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Theories of change: navigating diverse expert perceptions and preferences for global food system transformation

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Introduction: Efforts are underway to transform food systems in light of their contributions to global challenges like climate change. However, food systems are highly complex, involve noteworthy place-based challenges, and there is often debate and disagreement among experts over appropriate technologies or interventions to prioritize. Tracking progress, and understanding these differences, is thus a critical need.

Methods: We surveyed food systems experts in eight countries about their preferences for 20 different food system transformation strategies and their sentiment regarding whether current initiatives are sufficient to meet 2030 goals for climate and biodiversity.

Results: Expert sentiment is overwhelmingly negative, and experts are concerned about multiple "transformation gaps," including gaps in ambition, strategy, and implementation. Expert rankings for 20 strategies vary notably among countries and in ways that do not match those same experts' rankings for the strength of the science behind each lever. Factor analysis reveals four distinct theories of change informing experts' subjective biases: transformation via technical optimization, via smallholder support, via nature-positive solutions, and via supply chain enabling conditions.

Discussion: These findings provide insights for navigating the complexities of food system transformation and illustrate the influence on our strategies of preconceptions and biases in how we have come to understand the nature of the challenge.

KEYWORDS

food policy, food systems, multi-stakeholder collaboration, nature-based solutions, science-based decision making, theory of change, transformation

Main text

Our food systems represent a critical strategic theater in the work towards addressing the major intersecting, worldwide challenges of climate change, biodiversity loss, food insecurity, and sustainable development (Schneider et al., 2023). In the last few years, the concept of food systems transformation has taken center stage (Willett et al., 2019; Loring, 2021), and there is mounting consensus that nothing less than a radical reorganization of how we produce, distribute, share, and consume food will suffice for successfully reducing greenhouse gas emissions, reversing deforestation and biodiversity loss, and improving human health and well-being (Rockström et al., 2020; Stephens and Clapp, 2020). Yet, while advocacy, activism, and innovation abound at all levels of society, much progress still needs to be made (Béné, 2022; Loken, 2023). At the 2023 UN Food Systems Summit+2 Stocktaking Moment, the UN Secretary General acknowledged the need for rapid change and called for a system-wide, cross-sector strategy for transforming food systems via bold initiatives in governance, health and nutrition, business, finance, and science and technology (United Nations, 2023).

The good news is that there is no shortage of good ideas for making our food systems more sustainable, equitable, and just (Fraser et al., 2016). For many decades, those promoting food systems reforms focused almost singularly on accelerating production and increasing efficiency (Thompson, 2017; Dornelles et al., 2022); from 1995 to 2015, for example, global food systems were characterized either by trends of expansion, i.e., increased in agricultural area, synthetic fertilizer use, and gross agricultural output, or consolidation, characterized by a focus on economies of scale to increase efficiency while still increasing output (Dornelles et al., 2022). These gains in production came with several negatives, including decreased resilience of agroecosystems and food chains, increased ecological footprint, and a variety of negative societal outcomes such as widespread malnutrition and political disenfranchisement and cultural severance of people from place (Stone, 2019; Loring and Sanyal, 2021; Dornelles et al., 2022). Indeed, alongside the ongoing march of industrialization and consolidation in global food systems Indigenous and other local communities have have consistently advanced a countercurrent a countercurrent of food activism and critique, arguing for alternative strategies rooted in human rights, food sovereignty, and agroecology (Via Campesina, 2007; Figueroa-Helland et al., 2018). In recent years, through the work of these communities, the credibility of their alternative visions have become more widely recognized at many levels, from local to global (Motta, 2021). It is now common to encounter mainstream conversations about food system transformation that eschew narrowly construed production-centric solutions and instead promote a diversity of systemic innovations, including agricultural and land tenure policies, empowerment of women, and reform to nature-positive practices that generate co-benefits for people and ecosystems (Béné et al., 2019; Bennett et al., 2021).

A challenge, however, is that global food systems are extremely diverse, comprising different forms and facing substantively different challenges from place to place. On one hand, much of the global food system is heavily industrialized and geared towards globe-spanning food markets and supply chains; on the other, these global systems intersect and interact with the myriad place-based systems of smallholder agriculture, local markets, and small-scale fisheries that provide most of the food being consumed globally (Rotz and Fraser, 2015; Flachs, 2020). So, the workings of the food system that any given person eats from reflect the ecological, political, and cultural nuances and histories of where they live, which invariably include socioeconomic inequities and racist and colonial legacies (Loring and Gerlach, 2009; Downs et al., 2020). As such, one-size-fits-all solutions are untenable from both a social and ecological perspective (Béné, 2022).

There are also myriad perspectives and little consensus on the best technologies, practices, or policy interventions for remaking food systems to address challenges like climate change, biodiversity loss, and food insecurity and malnutrition. Some experts advocate for increased attention to advanced technologies and efficiencies, others focus on finding efficiencies through changing consumer consumption patterns, and still others focus on social and human rights entry points like food sovereignty and land tenure reform. In other words, the theories of change—the assumptions about how we get from intervention to impact—that motivate people's work on food systems are as varied and nuanced as the places where changes need to happen (Vogel, 2012; Thornton et al., 2017).

A theory of change, in the most general sense, comprises both one's understanding of how current problems or circumstances have come to be, and how, based on that understanding, interventions can result in new and ostensibly more desirable outcomes (Vogel, 2012). Theories of change can be informal, such as people's general ideas about nature, progress, and how to improve society and social welfare, or they can be highly detailed and systematized, attending to the specific steps needed to achieve long-term goals and the relationships between activities, outputs, and outcomes (Thompson et al., 1990; Stein and Valters, 2012). Theories of change also invariably involve assumptions that underpin their causal logic and are, hence, critical to understand. These can include assumptions about the science basis, assumptions about human behavior or social context, and deeper cultural assumptions about the right and wrong way to solve problems (Opatovsky et al., in review). In the context of food systems transformation, the use of systematized theory of change frameworks is advancing as a way prioritize and improve the pace and learning potential of new interventions (Thornton et al., 2017; Dinesh et al., 2021). Recognizing the deep and often-unstated underpinnings of experts' theories of change in food systems is essential to ensuring these efforts do not have unintended consequences or trade-offs that undermine progress toward environmental and social goals. In addition, recognizing when different actors are working with different theories of change can also be critical for collaboration and developing a deeper understanding of disputes and conflict (McEvoy et al., 2017; Harrison and Loring, 2020).

In this paper, we report on research that elicited perceptions and preferences from food systems experts in eight countries regarding progress toward, and opportunities for, food system transformation. The goal of the work was to identify insights that could help practitioners and policymakers identify develop effective and place appropriate strategies for interventions that contribute to national commitments for climate, biodiversity, and sustainable development. With a survey and series of interviews, we evaluated experts' sentiment regarding current initiatives in their countries with an eye toward four related aspects: current ambitions, strategies, implementation, and overall progress toward meeting their nationally determined 2030 goals for climate and biodiversity (Figure 1). In the survey, experts ranked the potential for impact and the strength of science behind 20 country-level 'transformation levers' (Table 1) to create systemic food system change, levers that span such areas as natural resource management, governance, education, technology, trade, and finance. The findings reveal widespread concerns about country-level progress toward addressing climate change and biodiversity loss, shed light on expert perceptions about the strength of the science behind popular food systems innovations such as high-tech protein alternatives, and offer critical insights for navigating the subjectivities and competing theories of change that currently inform prominent debates over food system transformation.

Methods

Experts responded to a web-based survey that was made available in English, Spanish, and Cantonese (Supplementary Table S1).

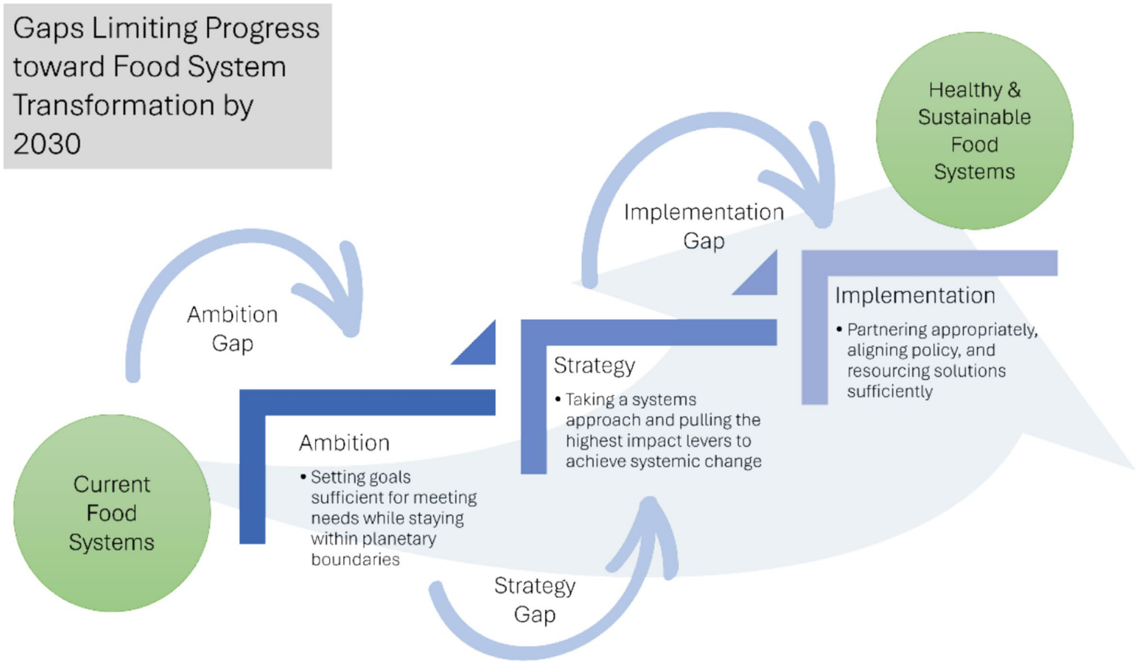

FIGURE 1
Gaps in ambition, strategy, and implementation can stall food system transformation. Adapted from WWF (2023).

We designed the survey in English, and then for translation purposes, discussed the questions with team members before translation to ensure that key meanings were retained. The survey includes four Likert-scale questions related to their sentiment about overall progress and the three gaps illustrated in Figure 1. The survey also asked experts to rank 20 transformation levers (Table 1) for their potential to create a positive impact in their country's food system, on a Likert scale of 1–5. The 20 transformation levers used in this survey were first identified in the WWF report, *Solving the Great Food Puzzle* (WWF, 2022). In that report, WWF solicited expert suggestions to identify a representative subset of the 42 policy actions identified by Hawkes et al. (2020) and WWF (2022). We chose not to provide formal definitions for words that have been formalized in this area of practice, such as smallholder, as these definitions are sometimes contested and when survey takers encounter statements or concepts they disagree with it can undermine their engagement in the survey (Fowler and Mangione, 1990). Since publication, these 20 levers have been vetted and refined by multiple national-level WWF teams and in countries other than those included here; as such we believe they are representative of the range and types of strategies currently being pursued for food systems transformation around the world. The survey also asked experts to rate the strength of the science that exists in support of each of the 20 levers, on a Likert scale of 1–3.

To analyse survey data, we performed all statistics using R (R Development Core Team, 2021). This included the creation of an expert sentiment index by averaging the rankings of the four sentiment questions for each respondent, checking first for agreement (shared variance) among the four questions using the Chronbach's alpha test.

To explore correlations between transformation levers and among levers and their science ratings, we used Spearman's test (which is preferred over Pearson's for categorical and ordinal data). To surface unknown influences on expert lever rankings we used factor analysis with varimax rotation, a method often used for uncovering latent discourses that inform people's subjectivities (Eden et al., 2005). We also used ANOVA with pairwise post-hoc analysis to identify sources of variance in lever rankings and in the expert sentiment index.

Note that in the cases where we used averages or other parametric tests (ANOVA) with Likert-style data, we did so with the understanding that while some have questioned the validity of transforming ordinal data in this manner, scrutiny has shown that parametric tests not only can be used with ordinal data but in many cases they will be more robust than nonparametric alternatives (Norman, 2010).

Participants were recruited from eight countries: China, India, Pakistan, Philippines, Mexico, Netherlands, South Africa, and the United States of America. While we acknowledge that this was a sample of convenience, the set does include at least one country from each food system type articulated by Marshall and colleagues, which range along an axis of industrialization, from food systems characterized by smallholders engaged in traditional cultural activities to fully industrialized food systems (Marshall et al., 2021).

For survey and interview recruitment, we relied on local WWF offices to compile an initial recruitment list that prioritized representative diversity, i.e., attempting to ensure participation by respondents from all relevant sectors, which is a desirable approach for sampling saturation in social research when working with logistically constrained sample sizes or in loosely defined communities like experts where it is impossible to credibly estimate a population size (Saunders et al., 2018). We opted to not define "expert" too narrowly but rather rely on local discretion in order to not unintentionally exclude critical perspectives (Sandelowski, 1998). We began with an initial recruitment target of 20–30 survey participants and 8–10 interview participants per country. An important nuance about this kind of qualitative inquiry is that we are trying to surface insightful patterns in perspectives and subjectivities, not present an authoritative picture of the current state of expert opinion for each country or intervention. In other words, the research is about what we can learn from *these experts* not what we can learn about *all experts*. The latter would require more attention to the relationships among population and sample size and statistical power.

We sent participants surveys links by email and up to three reminders were sent over the course of a month. Experts were asked to self-select in the survey if they would be willing to participate in additional, one-on-one interviews. Interview questions (Supplementary Table S2) were customized to include a mix of shared questions and questions informed by the preliminary results of the survey. For logistical purposes (e.g., constraints on time, technology, internet access), our partners in the Philippines opted to hold in-person expert workshops instead of interviews. Our workshops followed the same question format as the interviews. All interviews were done in English and co-led by authors 1 and 2, who are both experienced interviewers; in cases where language could be a barrier, at least one multi-lingual member of the research team participated in the interview as well.

Author 1 coded the fully anonymized interview transcripts and workshop notes using the MaxQDA qualitative data analysis platform (VERBI Software, 2024). Coding was done deductively, based on the 20 transformation levers listed in Table 1, the four dimensions of our sentiment index, and by the four factors we identified and named as emergent theories of change. In the context of this paper, we use the interview data largely to identify exemplar quotes that can provide context or specific examples and to inform our synthesis and interpretation of survey findings. This is consistent with an abductive approach to mixed methods ethnographic research (Agar, 2013).

The sponsoring agency (WWF) did not require human subject research review; nevertheless, the lead author is trained and certified for ethical human subjects research and proactively ensured that the project followed standard best practices for human subjects research, including collection, security, anonymity, and confidentiality; free, prior, and informed consent was received from all participants prior to data collection.

Results

A total of 232 participants from eight countries—China (CHN), India (IND), Mexico (MEX), Netherlands (NLD), Pakistan (PAK), Philippines (PHL), South Africa (ZAF), and the United States (USA)—opted to participate in the survey and 83 (35%) opted to participate in in-depth interviews or workshops with the research team (Supplementary Tables S3, S4).

Expert sentiment and concerns

Overall, our expert sentiment index, (Figure 2), which combines respondents' individual rankings for ambition, strategy, implementation ($\alpha = 0.9035$), suggests that expert sentiment about food system transformation progress is largely negative. Only experts from China reported positive sentiment across all aspects of the sentiment index (Figure 2b)—implying a positive outlook on their country's ambition, strategy, etc. Expert sentiment is lowest in The Netherlands; in countries other than China, pairwise differences in sentiment were found to be statistically significant between some, but not all, Global North–Global South pairings (Supplementary Table S5). Respondents in countries other than China were all generally split regarding whether actors in their country are exhibiting the necessary level of ambition and pursuing sufficiently robust strategies (Figure 2c); 60% of respondents outside of China are not convinced that sufficient resources are going to food systems initiatives, and 68% do not believe that their country is on track to meet existing 2030 commitments for food systems transformation.

When asked to characterize existing initiatives in their countries, respondents unsurprisingly reported that production-focused initiatives are the dominant focus, with 77% of survey respondents describing production as the area with the most interventions/programs in place, while only 13% listed food loss and waste and 11% listed diets and nutrition as being the most active areas. Food loss and waste and diets and nutrition were instead mostly split, ranked as having average and least activity, a pattern that holds for all eight countries surveyed (Supplementary Table S4).

Interview participants identified numerous areas in their country where there are gaps in ambition, strategy, and implementation (Table 2). Implementation gaps were the most discussed (Supplementary Table S7), and included inadequate funding, unfinished and abandoned work caused by administrative and political change and corruption. Another significant challenge to implementation identified was inadequate or misdirected research and extension capacity, specifically in service of smallholders and alternative production systems like agroecology, agroforestry, nutrition-focused strategies, and regenerative farming.

Strategy gaps were the second most common gaps discussed (Supplementary Table S8). Examples of perceived strategy gaps identified by experts include too little emphasis on empowering smallholders, hesitancy to move away from conventional practices and adopt alternatives like regenerative agriculture, and perceptions of misdirected strategy, e.g., too little focus on creating consumer change toward health, sustainable diets.

Lever rankings by potential impact and strength of the science

Regarding expert rankings of the potential impact of the 20 transformation levers (Figure 3), seven of the 20 levers reached the "top 10" list for six or more of the countries surveyed, notably levers focused on natural resource management strategies (NRM), education (ED), governance (GOV), and supply chain technologies (TECH; Supplementary Table S9). This is consistent with our interview findings. Carbon storage strategies (NRM3) never made the top 10 for a country. Alternative proteins (TECH3) only made the top 10 in The Netherlands.

Levers with the strongest expert rankings for the strength of science are from NRM, TECH, and ED categories (Supplementary Table S8). Conversely, experts rated FIN and TRADE levers as having comparatively weak science behind them. Noteworthy

TABLE 1 Food systems transformation levers.

Category	Abbreviation	Description
Natural Resource Management	NRM1	Use all agricultural lands to their maximum potential, including using existing agricultural land to feed humans and optimizing crop yields on these lands through better food production practices that more efficiently use water and fertilizers, reducing pollution from chemical inputs, preserving ecosystem functions, and contributing to resilient landscapes.
	NRM2	Develop and implement food production practices that restore biodiversity in active food producing lands/waters and restore less productive areas to natural habitat for biodiversity conservation.
	NRM3	Develop and implement food production and blue foods management practices that increase carbon stores in both below- and above-ground biomass and blue carbon.
	NRM4	Support the production and consumption of a diversity of terrestrial and aquatic foods and protein sources (e.g., legumes, nuts and nutri-cereals) through agrobiodiverse systems including agroecology and regenerative agriculture.
Governance	GOV1	Redesign development and extension programmes to all farmers/fishers, including women, to provide financial assistance, and develop new business models, infrastructure, and agricultural assets to grow/catch nutritious and sustainable, traditional foods and access markets.
	GOV2	Improve land tenure rights and develop actions that encourage collective ownership and indigenous land rights.
	GOV3	Coordinate and strengthen national-level commitments and implementation on shifting to healthy diets, reducing food loss and waste, and scaling nature-positive food production.
	GOV4	Support multi-stakeholder collaboration using a multi-level and participatory approach for addressing interrelated issues across economic, social and environmental dimensions.
Education and Research	ED1	Strengthen the science of healthy and sustainable food production and increase research and development opportunities with food producers, and domestic universities, to expand nature-positive practices that support production of healthy foods.
	ED2	Improve data collection and measurement of current behaviours, environmental impacts and progress of national-level commitments contributing to international health, climate and biodiversity targets.
	ED3	Launch engaging and compelling communication and behaviour change campaigns about healthy and sustainable eating and reducing food loss and waste.
	ED4	Promote healthy, sustainable and traditional food cultures associated with good nutrition by supporting and protecting healthy and traditional foods and protein sources (e.g., legumes, nuts and nutri-cereals), providing information about healthy and traditional dishes and protein sources, and through public awareness campaigns.
Technology	TECH1	Adopt high-tech nature-positive food production methods such as the sustainable use of non-conventional water sources and controlled environments for food production, and precision and digital agriculture technologies.
	TECH2	Develop innovative infrastructure and post-harvest storage technologies, packaging, and processing techniques for nutritious foods to reduce loss and waste of nutritious foods.
	TECH3	Develop and promote healthy alternative protein sources such as plant-based and cell-based meat alternatives that are high in nutritional value.
Trade	TRADE1	Design trade policies to prioritize the supply of nutritious foods over those that have large negative impacts for the environment and human health.
	TRADE2	Develop trade policies (e.g., deforestation- and conversion-free) that support nature-positive food production, such as trade agreements and traceability tools, and changes in markets.
Finance	FIN1	Redirect agri-food subsidies from harmful production practices and increase de-risking investments to increase nature-positive production of nutritious foods.
	FIN2	Finance school food and public procurement programs that promote and enable healthy and sustainable foods.

The 20 "transformation levers" used in this research described and organized by category.

country-level differences include lower than average ranking for the science behind multi-stakeholder collaboration (GOV4) in China, lower than average rankings for the science behind supply chain interventions (TECH2) in Pakistan, and higher than average rankings in Netherlands for the science behind alternative proteins (TECH3). The latter corresponds to the Netherlands being the only country to include alternative proteins in their top 10.

Inferring expert subjectivities

Interestingly, expert perceptions of the strength of the science behind each of the 20 levers does not appear to influence their rankings for the levers' potential for impact. No statistically significant correlations above our "weak correlation" threshold of $r = 0.4$ were found between experts' ranking of potential impact and strength of

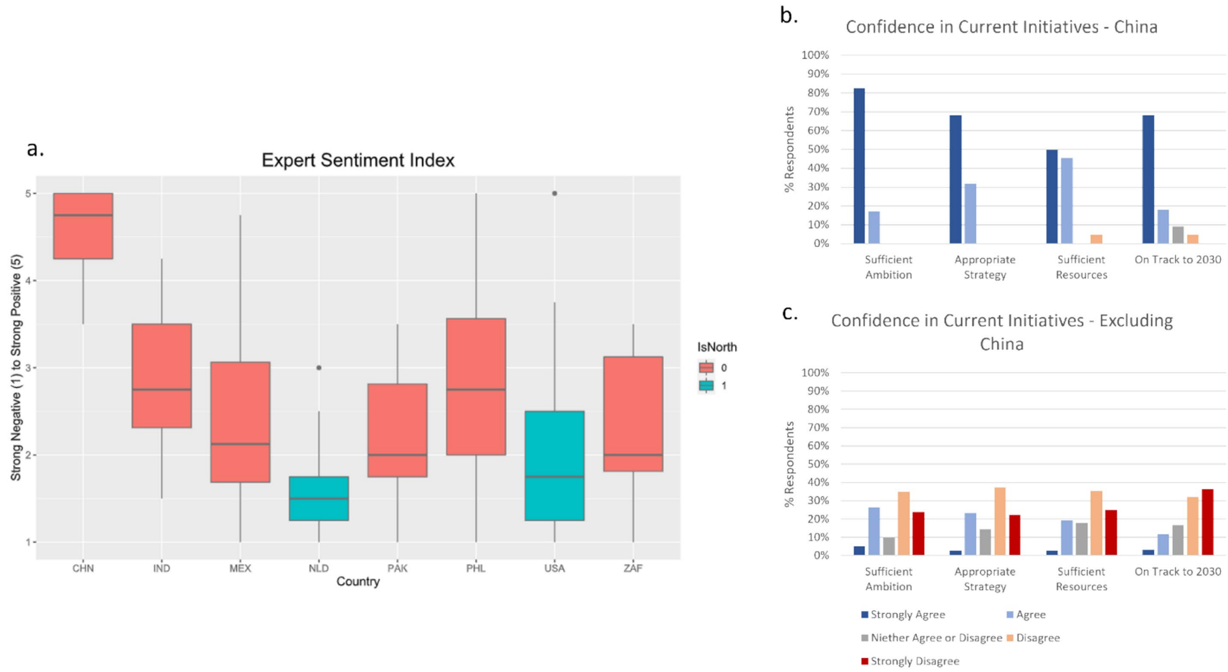

FIGURE 2
Expert sentiment about progress toward food systems transformation is poor. Results show negative expert sentiment in every country surveyed except China. (a) Distribution of sentiment index scores by country, with Global North countries in teal and Global South countries in red. (b) Responses to the four sentiment questions for China. (c) Responses to the four sentiment questions for all other countries.

science for any of the 20 levers. We interpret this in the discussion section. Still, experts do widely call for more science; strengthening science (ED1) made the top 10 for all countries except Netherlands; this emphasis was especially pronounced for countries in the Global South, which aligns with matters regularly raised by interviewees: that current science, especially in service of smallholders, is insufficient, not applied, or not disseminated.

To understand further what drives the different lever impact rankings, we first looked at whether rankings vary significantly by country. They do, and much, but not all, of the variance in lever rankings occurs between Global North and Global South country pairs (Supplementary Table S10).

We also identified multiple strong and statistically significant correlations among levers in the same group (Figure 4a). That is, if an expert ranked one NRM lever high, they were likely to rank others in that same group high as well. This early observation in the survey data informed our working hypothesis and analysis to explore whether respondents are rating and ranking food system interventions based on some set of subjectivities or strategic preferences in addition to their sector-specific understanding of the science alone.

To that end, factor analysis identified four factors that explain roughly 50% of the variance in expert rankings of the transformation levers ($p <= 0.01$; Supplementary Table S11). Interpreting these factors by triangulating the statistics with individual survey response records and patterns evident in the one-on-one interviews, we propose that these factors represent four discrete expert subjectivities, or "theories of change" that inform individual expert perceptions about the strategic importance of various food systems interventions (Figures 4b–d).

The four apparent theories of change are: (1) an optimization focus, in which respondents prefer production efficiency-oriented levers such as TECH1 and NRM1; (2) a market enabling conditions focus, in which respondents emphasize coordinated intervention in issues such as trade and finance; (3) a nature-positive focus, in which respondents prefer solutions that emphasize NRM strategies; and, (4) a smallholder focus, in which people specifically focus on transforming food systems through interventions that address and empower smallholders (GOV1), reform land tenure (GOV2), strengthen science and extension (ED1), and increase public awareness of traditional foods (ED4). Interestingly, all theories of change except the nature-positive focus involve levers from at least two or more lever categories (Table 3).

Discussion

The widespread negative sentiment we identify among experts surveyed regarding their countries' approach and progress toward food system transformation is both troubling and informative. Experts from all countries involved except China are concerned about gaps they see between current efforts and the ambition, strategies, and implementation measures that they believe are necessary to achieve the speed and degree of transformation necessary to meet global climate and biodiversity goals for 2030. A cross-cutting pattern in these concerns is apprehension that current strategies and investments are scoped too narrowly and/or lack coordination. For example, experts in the Netherlands emphasized that without more work on consumer change, including through dietary guidance, the impact of innovations for more sustainable and climate friendly crops and food

TABLE 2 Summary of transformation gaps as explained in interviews.

Gap	Examples
Ambition Gaps	• Lack of political will for dramatic change to production systems • Lack of political will to push for consumer changes • Favoring production and efficiency issues over social issues • Ambivalence towards agro-ecological solutions • Favoring high-tech over low-tech solutions
Strategy Gaps	• Lack of government leadership • Inconsistent priorities of government programs • Too little focus on demand side and food consumption patterns • Limited, incremental approaches towards regenerative systems • Over-reliance on industrial agriculture and non-food crops • Need to value and pay for on-farm ecosystem services • Paucity of emphasis on education and international development
Implementation Gaps	• Insufficient policy support • Lack of coordination and mismanagement of resources • Inadequate monitoring and evaluation systems • Inadequate government incentives and subsidies • Administrative turnover • Corruption and other governance failures • Limited funding and resources for small-scale farmers • Inadequate extension services for small-scale farmers

products will be stalled. In several countries, including Mexico, Pakistan, the US, and South Africa, experts likewise pointed to the challenge of consolidation in food systems as a systemic issue that undermines the potential and impact of innovative change on farms and across the supply chain.

In this regard, our findings align with an increasing recognition in the sustainable food systems literature that transforming food systems requires attention not just to cropping technologies, inputs, and other on farm-innovations, but more broadly to the organizational features and social dimensions of our food systems (Béné, 2022). This includes issues ranging from the length, complexity, and transparency of supply chains to the quality of food and the distribution of wealth, land, and power, and equity among actors (Clapp and Fuchs, 2009; Rotz et al., 2019; Loring and Sanyal, 2021; Van Dooren et al., 2024). Improving production technologies is no doubt important, but focusing on technology alone can cause unintended consequences such as efficiency paradoxes and rebound effects (Loring and Sanyal, 2021; Goulart et al., 2023). Likewise, production innovations, if deployed without attention to existing social needs and circumstances, can create or exacerbate existing problems like farmer and consumer disempowerment (Clapp, 2021; Poelman et al., 2023), or marginalization and dispossession of land and food sovereignty from smallholders (Howard, 2022). Indeed, many have pointed out that the fundamental issues needing transformation in food systems are inherently political and must be addressed as such (Tittonell et al., 2022; Graddy-Lovelace and Roman-Alcalá, 2024).

We also think it is important to highlight the role that power and disempowerment no doubt plays in maintaining and exploiting these transformation gaps in order to maintain the status quo. That is, it would be a mistake to assume that these gaps are just the result of oversights or poor planning; from trade agreements to land and market consolidation and other anti-competitive behavior (Clapp and Fuchs, 2009), the current global food regime is built to be extremely difficult to change. Closing the gaps, thus, is not just about implementing a specific set of innovations, but recognizing that the work of food system transformation is fundamentally about disruption and movement building (Motta, 2021; WWF, 2023).

Articulating our theories of change

Experts in this study are clear in their support for implementing a mix of innovations that are tailored and responsive to multiple aspects of their local food systems. This is not inherently surprising, given the often-stark differences facing Global North and Global South economies and ecosystems. What is surprising, however, is that experts' rankings do not appear to be influenced by their estimation of the strength or weakness of the science behind each particular lever. Two noteworthy examples stand out: high-tech food production (TECH1) is the second-ranked lever overall for its strength of science, but it only reaches the top 10 for its potential for impact in three countries. And, even in these cases it ranks relatively low compared to several other levers with relatively weaker science rankings. Similarly, finance to support public procurement of sustainable and nutritious food (FIN3) also makes the top ten three times, and overall ranks higher than TECH1, despite having the weakest science rating of all 20 levers.

Even though the strength of the science does not appear to weigh heavily in experts' preferences for the transformation levers, the majority of experts in our sample did call for more science. Strengthening the science (ED1) was a top-10 lever for all nations except The Netherlands. And, we heard regularly in interviews that there is still a need for breakthroughs in science and technology, on-farm research collaborations, and increased public investment in extension to smallholders, especially in the Global South. So, it is not that experts are saying science does not matter when it comes to setting strategy for food system transformation, but just that it does not, or perhaps should not, determine strategy or prioritization on its own.

Instead, we believe that the data collectively suggest that experts' rankings are informed by their pre-existing subjectivities or biases--specifically the theory of change they believe will be most effective in their local ecological and sociopolitical context. In research on social psychology and anthropology the four theories of change evident in the data would likely be referred to as "discourses" (Barry and Proops, 1999); we are electing to use the term "theory of change" both because it is a more easily relatable term to people working in this area and also because we believe that theories of change are a specific kind of social discourse that are particularly important to understand in the context of social movements for sustainability and food system transformation. That is to say, these four theories of change are exemplars of the oft-unstated assumptions about the causes of food systems problems and the "right" way to solve them.

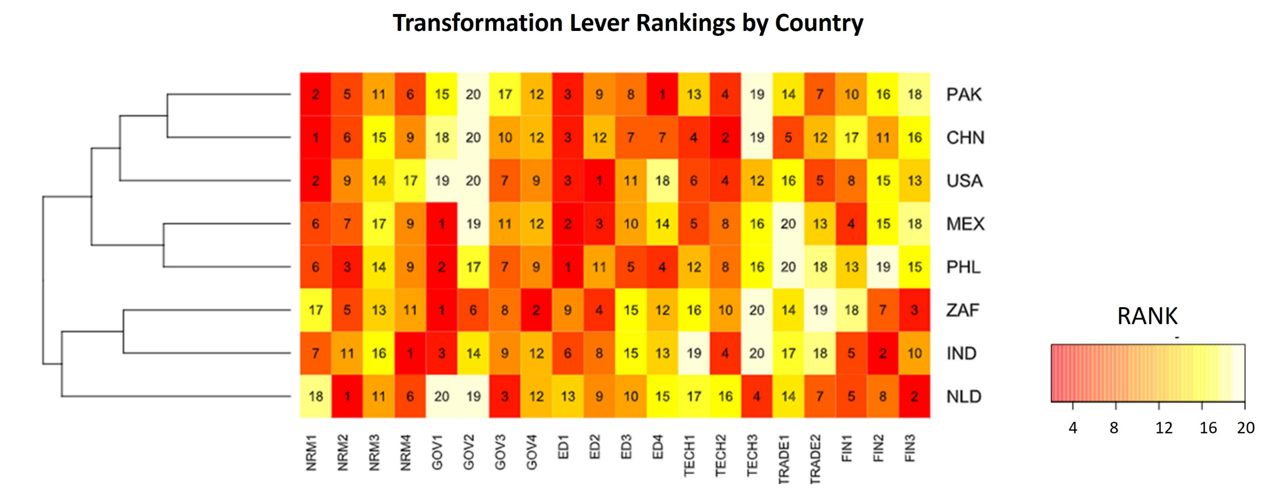

FIGURE 3
Experts' rankings of transformation levers varies by country. Lever abbreviations are defined in Table 1. Countries ordered by similarly of rankings using hierarchical cluster analysis.

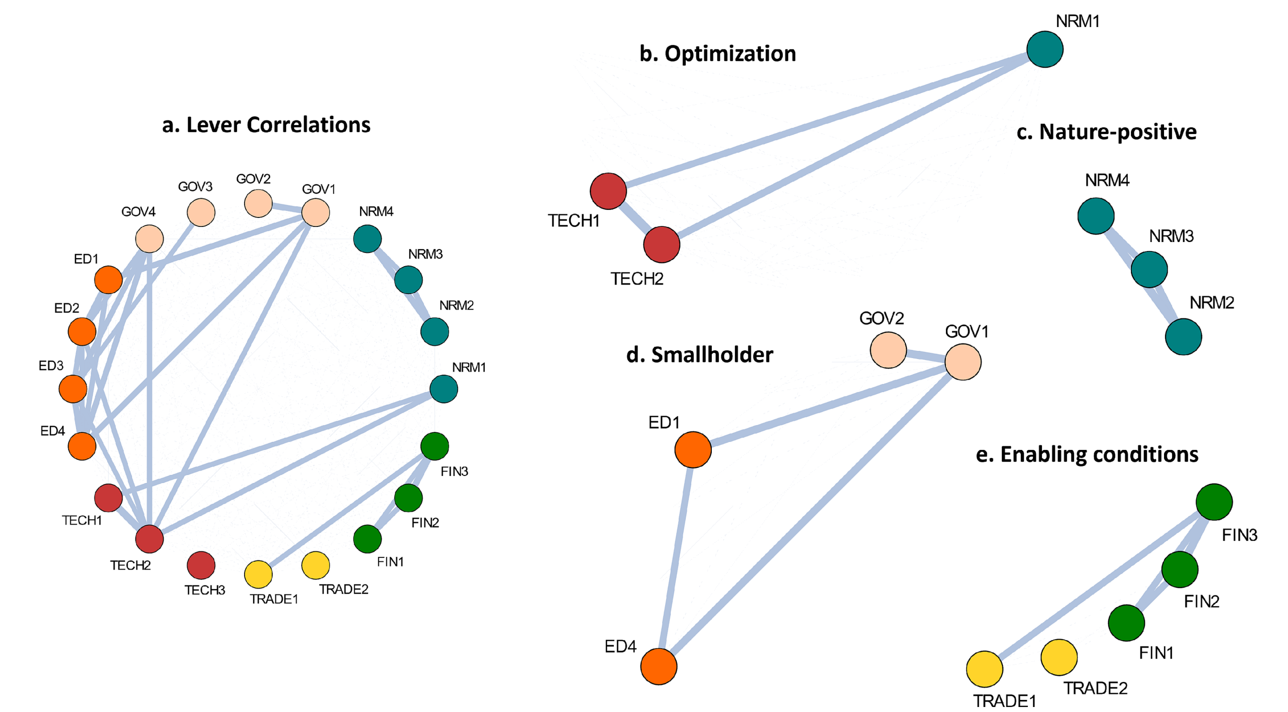

FIGURE 4
Distinct theories of change are evident in lever correlations. Network diagrams visualizing correlations among transformation levers for all experts: (a) within lever groups; (b) for the optimization theory of change; (c) for the nature-positive theory of change; (d) for the smallholder theory of change; and (e) for the enabling conditions theory of change. Nodes in (b–e) are shown where factor loading is >0.4 and ties are only visualized for correlations with $r >= 0.4$ and $p < 0.01$.

No doubt, the four theories of change evident in this work will be easily recognized by those working in food systems, and may be framed as "biases" that different experts have, e.g., toward ecomodernist, degrowth, or anticolonial framings (Thompson, 2017). While they are not necessarily mutually exclusive, they do often align with the opposing camps in long-standing debates over food system reform, for example the debate between land sparing and land sharing (Chappell and LaValle, 2011; Fischer et al., 2014). The so-called "land sparing" philosophy of food system reform, which argues that we need to increase efficiencies and move away from animal proteins to shrink the agricultural footprint and put more land aside for nature, aligns most with ToC1—transformation via optimization. The land-sharing philosophy, by comparison, which argues for transitions to cropping practices that work with natural ecosystems, i.e., agroecology. Aligns mostly with ToC3—nature positive transformation—and ToC2—transformation via smallholder support.

In sum, we see three policy-relevant take-aways of this work. The first is that we offer a look "under the hood" so to speak of the biases that inform expert preferences for food systems interventions. That is, expert knowledge is not only limited to the scope of the experts' field of study and lifelong experience, but also influenced by prevailing narratives in their country, the field, and the agendas they come to the table with. The politics inherent to these opinions is an undeniable but rarely scrutinized fact, and the stark differences in sentiment among experts from different countries underscores the importance of recognizing how politics infiltrates the science of transformation and the recommendations of scientific experts. Nevertheless, it would be a mistake to interpret these biases that as undermining the validity of expert opinions entirely. Rather, we recommend instead considering the four theories of change identified here as informed assessments that are inherently contextual, likely political, but nevertheless exhibit systems thinking by linking multiple levers in a coherent, shared strategy.

Setting aside for now the possibility that some experts may have responded in a way that reflects political influence or promotes specific special interests, we should expect that expert priorities and preferences will draw from a variety of forms of academic knowledge and practical experience (Davis and Wagner, 2003): not just the science they are aware of but also their knowledge of local history, their sensitivity to political realities, and their commitments to cultural sensitivity and plurality as they make and justify their recommendations. We rely on experts to translate science into practice at the local scale; policymakers and funders must be wary of leaning too heavily on science *alone* to provide guidance when making decisions. Decisions about our food systems are inherently value-laden, culturally esoteric, and heavily influenced by local ecologies, markets and politics. Given the urgency of challenges like climate change, climate action is at risk of becoming climate colonialism if local agency and the right to self-determination take a second seat to the agendas and priorities of international actors, regardless of how science-based those agendas purport to be (Sultana, 2022).

Another way to interpret the four theories of change is that experts are adopting a holistic, food system perspective rather than focusing on single interventions. As noted in the results section, all but the nature-positive theories of change involve levers from more than one lever category, indicating that experts see these strategies as multifaceted. More conversation and research are necessary to explore whether experts working from a nature-positive theory of change could do more to explicitly incorporate the complementary role of interventions in other categories (Table 3).

Next, our work highlights the importance of developing multi-stakeholder collaborations and interdisciplinary assessments of potential food systems interventions. Navigating differences among experts who start from different theories of change can be challenging but also offers opportunities for developing strategies that bring multiple solutions and ways of knowing to bear. To reconcile differing theories of change, it is crucial to create inclusive and interdisciplinary platforms that facilitate continuous dialogue and collaboration among outside experts and expert stakeholders. These could include committees or working groups that include representatives from different sectors (e.g., smallholders, industry leaders, scientists, policymakers, civil society, and so on). And to facilitate learning and growth, the goal of such collaborations should be not to identify a single "best" solution but flexible portfolios of strategies that accommodate multiple theories of change to promote multiple objectives or co-benefits simultaneously. This could include the use of adaptive management, which involves ongoing monitoring, evaluation, and adjustment of policies based on feedback and changing conditions.

Third, there are still many opportunities to strengthen the scientific basis for decision-making and encourage cross-sectoral research to bridge gaps between different theories of change. Building evidence can build consensus; several transformation levers that are ranked high by experts were ranked as having weak science, specifically finance and education levers. These two categories of levers are critical from a systems-change perspective, in that they target deeper and ostensibly harder to change features of the system that, if changed, could accelerate progress toward positive tipping points (Abson et al., 2017). Promoting the use of robust, evidence-based assessments to highlight the benefits and trade-offs of different approaches can contribute to a shared, data-driven understanding, help align rightsholders and stakeholders around common goals, and perhaps even facilitate greater consensus on the most effective strategies. But we also caution that that attention to science evidence is not a substitute for addressing the power inequities that are arguably at the root of the many global challenges we wish to redress.

We are amid a paradigm shift in how society thinks about the relationships among food, technology, and development. Prevailing

TABLE 3 Our interpretation of the four theories of change that are evident in the factor analysis of respondents' preferences regarding transformation levers.

Theory of change	Description	Dominant levers
Optimization	This theory of change emphasizes developing new technologies and practices that increase efficiency and productivity of existing cropping systems and supply chains, with the goal generally being to reduce the overall footprint of agriculture.	NRM1, TECH1, TECH2
Smallholder support	This theory of change emphasizes transforming food systems by supporting smallholder agency, rights, and self-determination, including through extension, science, and support for traditional food cultures	GOV1, GOV2, ED1, ED4
Nature positive	This theory of change emphasizes on-farm practices that enhance wild biodiversity, carbon sequestration, and promote agrobiodiversity	NRM2, NRM3, NRM4
Enabling conditions	This theory of change emphasizes markets, financial strategies, and trade policies that create conditions that enable food systems actors, from farmers to consumer, to adopt new practices.	TRADE1, TRADE2, FIN1, FIN2, FIN3

See Table 1 for explanation of lever abbreviations.

wisdom about how best to remake and reimagine food systems is still heavily anchored to old ways of thinking about food problems and their solutions, that is, in terms of production, technology, and efficiency. We believe that the expert sentiments and preferences we elicited in this research paint a portrait of experts actively trying to adopt a more systems-oriented perspective, attempting to bring local contextual wisdom and experience into conversations that historically have been dominated by science and technologies that are a-contextual. Importantly, this reframing also introduces new and sometimes conflicting normative positions related to human behavior, human rights, and economic development. We believe these messy aspects of food system transformation are unavoidable, and hope by unpacking them here we have opened a conversation about how to navigate this messiness in practice.

Limitations

We did not undertake this study to identify generalizable statements about the current state of attitudes or perceptions of all food systems experts working in these eight nations, but to find insights that can inform how we understand larger patterns of thinking and conflict in discussions around food systems transformation. The four theories of change presented here, for example, are not comprehensive of all possible theories of change that might be influencing experts' preferences and opinions. However, the finding that expert subjectivities are heavily informed by one or more theories of change of the nature of the four identified here is an important and generalizable finding. We did not attempt, given that our design and sampling strategy would not support such questions, explore whether the likelihood of an expert thinking with a specific theory of change correlates with their characteristics, i.e., sector, gender, country, and recommend this for future research.

Other possible limitations to our findings could derive from misunderstandings or differences in understandings of terms and jargon. By opting to not define terms for the reasons noted in the methods, and because the survey was also performed in translation, there is a possibility that some respondents answered and ranked transformation levers with different kinds of interventions in mind. However, given the steps we took in our one-on-one interviews to calibrate our interpretation of the survey results we believe that this risk is minimal. Another limitation is that the previous selection of the 20 chosen transformation levers from the 42 initially identified by Hawkes and colleagues may be missing levers that are important in specific locales. The subset of the 20 was vetted and refined through community input in previous work by members of our writing team, but could nevertheless carry institutional or place-based biases regarding the appropriate logic or scale of strategies (WWF, 2022). For example, these are all country-level interventions, and in social movements, action by local and trans-local communities of practice can also be important and effective (Motta, 2021; Amo, 2023). This is why, above, we concede that the four theories of change we identify here are not comprehensive to all possible theories of change; many of them also leave a lot unsaid about how they disrupt or reinforce inequities and power dynamics. Understanding food systems change from a multi-level perspective and bringing in concepts from political ecology related to activism, alterity, and power, is critical as we continue to explore how best to envision and achieve food systems that ethical, sustainable, and just.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation upon request to the corresponding author.

Ethics statement

The requirement of ethical approval was waived by Word Wildlife Fund International for the studies involving humans. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

PL: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. BL: Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Visualization, Writing – review & editing. IB: Formal analysis, Writing – review & editing. AD: Project administration, Writing – review & editing. ATo: Project administration, Writing – review & editing. SF: Methodology, Project administration, Writing – review & editing. MM-R: Investigation, Validation, Writing – review & editing. LS: Writing – review & editing. ATa: Data curation, Project administration, Writing – review & editing. CD: Investigation, Methodology, Project administration, Writing – review & editing. GU: Project administration, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1479865/full#supplementary-material

References

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., et al. (2017). Leverage points for sustainability transformation. *Ambio* 46, 30–39. doi: 10.1007/s13280-016-0800-y

Agar, M. (2013). The lively science: Remodeling human social research. Maitland, FL: Mill City Press.

Amo, E. (2023). The slow food movement and the Terra-Madre project: food sovereignty and translocal assemblages. *Globalizations* 20, 644–660. doi: 10.1080/14747731.2022.2149158

Barry, J., and Proops, J. (1999). Seeking sustainability discourses with Q methodology. *Ecol. Econ.* 28, 337–345. doi: 10.1016/S0921-8009(98)00053-6

Béné, C. (2022). Why the great food transformation may not happen – a deep-dive into our food systems' political economy, controversies and politics of evidence. *World Dev.* 154:105881. doi: 10.1016/j.worlddev.2022.105881

Béné, C., Oosterveer, P., Lamotte, L., Brouwer, I. D., de Haan, S., Prager, S. D., et al. (2019). When food systems meet sustainability – current narratives and implications for actions. *World Dev.* 113, 116–130. doi: 10.1016/j.worlddev.2018.08.011

Bennett, E. M., Baird, J., Baulch, H., Chaplin-Kramer, R., Fraser, E. D. G., Loring, P. A., et al. (2021). "Ecosystem services and the resilience of agricultural landscapes," in The future of agricultural landscapes, part II, eds. D. A. Bohan and BergenA. J. Van (London, UK: Elsevier), 1–43.

Chappell, M. J., and LaValle, L. A. (2011). Food security and biodiversity: can we have both? An agroecological analysis. *Agric. Hum. Values* 28, 3–26. doi: 10.1007/s10460-009-9251-4

Clapp, J. (2021). Explaining growing glyphosate use: the political economy of herbicide-dependent agriculture. *Glob. Environ. Chang.* 67:102239. doi: 10.1016/j.gloenvcha.2021.102239

Clapp, J., and Fuchs, D. A. (2009). Corporate power in global Agrifood governance: Cambridge, MA, US: MIT Press.

Davis, A., and Wagner, J. R. (2003). Who knows? On the importance of identifying "experts" when researching local ecological knowledge. *Hum. Ecol.* 31, 463–489. doi: 10.1023/A:1025075923297

Dinesh, D., Hegger, D. L. T., Klerkx, L., Vervoort, J., Campbell, B. M., and Driessen, P. P. J. (2021). Enacting theories of change for food systems transformation under climate change. *Glob. Food Secur.* 31:100583. doi: 10.1016/j.gfs.2021.100583

Dornelles, A. Z., Boonstra, W. J., Delabre, I., Denney, J. M., Nunes, R. J., Jentsch, A., et al. (2022). Transformation archetypes in global food systems. *Sustain. Sci.* 17, 1827–1840. doi: 10.1007/s11625-022-01102-5

Downs, S. M., Ahmed, S., Fanzo, J., and Herforth, A. (2020). Food environment typology: advancing an expanded definition, framework, and methodological approach for improved characterization of wild, cultivated, and built food environments toward sustainable diets. *Food Secur.* 9:532. doi: 10.3390/foods9040532

Eden, S., Donaldson, A., and Walker, G. (2005). Structuring subjectivities? Using Q methodology in human geography. *Area* 37, 413–422. doi: 10.1111/j.1475-4762.2005.00641.x

Figueroa-Helland, L., Thomas, C., and Aguilera, A. P. (2018). Decolonizing food systems: food sovereignty, indigenous revitalization, and agroecology as counter-hegemonic movements. *Perspect. Glob. Dev. Technol.* 17, 173–201. doi: 10.1163/15691497-12341473

Fischer, J., Abson, D. J., Butsic, V., Chappell, M. J., Ekroos, J., Hanspach, J., et al. (2014). Land sparing versus land sharing: moving forward. *Conserv. Lett.* 7, 149–157. doi: 10.1111/conl.12084

Flachs, A. (2020). Political ecology and the industrial food system. *Physiol. Behav.* 220:112872. doi: 10.1016/j.physbeh.2020.112872

Fowler, F. J., and Mangione, T. W. (1990). Standardized survey interviewing. Newbury Park, CA, US: SAGE Publications.

Fraser, E. D. G., Legwegoh, A., Krishna, K., CoDyre, M., Dias, G., Hazen, S., et al. (2016). Biotechnology or organic? Extensive or intensive? Global or local? A critical review of potential pathways to resolve the global food crisis. *Trends Food Sci. Technol.* 48, 78–87. doi: 10.1016/j.tifs.2015.11.006

Goulart, F. F., Chappell, M. J., Mertens, F., and Soares-Filho, B. (2023). Sparing or expanding? The effects of agricultural yields on farm expansion and deforestation in the tropics. *Biodivers. Conserv.* 32, 1089–1104. doi: 10.1007/s10531-022-02540-4

Graddy-Lovelace, G., and Roman-Alcalá, A. (2024). Agroecology beyond the statist quo? Transforming U.S. imperial agricultural policy. *J. Agric. Food Syst. Commun. Dev.* 13, 1–7. doi: 10.5304/jafscd.2024.133.008

Harrison, H. L., and Loring, P. A. (2020). Seeing beneath disputes: a transdisciplinary framework for diagnosing complex conservation conflicts. *Biol. Conserv.* 248:108670. doi: 10.1016/j.biocon.2020.108670

Hawkes, C., Walton, S., Haddad, L., and Fanzo, J. (2020). 42 policies and actions to orient food systems towards healthier diets for all. London, UK: Centre for Food Policy, City University of London.

Howard, P. H. (2022). Cellular agriculture will reinforce power asymmetries in food systems. *Nat. Food* 3, 798–800. doi: 10.1038/s43016-022-00609-5

Loken, B. (2023). Closing the gaps: Scaling national-level action on food system transformation. Gland, Switzerland: WWF.

Loring, P. A. (2021). The imperative to transform global food systems. *Can. Food Stud. Rev. Can. Études Sur Aliment* 8:8. doi: 10.15353/cfs-rcea.v8i3.561

Loring, P. A., and Gerlach, S. C. (2009). Food, culture, and human health in Alaska: an integrative health approach to food security. *Environ. Sci. Pol.* 12, 466–478. doi: 10.1016/j.envsci.2008.10.006

Loring, P. A., and Sanyal, P. (2021). Indicators of complexity and over-complexification in global food systems. *Front. Sustain. Food Syst.* 5:431. doi: 10.3389/fsufs.2021.683100

Marshall, Q., Fanzo, J., Barrett, C. B., Jones, A. D., Herforth, A., and McLaren, R. (2021). Building a global food systems typology: a new tool for reducing complexity in food systems analysis. *Front. Sustain. Food Syst.* 5:746512. doi: 10.3389/fsufs.2021.746512

McEvoy, J., Gilbertz, S. J., Anderson, M. B., Ormerod, K. J., and Bergmann, N. T. (2017). Cultural theory of risk as a heuristic for understanding perceptions of oil and gas development in Eastern Montana, USA. *Extr. Ind. Soc* 4, 852–859. doi: 10.1016/j.exis.2017.10.004

Motta, R. (2021). Social movements as agents of change: fighting intersectional food inequalities, building food as webs of life. *Sociol. Rev.* 69, 603–625. doi: 10.1177/00380261211009061

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Adv. Health Sci. Educ.* 15, 625–632. doi: 10.1007/s10459-010-9222-y

Poelman, M. P., Wopereis, T., Wierda, J., Rongen, F., and Dijkstra, S. C. (2023). Systems dynamics for healthy and sustainable local food environments. *Eur. J. Pub. Health* 33:944. doi: 10.1093/eurpub/ckad160.944

R Development Core Team (2021). R: A language and environment for statistical computing. Available at: https://www.R-project.org/

Rockström, J., Edenhofer, O., Gaertner, J., and DeClerck, F. (2020). Planet-proofing the global food system. *Nat. Food* 1, 3–5. doi: 10.1038/s43016-019-0010-4

Rotz, S., and Fraser, E. D. G. (2015). Resilience and the industrial food system: analyzing the impacts of agricultural industrialization on food system vulnerability. *J. Environ. Stud. Sci.* 5, 459–473. doi: 10.1007/s13412-015-0277-1

Rotz, S., Fraser, E. D. G., and Martin, R. C. (2019). Situating tenure, capital and finance in farmland relations: implications for stewardship and agroecological health in Ontario, Canada. *J. Peasant Stud.* 46, 142–164. doi: 10.1080/03066150.2017.1351953

Sandelowski, M. (1998). The call to experts in qualitative research. *Res. Nurs. Health* 21, 467–471. doi: 10.1002/(SICI)1098-240X(199810)21:5<467::AID-NUR9>3.0.CO;2-L

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., et al. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Qual. Quant.* 52, 1893–1907. doi: 10.1007/s11135-017-0574-8

Schneider, K. R., Fanzo, J., Haddad, L., Herrero, M., Moncayo, J. R., Herforth, A., et al. (2023). The state of food systems worldwide in the countdown to 2030. *Nat. Food* 4, 1090–1110. doi: 10.1038/s43016-023-00885-9

Stein, D., and Valters, C. (2012). Understanding theory of change in international development. London, UK: Justice and Security Research Programme, International Development Department, London School of Economics and Political Science.

Stephens, P., and Clapp, J. (2020). "Financing food system regeneration?: the potential of social finance in the agrifood sector" in J. Duncan, M. Carolan and J. S.C. Wiskerke (Eds). Routledge handbook of sustainable and regenerative food systems (London, UK: Routledge).

Stone, G. D. (2019). Commentary: new histories of the Indian green revolution. *Geogr. J.* 185, 243–250. doi: 10.1111/geoj.12297

Sultana, F. (2022). The unbearable heaviness of climate coloniality. *Polit. Geogr.* 99:102638. doi: 10.1016/j.polgeo.2022.102638

Thompson, P. B. (2017). Spirit of the soil: Agriculture and environmental ethics. *2nd* Edn. New York: Routledge.

Thompson, M., Ellis, R., and Wildavsky, A. (1990). Cultural theory. CO, US: Westview Press.

Thornton, P., Schuetz, T., Förch, W., Cramer, L., Abreu, D., Vermeulen, S., et al. (2017). Responding to global change: a theory of change approach to making agricultural research for development outcome-based. *Agric. Syst.* 152, 145–153. doi: 10.1016/j.agsy.2017.01.005

Tittonell, P., El Mujtar, V., Felix, G., Kebede, Y., Laborda, L., Luján Soto, R., et al. (2022). Regenerative agriculture—agroecology without politics? *Front. Sustain. Food Syst.* 6:844261. doi: 10.3389/fsufs.2022.844261

United Nations (2023). UN secretary-general call to action. UNFoodSystems. Available at: https://www.unfoodsystemshub.org/fs-stocktaking-moment/documentation/un-secretary-general-call-to-action/en (Accessed April 1, 2024).

Dooren, C.Van, Loken, B., Lang, T., Meltzer, H. M., Halevy, S., Neven, L., et al. (2024). The planet on our plates: approaches to incorporate environmental sustainability within food-based dietary guidelines. *Front. Nutr.* 11,:1223814. doi: 10.3389/fnut.2024.1223814

VERBI Software (2024). MaxQDA.

Via Campesina (2007). Nyéléni Declaration Sélingué, Mali: Forum for Food Sovereignty. Available at: http://www.foodandwaterwatch.org/world/global-trade/NyeleniDeclaration-en.pdf/view

Vogel, I. (2012). Review of the use of 'theory of Change'in international development. Review Report. UK Department of International Development.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., et al. (2019). Food in the Anthropocene: the EAT–lancet commission on healthy diets from sustainable food systems. *Lancet* 393, 447–492. doi: 10.1016/S0140-6736(18)31788-4

WWF (2022). Solving the great food puzzle: 20 levers to scale national action. Gland, Switzerland: World Wildlife Fund.

WWF (2023). Solving the great food puzzle: Right innovation, right impact, right place. Gland, Switzerland: WWF.