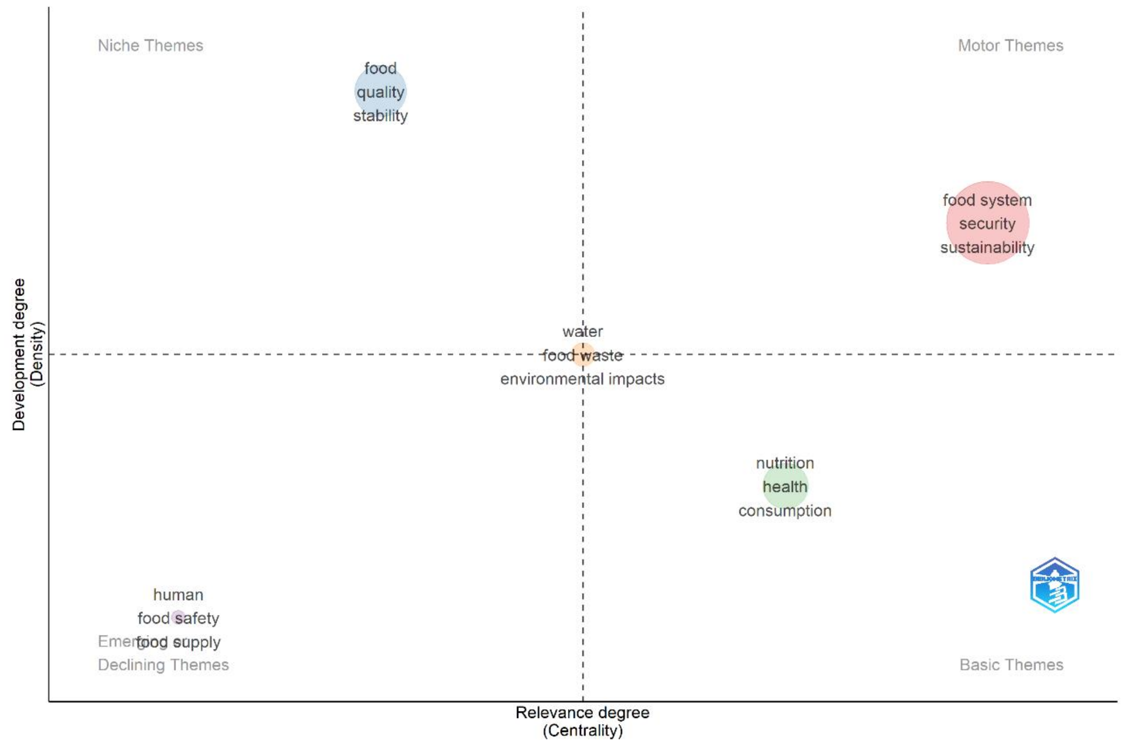

Figure 6: Thematic map to show the intellectual structure of the food system transformation field with top 500 keywords search

Figure 6 suggests that the FST literature is strongly anchored around sustainability-oriented food system security, while other dimensions of transformation remain unevenly developed. Although nutrition, health, and consumption are central to the field, their relatively low density indicates that these themes are frequently referenced but lack cohesive theoretical consolidation within FST research. Conversely, technically focused themes such as food quality and stability appear well-developed but remain weakly integrated into broader social system-level transformation debates. FST's intellectual landscape is primarily conceptualized through environmental and security frameworks, with limited integration of food quality and stability driven research.

Figure 7 is plotted on two dimensions, Dim 1 (29.56%) and Dim 2 (21.82%). These percentages indicate the amount of variance in the data explained by each dimension. Dim 1 explains a larger portion of the variance than Dim 2, suggesting that the horizontal axis is capturing a more dominant theme or distinction within the data. This map uses Multidimensional scaling to arrange items, in this case keywords, in a visual arrangement that represents the distance between them.

The map reveals four distinct clusters, each represented by a different color. The purple cluster is the largest and most central cluster. Key terms in this cluster suggest an association between food production and the challenges posed by climate change. The red cluster indicates a focus on localized food production, distribution, and the importance of network-based approaches to food systems. The green cluster orients around microbial food safety and preservation. The presence of "listeria-monocytogenes" indicates research on foodborne pathogens, while "encapsulation," "stability," and "protein" suggest related areas like core food science. The blue cluster consists only of the term "embeddedness." The isolation of "embeddedness" suggests this term is distinct from the other clusters and may represent a more specific or niche research area.

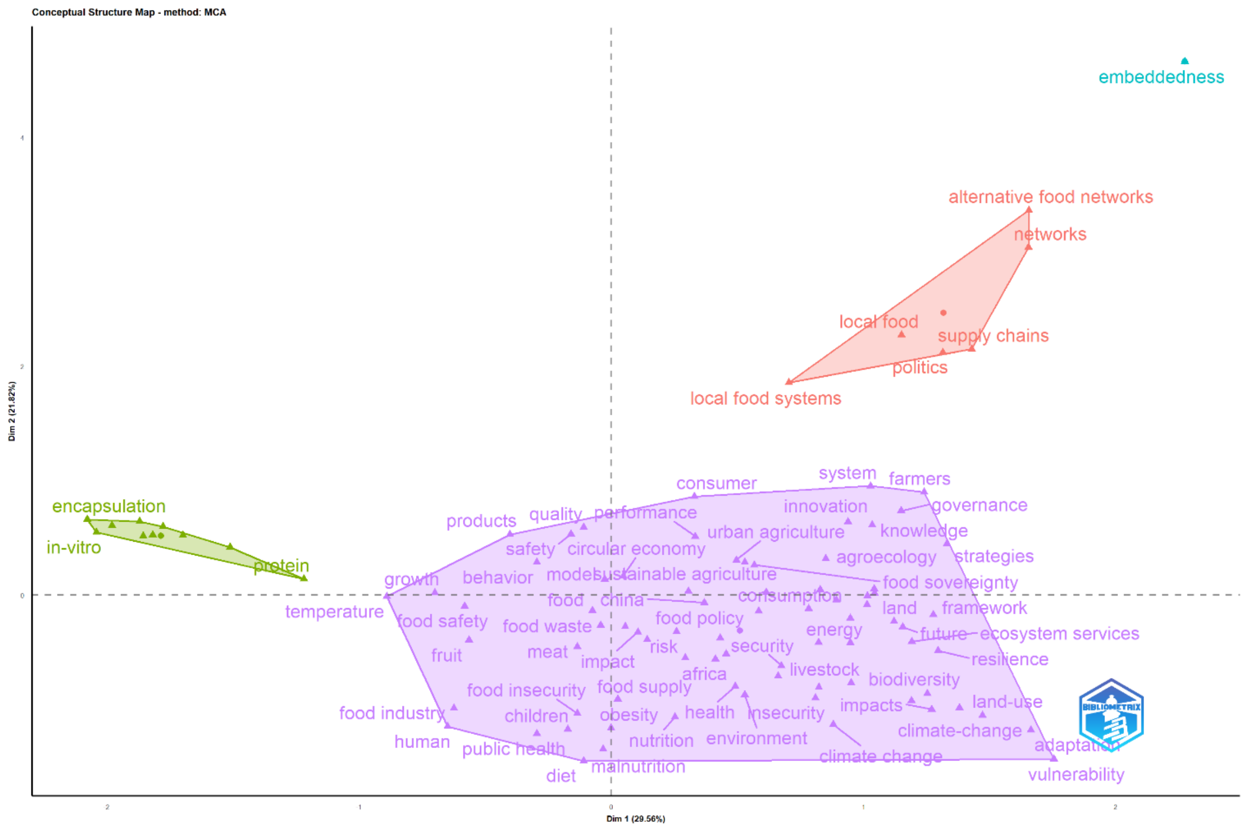

Figure 7: Factorial analysis of top 100 most frequent terms, with top 100 terms and four clusters

Figure 7 suggests a conceptual separation within the FST literature between system-level, sustainability-oriented research and more specialized technical or localized strands. The proximity of governance-, nutrition-, and climate-related terms within the largest cluster indicates that these concepts are frequently addressed together, forming an integrative core of the field. In contrast, the separation of food science–oriented terms highlight limited conceptual overlap between technical food sciences research, and the dominant systems-oriented literature. The isolation of "embeddedness" further suggests that certain theoretical concepts remain weakly integrated into mainstream FST research despite their relevance to understanding social and political dimensions of food systems.

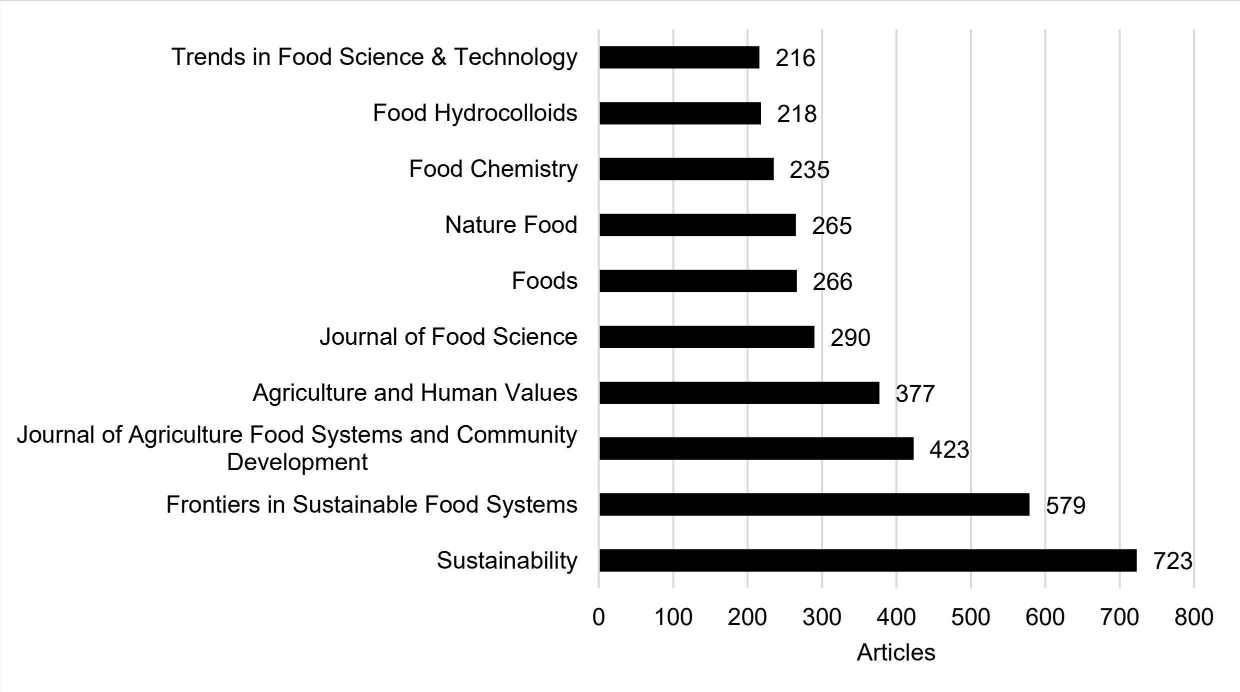

Figure 8: Top ten journals in no. of articles produced.

In terms of journal productivity, figure 8 shows that the Sustainability Journal is the most frequent source of studies in the dataset with a total of 723 publications followed by Frontiers in Sustainable Food Systems. Sustainability Journal is the leader by a clear margin. The remaining journals fall into two broad categories. Journals such as the Journal of Agriculture, Food Systems, and Community Development and Agriculture and Human Values reflect systems-oriented and socio-institutional approaches to food systems, while outlets including the Journal of Food Science, Food Chemistry, Food Hydrocolloids, and Trends in Food Science & Technology represent food science and technological research. This distribution suggests that while FST research is anchored in sustainability and agricultural science journals, it is simultaneously dispersed across technical food science outlets, with comparatively limited representation from journals centered in public health, economics, and policy.

Figure 9 depicts the annual publication counts for the top five sources over time. Despite the historic presence of The Journal of Food Science, the publication rate over the years remained steady. On no occasion did the Journal surpass 10 publications annually, but there has been at least one publication each year since 1974 except for one year, 1993. Since taking off in 2010, the Journal of Agriculture Food Systems and Community Development have experienced variation in annual publication, with a peak in 2018 and a downward trend following. Agriculture and Human Values have a slow start with an average annual production of 0.8 studies in the first decade. In the past decade, they averaged 25.5 publications annually with a peak of 46 in 2024. The two production leaders, the Sustainability Journal and Frontiers in Sustainable Food Systems, follow different trend patterns. The leading Sustainability Journal follows a less predictable trend while Frontiers in Sustainable Food Systems has a strong and predictable upward trend, with the most annual publications of all sources in 2023 (178).

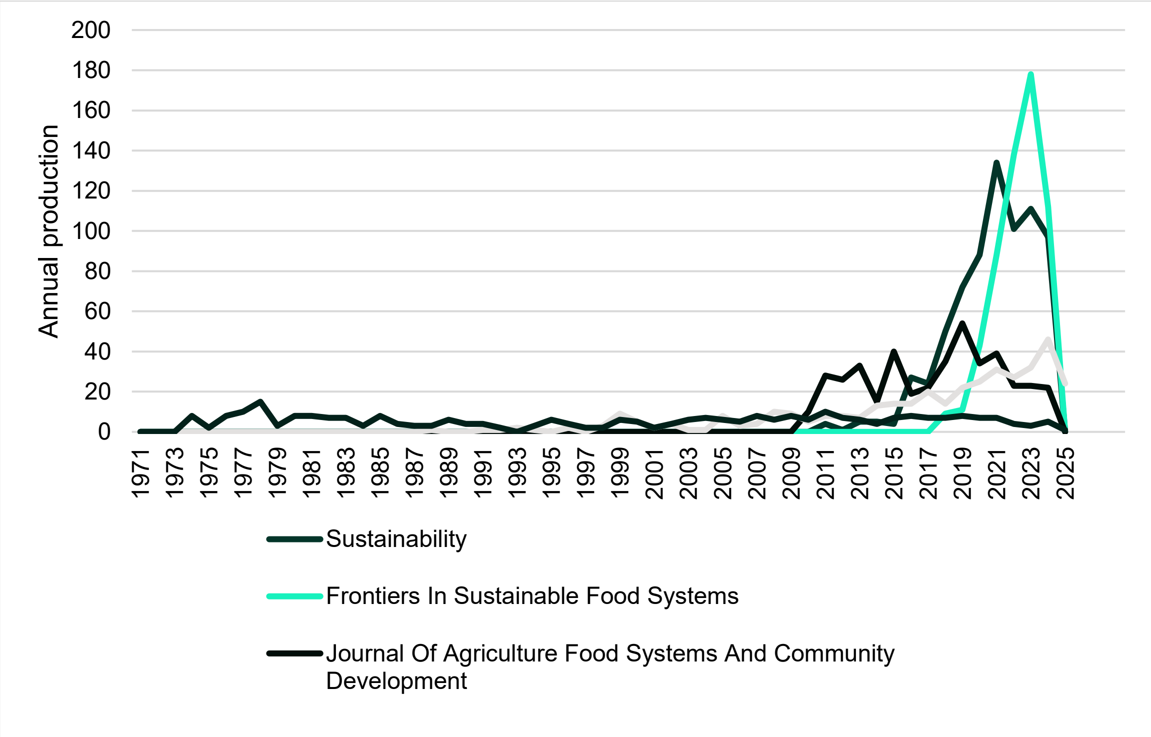

Figure 9: Annual production per year of top five most productive journals

These trends indicate a clear temporal shift in the consolidation of FST research. Earlier contributions were concentrated in long-standing food science and values-oriented journals with relatively stable publication rates, while rapid growth after 2010 is driven primarily by sustainability- and systems-focused outlets. The sharp rise in publications within Sustainability and Frontiers in Sustainable Food Systems reflects the increasing institutionalization of FST as a distinct research domain, while the more gradual growth of Agriculture and Human Values and the variability observed in Journal of Agriculture, Food Systems, and Community Development suggest continued but uneven integration of social and values-based perspectives within the field.

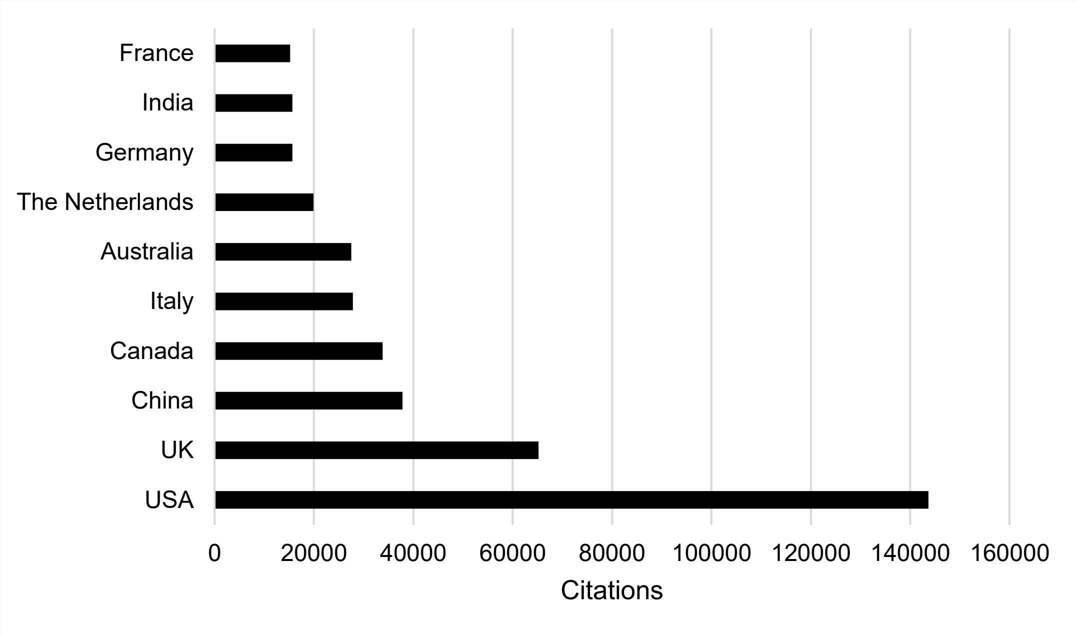

Figure 10: Top ten countries with highest citations

Figure 10 shows that there is no representation for Latin America and Africa in the top 10. It is important to note that there is substantial variation among the number of citations within the top 10. Although Europe has the most countries in the top 10, North America has the most citations totaling 177,521, led by the United States. Europe totals 143,870.

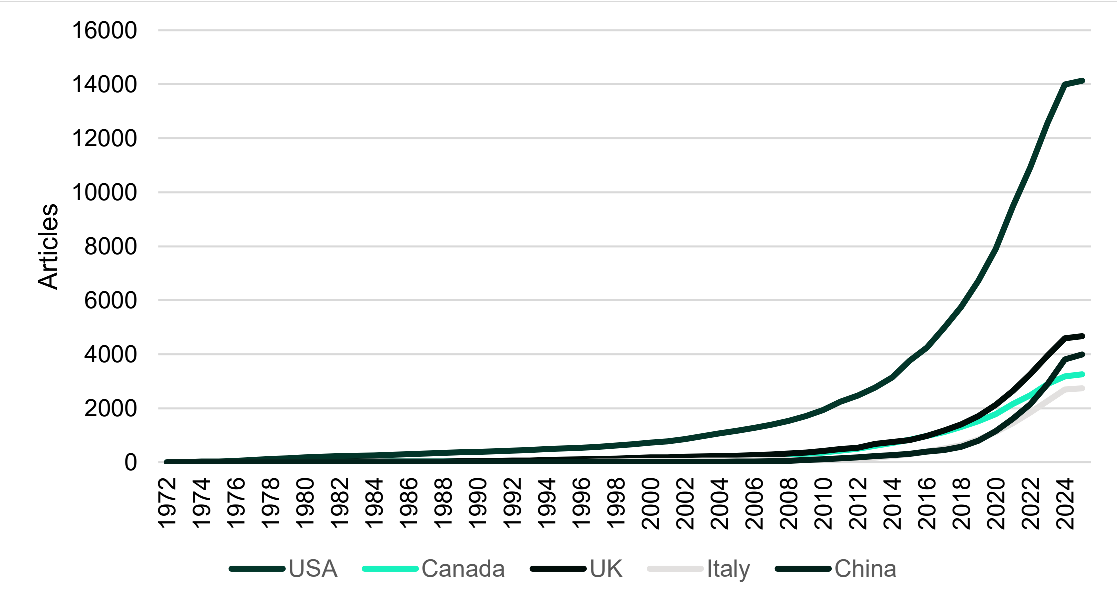

Figure 11: Production trends for top five producing countries

Figure 11 indicates that from 1972 through the late 90's the production gap among countries was narrow, with the United States holding a slight lead over time. At the turn of the century, the United States began producing studies at an exponentially higher rate compared to other country leaders. In the past decade, the production in the United States continued to increase with a total of 14,133 studies published since 1972. There has been a notable shift among trailing countries in the past decade as well. The United Kingdom and Canada that once trended similarly deviated in 2018, with the United Kingdom skewing towards higher production, Canada towards lower production. In 2022, China surprised Canada's production and remained in the third place slot.

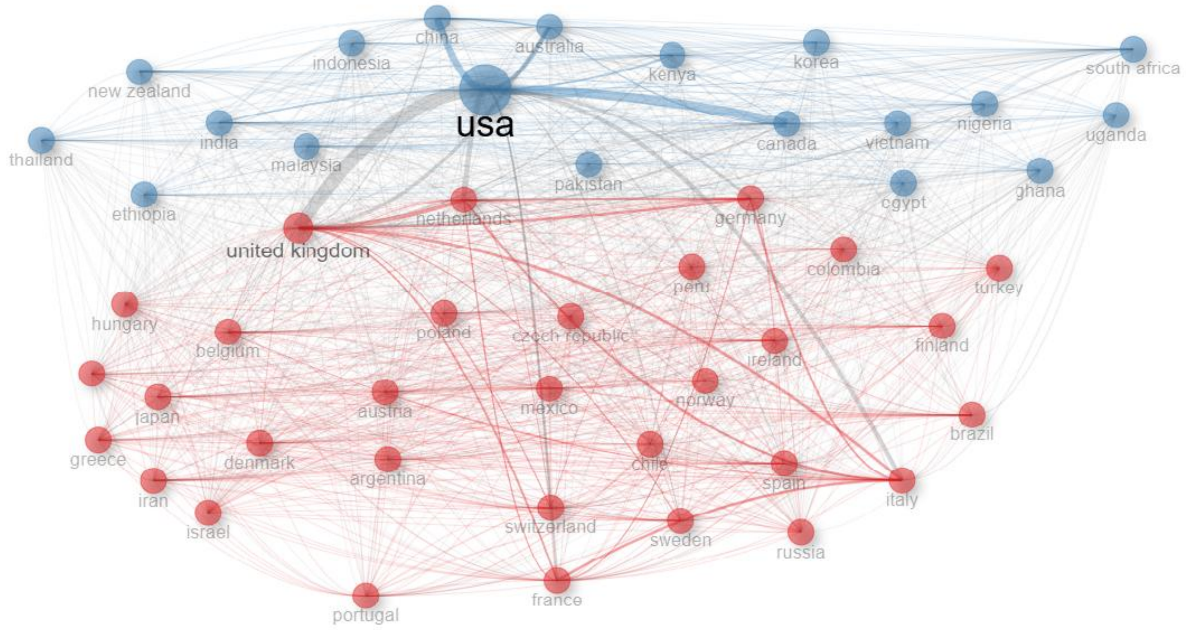

Figure 12: Collaboration network of top 50 countries with highest degree centrality

Figure 12 depicts the centrality of top countries in the dataset. The USA has the largest node by a clear margin, indicating that it is the most frequent collaborator in this dataset. It serves as a major hub connecting to many other countries, particularly within the blue community. The United Kingdom emerges with the second-largest node. It also acts as a major hub, particularly within the red community, but its connections extend beyond to the blue community as well. The network reveals two dominant collaboration communities: one centered on the United States with globally distributed connections, and another centered on the United Kingdom and continental Europe with strong internal collaboration. This structure suggests that international FST research is organized around a small number of highly central countries that mediate collaboration across otherwise clustered regional networks.

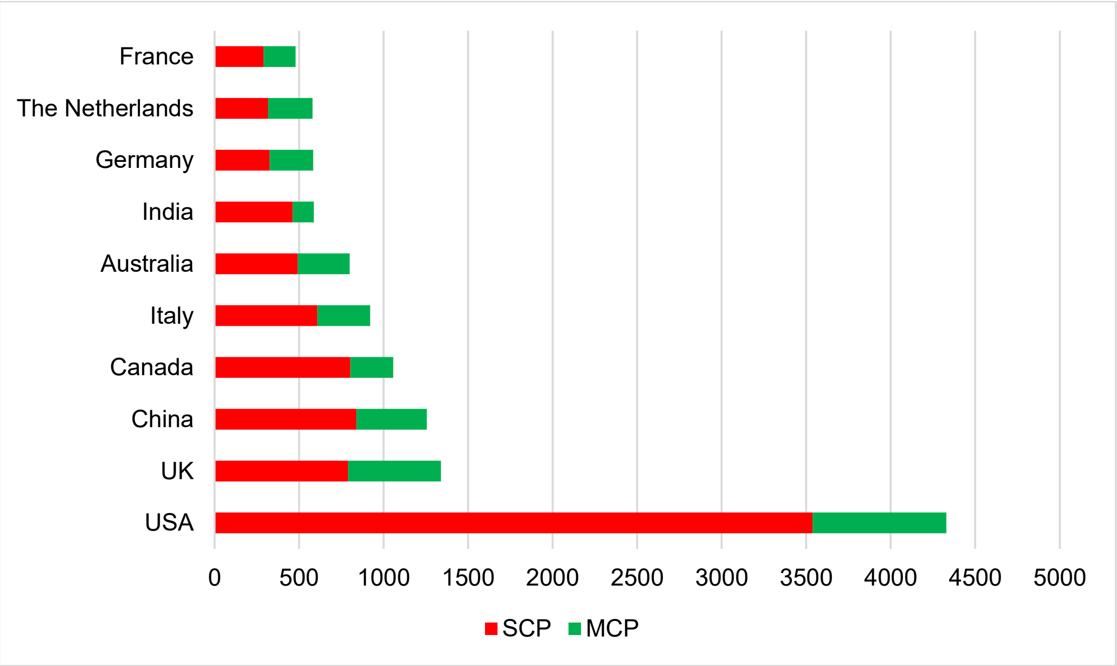

Figure 13: Top ten countries with corresponding authors of articles.

SCP: Single Country Publication; MCP: Multiple Country Publication

Figure 15 presents the distribution of single-country publications (SCP) and multiple-country publications (MCP) among the top ten countries based on corresponding author affiliations. SCP represents articles authored entirely within one country, while MCP reflects internationally co-authored publications. The United States has the largest number of corresponding-author publications overall, with a substantial majority classified as single-country publications. This indicates that U.S.-led FST research is predominantly conducted within domestic institutional networks. In contrast, several European countries—including the United Kingdom, Germany, the Netherlands, and France—exhibit a higher proportion of multiple-country publications, suggesting stronger reliance on international collaboration when serving as corresponding authors. China and India show mixed patterns, with domestic-led publications remaining dominant but with notable levels of international collaboration. Overall, the SCP–MCP distribution highlights substantial variation in collaboration strategies across countries, reflecting differences in research capacity, institutional scale, and integration into global research networks.

The MCP Ratio (MCP %) provides the percentage of publications that are the result of international collaboration. This helps to understand how globally engaged each country's research community is the USA is by far the most productive country in terms of the total number of publications (4329 articles). This is not surprising given the size of its research infrastructure and funding. However, its MCP percentage (18.3%) is the lowest among the top-ranked countries, suggesting a stronger focus on domestic research, or potentially that US institutions are large enough to support comprehensive research projects internally. The United Kingdom and China follow, with significantly fewer publications than the USA (1339 and 1256 articles, respectively). These countries have a notable research presence. China has surpassed UK in domestic publications. It is important to note that the numbers reflect the corresponding author's* country. This might not fully represent the contribution of researchers from other countries involved in projects led by US-based corresponding authors, and vice versa.

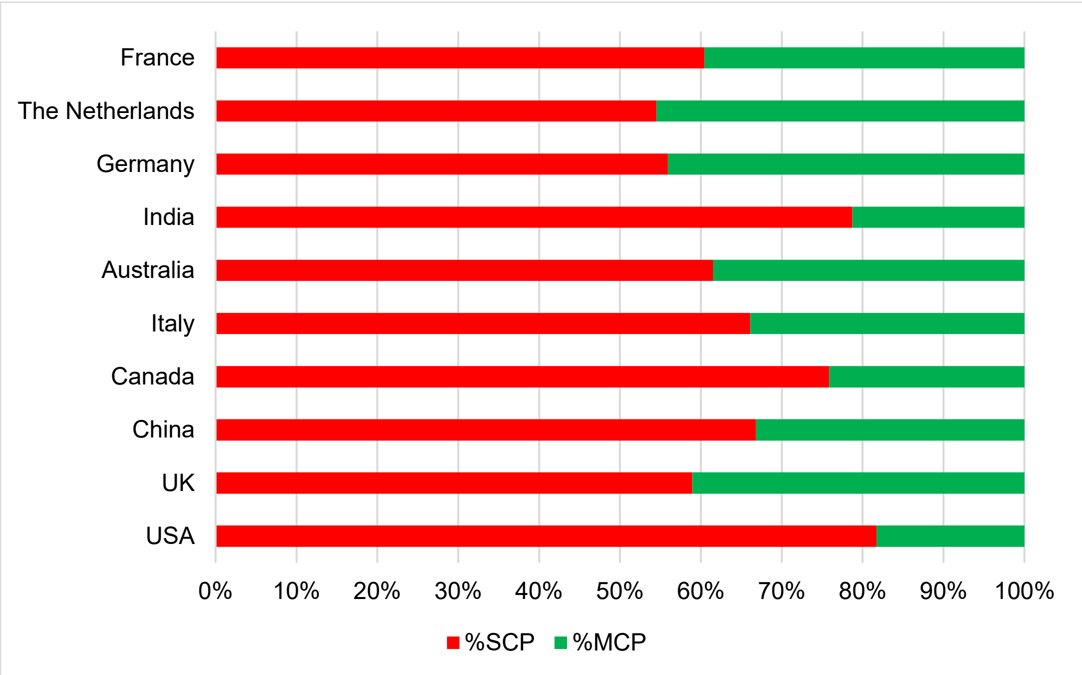

Figure 14: % distribution of SCP and MCP for top ten countries with corresponding authors of articles.

SCP: Single Country Publication; MCP: Multiple Country Publication

Switzerland (49.3%), Netherlands (45.5%), Germany (44.1%), United Kingdom (41.1%) and Sweden (41.3%) have the highest MCP percentages, which indicates a strong emphasis on international collaboration in these countries. This might be due to smaller research systems, strategic partnerships, proximity or a greater openness to international collaboration. Additionally, Australia, France and Belgium have a substantial amount of MCP (38.5%, 39.6% and 39.2% respectively), highlighting their engagement in international research networks alongside a domestic research base. The balance between SCP and MCP reflects a country's research strategy and funding priorities. A high SCP suggests a strong domestic focus, potentially supporting local researchers and addressing local challenges. A high MCP indicates active participation in global research efforts, leveraging international expertise and resources. The presence of several European countries (UK, Germany, Netherlands, France, Spain, Belgium, Sweden, Switzerland, Italy and Ireland) in the top 20 suggests Europe as a significant hub for scientific research, with many countries actively involved in international collaborations. Countries like India (21.3%) and the USA (18.3%) have relatively lower MCP percentages, which could stem from a greater capacity for conducting research domestically or potentially differing priorities in research funding and collaboration policies.

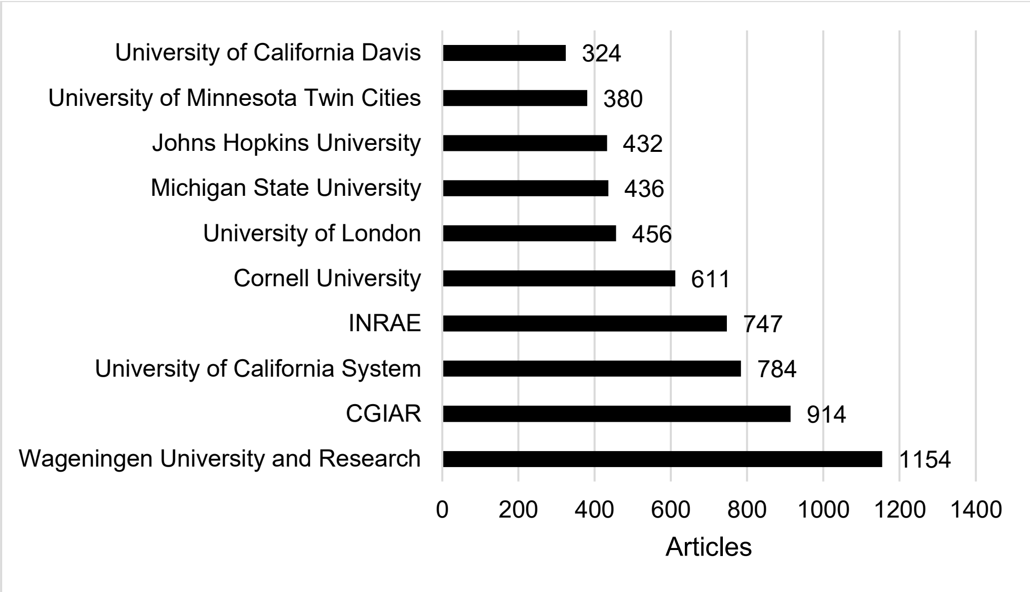

Figure 15: Top 10 most productive institutions in number of articles produced

The results in figure 15 reveal a clear concentration of scholarly output within a relatively small set of institutions, primarily located in North America and Europe. Wageningen University & Research emerges as the most prolific institution by a substantial margin, producing 1,154 articles. This position aligns with Wageningen's long-standing leadership in agricultural science, sustainability, and food systems research. CGIAR follows as the second most productive institution with 914 articles, reflecting its global mandate in agricultural development, food security, and climate adaptation research. Together, these two institutions account for a significant share of the total output among the top ten, underscoring the central role of agricultural and agroecological research organizations in shaping the FST literature. The remaining institutions show a gradual decline in production volume. The University of California System ranks third with 784 articles, followed by INRAE (747) and Cornell University (611). These institutions represent major research hubs with strong capacities in agriculture, environmental science, nutrition, and sustainability. Additional contributors include the University of London, Michigan State University, Johns Hopkins University, the University of Minnesota Twin Cities, and the University of California, Davis, each producing between 324 and 456 articles. The institutional distribution indicates that FST research is heavily concentrated within large, well-funded research universities and international agricultural research organizations. The dominance of institutions with strong agricultural and environmental science orientations suggests that the field has been shaped primarily through technical, sustainability-focused, and production-oriented perspectives. Institutions from the Global South do not appear among the top ten producers, highlighting an uneven institutional geography in the generation of FST knowledge.

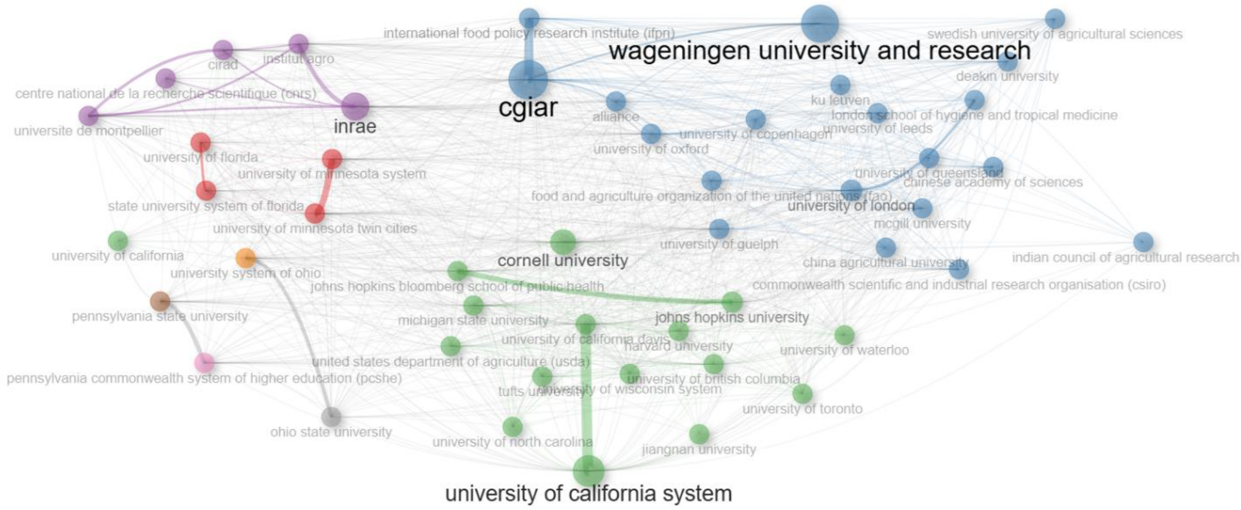

Figure 16: Collaboration network of top 50 institutions with highest degree centrality

The collaboration network in figure 16 clearly shows several distinct communities, visually differentiated by color. The blue cluster appears centered around CGIAR and Wageningen University and Research. The presence of

Wageningen, a leading agricultural university, and CGIAR, an international agricultural research consortium, suggests a strong community focused on agricultural research, potentially with global reach. This underscores their prominent role as collaboration hubs in the represented by this network. It confirms their leading position in international agricultural research. University of California System and Cornell University also appear to be quite central, confirming the importance of the institution to collaboration in this network. The green cluster is dominated by North America, specifically the United States, and revolves around the University of California System and Cornell University. The involvement of the University of California system and Cornell suggests research related to a broad spectrum of fields, but not a strong collaboration between the two of them.

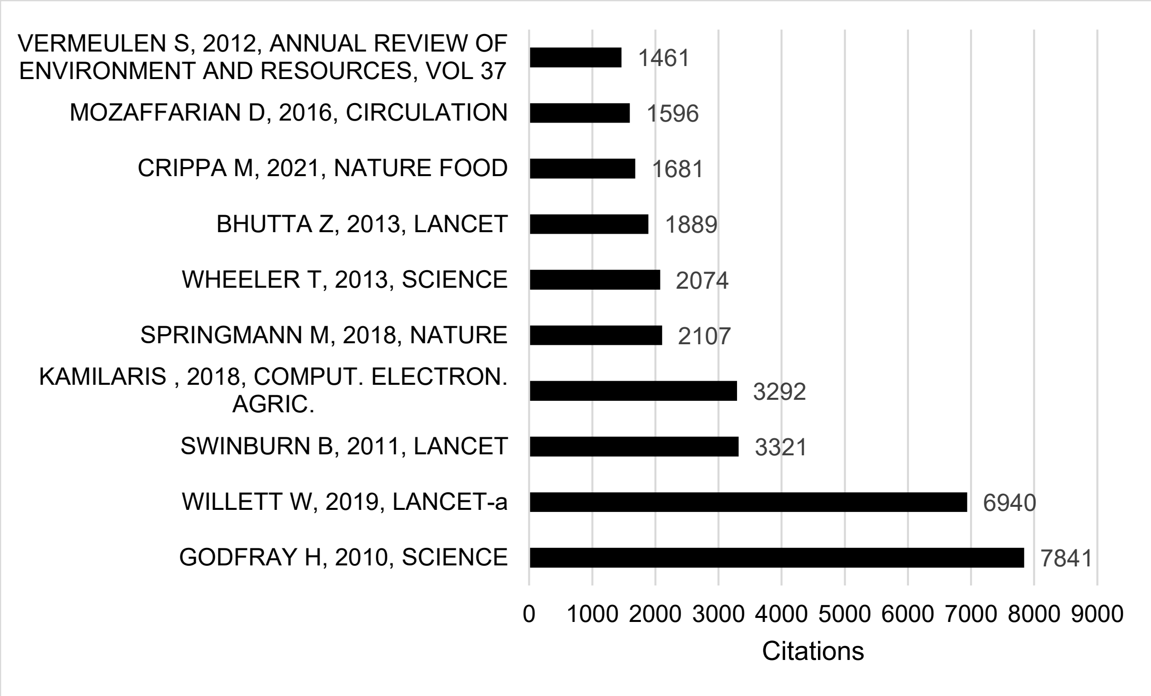

Figure 17: Top ten authors with highest total citations

The data provides the most impactful articles in terms of citations received. Godfray H et. al., published a manuscript in Science in 2010 that was titled “Food security: the challenge of feeding 9 billion people” (Godfray et al., 2010) has received the highest total citation ever. It is closely followed by Willet’s manuscript titled Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems (Willett et al., 2019). Figure 17 indicates that articles highlighting global challenges around food security and transformations have a higher likelihood of gaining visibility.

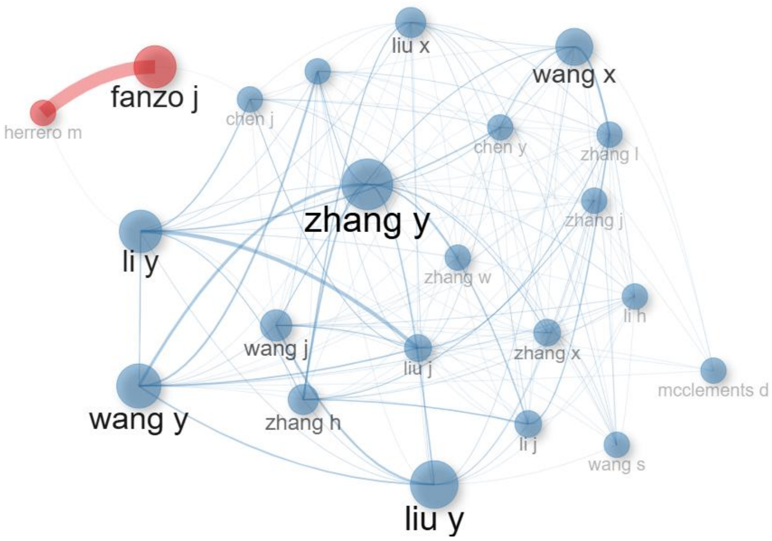

Figure 18: Collaboration network of top 22 authors with highest degree centrality

Figure 18 presents a collaboration network of the top 22 authors with the highest centrality, which used only Web of Science and PubMed data. The most notable feature is the fragmentation with two distinct groups of researchers.

Researchers in these groups have very little collaborative overlap. One group consists of "Fanzo J" and "Herrero M". The second community is substantially larger and more densely interconnected. This cluster exhibits high internal collaboration, suggesting a tightly knit research network with frequent co-authorship. The sharp separation between these two communities highlights fragmentation within the FST author collaboration landscape, suggesting that influential research streams may operate in parallel with limited cross-network integration.

Discussion

Even as the FST field expands, its intellectual center remains difficult to define. Scholars often work in parallel rather than in conversation, drawing from distinct disciplines with different methods, assumptions, and priorities. As a result, “transformation” itself is defined in multiple—and sometimes conflicting—ways. Understanding this fragmentation is crucial for interpreting the field’s evolution: which disciplines have shaped dominant narratives, which remain peripheral, how debates have unfolded over time, and what conceptual tensions continue to impede coherence.

The findings contextualize the shifting landscape of FST. The network of collaborations among countries and institutions underscore the distinct but interconnected nature of the different aspects of FST. Tensions between agricultural productivity and environmental sustainability or between food security and affordability force compromise in the field of FST to optimize results. These tradeoffs emphasize the need for systemic approaches to FST. The emergence of the "Systems & Governance" cluster in Figure 5 indicates the growing importance of systemic approaches to understanding and transforming food systems. Future research may focus on how to design and implement policies and governance structures that promote more sustainable, equitable, and resilient food systems. The inclusion of terms like "climate change," "food policy," and "greenhouse-gas emissions" in Figure 5 underscores the critical role of food systems in addressing global challenges. It is important to consider the trade-offs when implementing policies to boost food security and sustainable development. Research might focus on strategies for mitigating the environmental impact of food production and consumption while ensuring food security for a growing population.

The quadrant analysis (Figure 6) complements the insights of the keyword co-occurrence network by highlighting the dominance of "food system, security, and sustainability" as the most central and developed theme, which suggests a strong focus on holistic, systems-level approaches to food-related challenges. "Nutrition, health, and consumption" is a central but less developed theme, indicating an opportunity for more research to understand the complex relationships between food, diet, and well-being. Food quality and stability dominate as highly developed themes, but with low centrality suggesting there is an area of opportunity to integrate these findings into FST programming and policies. When viewed together, the keyword co-occurrence network (figure 5) and the thematic map (Figure 6) suggest that FST is moving towards a more holistic view. Still, gaps remain in underdeveloped areas and minimally integrated themes. Bridging these gaps requires a multisectoral approach that balances foundational knowledge with new findings to develop sustainable, equitable solutions.

Finally, bibliometric analysis offers a systematic procedure to take a broader view on the intellectual growth on FST. Unlike narrative or scoping reviews, which summarize findings, a bibliometric analysis maps the structural features of a field—its conceptual clusters, geographic patterns, institutional concentrations, collaborative networks, and thematic trajectories (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). This approach was particularly useful for FST, given its rapid expansion, disciplinary diversity, and uneven global representation. Bibliometric tools can reveal which regions and institutions exert the most influence, how collaboration networks evolve, whether certain framings dominate, and where conceptual or geographic blind spots remain. They illuminate how key concepts cluster and shift over time, providing insight into whether the field is moving toward greater integration or continued fragmentation.

Conclusion

Over the past five decades, scholarships on food systems has gradually expanded from biophysical and nutritional concerns toward market dynamics, governance structures, technological innovation, and justice-oriented approaches. This evolution is reflected in the major disciplinary strands that now shape the field. Agricultural and environmental sciences constitute one of the earliest and most influential strands. Rooted in agronomy, crop science, and climate modeling, this work views transformation primarily as a biophysical and technical challenge. Studies in this tradition focus on improving yields, optimizing inputs, enhancing soil health, expanding climate-resilient crop varieties, and reducing emissions through sustainable intensification (Pretty, 1997). These contributions are essential for securing food production amid intensifying droughts, floods, and ecological disruption. Yet resilience is not only technical, it depends on local capacity, access to resources, and the ability of farmers and communities to withstand shocks. As a result, agricultural science often identifies the “what” of transformation but less often engages with the “who” that absorbs the risks when change is unevenly distributed. Public health and nutrition research offers a second perspective centered on dietary patterns, food environments, food safety, and the nutrition transition—the global shift toward ultra-processed, calorie-dense diets linked to rising rates of chronic disease (Willett et al., 2019). From this vantage point, transformation is defined through nutritional outcomes: improving affordability, accessibility, dietary diversity, and the sustainability of consumption. These insights are vital for addressing the twin burdens of malnutrition and obesity. Yet public health frameworks often assume that agricultural systems and markets can adapt to supply healthier diets, without fully confronting upstream drivers such as subsidies, trade agreements, input costs, or corporate concentration. This gap can produce technically sound recommendations that remain structurally unfeasible in practice.

Economics and development-policy research shape a third influential strand. Economists conceptualize transformation through market structures, incentive design, trade patterns, and productivity growth. Their analyses illuminate how investments, subsidies, and market integration influence production and distribution on a scale. However, economic models often rest on assumptions about rational behavior or efficient markets that do not always reflect lived realities such as unequal bargaining power, land precarity, or systemic poverty. As a result, economic framings can underemphasize justice concerns, obscuring the uneven distribution of risk and reward across food value chains. Governance, political ecology, and institutional analysis contribute to another key strand, arguing that food systems are structured by political decisions, rights, and institutional arrangements. From this perspective, transformation requires addressing inequities in land tenure, labor conditions, environmental regulation, and participation (Hospes & Brons, 2016). These scholars foreground the political determinants of food outcomes, highlighting how power relations shape who benefits from change and who remains vulnerable. Yet governance-oriented work can sometimes under-engage with biophysical constraints or technical feasibility, creating a gap between political visions and ecological realities.

Meanwhile, STEM-oriented fields—including biotechnology, systems engineering, circular bioeconomy research, and digital agriculture—frame transformation primarily through innovation and technology. These fields explore precision agriculture, automation, sensors, synthetic biology, and low-waste circular systems as pathways to efficiency and climate resilience (von Braun et al., 2023). While expanding what is technically possible, these approaches often rely on assumptions about scalability, infrastructure, and data governance that privilege well-resourced regions. As a result, technologically driven visions risk reproducing or deepening global inequalities and concentrating decision-making power among a small number of actors. STEM-oriented fields also dominate research funding and publication landscapes, shaping which solutions appear visionary and which remain peripheral.

Finally, the social sciences—including sociology, anthropology, Indigenous studies, human geography, and science and technology studies—emphasize the cultural, relational, and political dimensions of food. These fields understand food systems as embedded in social relations, historical trajectories, and community practices (Holt Giménez & Shattuck, 2011). From their perspective, transformation requires addressing structural inequities, centering marginalized voices, and recognizing food as relational rather than merely material. Yet despite offering deep insights into justice, identity, and cultural meaning, these perspectives remain underrepresented in policy debates dominated by scientific, technological, and economic expertise.

Together, these disciplinary silos have produced a field that is undeniably rich but deeply fragmented. Each discipline brings its own methods and assumptions, yet few studies integrate these perspectives into a shared framework. The result is an FST literature defined by multiple interpretations of "transformation," diverging visions of desirable futures, and conflicting strategies for achieving change. This fragmentation carries real consequences: when disciplines work from incompatible assumptions, policies become harder to coordinate; investments may be guided by narrow logic rather than cross-sectoral needs; and interventions can reinforce inequities rather than resolve them. Fragmentation also makes it difficult to identify collective priorities or build transformation pathways that work across ecological, political, and cultural contexts. These tensions raise foundational questions about the field itself—whose voices shape the conversation, whose remain marginalized, how these patterns have shifted over time, and how disciplinary, geographic, and institutional dynamics structure the global narrative around FST.

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