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Commentary

Shortcuts for accelerating food system transitions

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In light of ongoing global challenges of health, climate change, and food security, there is urgent need to transform our food systems. Here, we call for stakeholders to leverage collective wisdom garnered from more than two decades of sustainability transitions research into developing and implementing systemic approaches to shortcut theory to action and accelerate the transformation of global food systems.

Findings from the United Nations (UN) Food Systems Summit 2021, dialogues in the Food Systems Summit +2, and the most recent UN Climate Change Conference in 2023 articulate the need for transitions in food systems to deliver human health and wellbeing while maintaining the stability of the Earth system. The urgency for this transition is highlighted by rising food insecurity, the cost-of-living crisis, and the exceedance of several Earth system boundaries, including climate change and freshwater use, across more than half of the global land area.[1] Globally, scientists and policymakers are working to address this urgent need, for instance in the European Union's Farm to Fork Strategy[2] and the Roadmap to Reshape Australia's Food Systems.[3] They argue for immediate change through a whole-systems approach that moves beyond siloes with holistic thinking that considers the web of relations across different stakeholders, scales, interventions, and value chain stages.[3]

Systemic change will never be straightforward because global food systems are inherently complex. Feeding the world's 8 billion people via globally interconnected markets and supply chains involves innumerable stakeholders with their own respective roles in the production, processing, distribution, marketing, and consumption of food. Furthermore, multiple persistent challenges impede whole-systems change.

Our complex food systems

The many interdependent parts of our complex food systems span from agricultural inputs (e.g., fertilizer), production, processing, manufacturing, transport, distribution, and marketing of food, to consumption and waste[4] (Figure 1). Although these components form (value) chains, each link often operates independently. Consequently, difficulties at any point or dimension can hinder change. Illustrating socioeconomic drivers, a food processing factory's investment in older technology can hamper uptake of new technology in distribution and retail. Biophysical drivers like heatwaves produced by climate change affect yields, impacting consumers. All parts are interconnected and drivers' effects flow across the system. Even well-intentioned change can result in negative impacts elsewhere. For example, intensification and homogenization of agriculture initially designed to increase yield and thus food supply can lead to soil degradation, which in turn can negatively impact yields. The complexity of these drivers and their interactions with different parts of food systems make them highly dynamic, sometimes resulting in unintended outcomes for food security, nutrition and health, livelihoods, the environment, and the economy. However, if considered holistically these same drivers can progress change. The inherent complexity of the food system sets the context for the challenges of pursuing change.

Triple challenge of change

Three common transition challenges and the ways they play out within food system complexities impede transformations. Firstly, investment in the existing system makes change untenable, creating resistance. Secondly, narrow focus on technologies and practices may ignore aspects that a given solution may need to succeed but can also negatively impact the rest of the system. Thirdly, ambitious solutions—particularly those that require rapid, widespread, and significant changes—are frequently unfeasible. We further discuss these three challenges.

Lock-in and resistance to change

The first challenge for transitions is the resistance to transformative change that keeps food systems *locked-in* to unsustainable practices. This prevents change and innovations like new agricultural practices from being implemented at scale. For example, large-scale and uniform food production for mass markets, linked to almost 80% of global deforestation and 70% of freshwater use in recent decades,[5] demands high volumes and intensifying yields of commodity products at ever lower costs. Four transnational corporations, which control about 70% of the worldwide agrochemicals market and nearly 90% of the global grain trade, dominate food systems and have significant financial incentives to maintain existing unsustainable practices, which creates path dependency and push back against change. This model and its

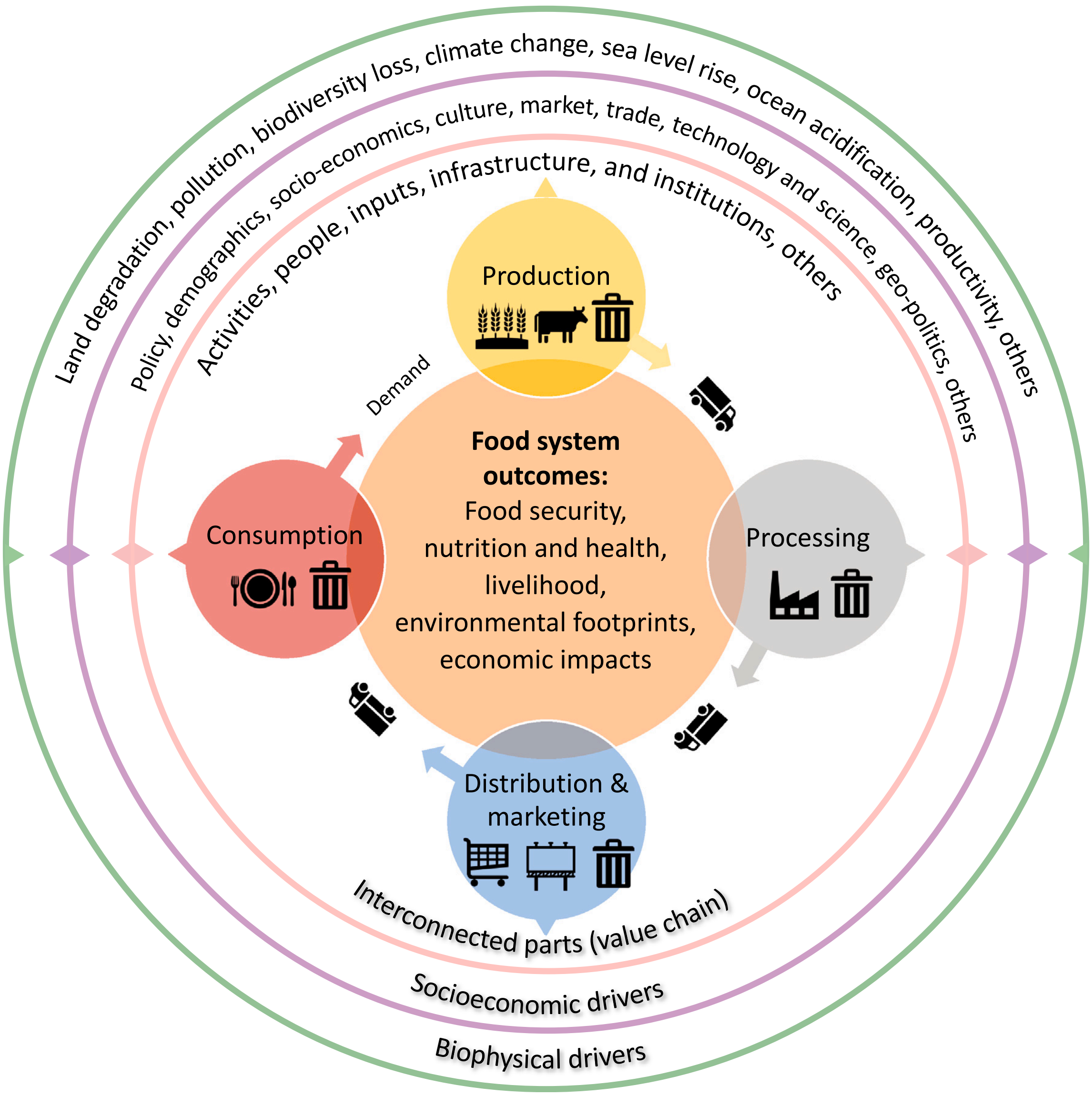

Figure 1. A conceptualization of food systems showing interconnected parts, outcomes, and drivers
Arrows within and between circles indicate flows and interconnected parts of the system.

dynamics constrain opportunities for more sustainable alternatives, among them regenerative approaches such as decreasing use of chemical fertilizers and locks in current approaches to production in food systems.

Narrow focus on optimal technology and practice

The second transition challenge is that narrow pathways, like technological interventions seeking to optimize farming practices, can have unintended consequences. The Green Revolution of the 1960s is one example.[6] The Green Revolution primarily focused on technological research and development, such as crop genetics for productivity increases, with the premise of addressing poverty and food insecurity in developing countries. However, later evidence showed that companies and national governments could not sustain investment and operationalization, in part due to huge geographic disparities and inadequate capacity to absorb novel technologies.[6] Moreover, despite positive impacts in productivity and agricultural outputs (e.g., 208% average yield increase for wheat in developing countries between 1960 and 2000[6]), some social inequities were exacerbated by technology transfer that largely concentrated on male farmers, overlooking women's social conditions, issues of caste, and patterns of land ownership. The technology-focused interventions also created issues through water use, soil degradation, and fertilizer runoff.

Limited feasibility of ambitious solutions

Feasibility, defined as implementation potential under realistic assumptions, represents another challenge in scaling sustainable food systems. Feasibility will reflect the maturity of a food system practice, but it also involves public acceptance, institutional capacity, political tenability, and geophysical potential

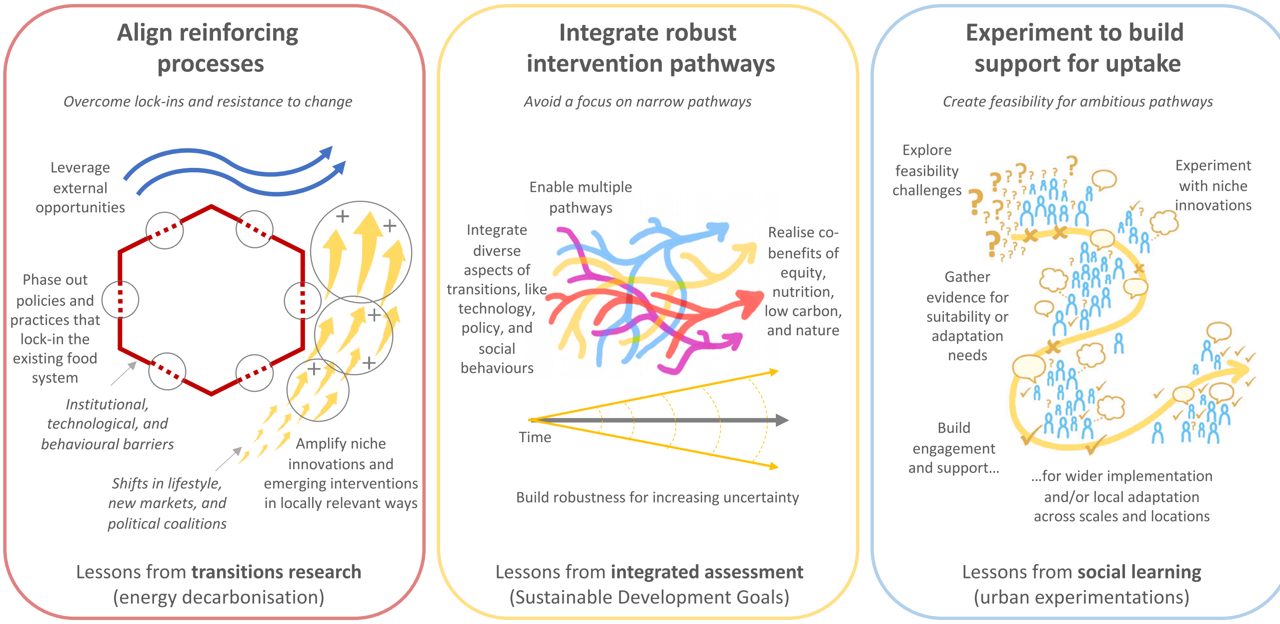

Figure 2. Overview of challenges and lessons from the broader sustainability transitions research to address them

(e.g., land availability). For example, research shows that food system transitions through diet change will require significant reduction in unhealthy high-level consumption of some foods by 2050.[7] The technical potential of diet change has been extensively explored through various options, including developing plant-based meat replacements, lab-grown meat, and taxation. If this broad-scale diet change is realized, significant outcomes for sustainability and human health could be achieved, among them avoiding about 10.8–11.6 million deaths per year.[7] However, achieving these outcomes depends on rapid behavioral change in the eating habits of *billions* of people whilst overcoming strong cultural and social norms around diets (e.g., association of meat with wealth). When feasibility aspects are factored in, the technical potential of diet change as a food system transition option is not sufficient alone to bring about sustainability.

Navigating transitions in food systems becomes exceedingly difficult when confronted with the triple challenges of change resistance, narrow technological focus, and feasibility. We can look to other contexts to learn how to address these complex challenges, to shortcut theory to action, and deepen the transformative power of food systems in a limited time (Figure 2).

Three transition lessons for food

Sustainability transitions are studied across diverse disciplines.[8] Here, we present lessons for whole-systems change from the fields of transitions research, integrated assessment, and social learning that respectively address the three challenges named here—resistance to change, a narrow pathway focus, and feasibility. We then describe how these lessons can be applied to food system transitions.

Lesson 1: Align reinforcing processes

Learnings from the field of transitions research in the context of energy decarbonization can help overcome lock-ins and resistance to change. One lesson is the role of an enabling context, i.e., how phasing out unsustainable systems while preparing stimulating conditions for new systems can drive change.[9] This "alignment of reinforcing processes" is demonstrated in German energy transitions, where technological progress played an instrumental role in the rapid uptake of renewable energy, but was not the only factor.[9] Transition was accelerated by a supportive surrounding context, jointly shaped by government policy stimulus (e.g., attractive feed-in tariffs) and economic incentivization of industrial coalitions (e.g., wind turbine manufacturers). Transition was also catalyzed by the phase-out of nuclear power due to significant public and political opposition and external shocks from the 2011 Fukushima nuclear accident.

Food system transitions likewise require multiple processes to co-align in a way that reinforces and then catalyzes further change, including overcoming economic barriers and dependency on industrial agriculture, changing policies that perpetuate unsustainable food systems, while harnessing emerging interventions such as shifts in lifestyle, new markets, and political coalitions. The diverse settings in which food systems operate necessitate timely and place-based interventions, specific to local and regional aspirations, resources available, and different cultural, political, and biophysical environments. An example of transitioning for affordable and healthy diets comes from Tajikistan where conditions have been established to favor traditional agricultural systems so that more than half of its population has access to affordable healthy diets.[10] Multiple processes there helped destabilize unsustainable practices, such as land reform in late 1990s that enabled more equal distribution of farm sizes, with a co-benefit of increased productivity and household income, and easing of international agricultural trade barriers for stable crops, contributing to price stability. The shift was reinforced by emerging interventions that supported healthy diets, such as the government's social safety net program for school meals benefitting a significant percent of the population.[10]

Lesson 2: Integrate robust intervention pathways

Learnings from the field of integrated assessment illuminate the limitations of narrow pathways and solutions. One example comes from efforts over the last decade to implement the Sustainable Development Goals (SDGs). SDGs represent standalone goals, but the 2023 Global Sustainable Development Report indicates evidence of spillovers, i.e., synergies and trade-offs[11] across the SDGs, revealing the complexity of transitions in how interlinked SDGs require integrated changes in technology, policy, and societal behaviors. These same interconnections can amplify risks (e.g., cost-of-living crisis, war in Ukraine), underscoring the need for robustness and adaptability, so pathways and solutions can endure long-term uncertainties.[11]

Food systems can learn from the complexities revealed by the SDGs. For instance, there are diverse food system transition initiatives, like developing technological innovations (e.g., feed conversion efficiency), building circular food networks (e.g., reusing food waste), and shifting diets (e.g., reducing animal protein intake).[12] Food systems need diverse transition pathways, but these pathways need to be coordinated with sectors beyond food to integrate health, finance, labor, trade, and resources to realize benefits and mitigate unintended consequences. Although this may seem difficult to imagine (and harder to achieve), there are examples of integrated assessment processes that cut across sectors, for example, to design robust and synergistic pathways that flow through multiple energy, food, and agriculture sectors to eradicate poverty while simultaneously reducing environmental pressures.[13]

Integrating intervention pathways for food systems can face barriers such as limited connection across jurisdictions, levels of government, and policy domains of food and other sectors. Some of these barriers are currently being addressed elsewhere. One example is "Food: Locally Embedded, Globally Engaged Partnership" in Canada, which sought to align different policy domains in support of an integrated change. Extending this idea, coordinating and communicating between various (e.g., agricultural, economic, industrial, environmental) programs and government bodies that often operate in silos or at different levels can help shape a unified policy landscape for food system transitions in relation to other sectors.

To ensure robustness, pathways in food systems also need to be prepared to adjust to changing conditions and future uncertainties. A range of decision and planning tools from integrated assessment and areas like climate change adaptation can support the design of adaptive pathways for food systems to improve durability through future systemic risks and viability long term.[14]

Lesson 3: Experiment to build support for uptake

The experience of transition in cities (e.g., urban living labs, grassroot experiments), as informed by social learning processes, demonstrates how experimentation can help answer if and under what conditions intervention pathways are feasible (technologically, economically) and meaningful (socially, politically). There are a large number of urban experiment sites across Europe for social learning and exploration of barriers constraining innovations, like smart city initiatives and urban adaption to climate change.[15] The project "Action-Oriented Research on Planning, Regulation, and Investment Dilemmas in a Living Lab Experience" (APRILab) explored political challenges around intervention, regulation, and investment (e.g., related to urban intensification and segregation) in multiple cities (e.g., Copenhagen, Amsterdam) and offered guidelines for how stakeholder engagements and learning processes can inform transition planning.[15]

Likewise, food systems can experiment with intervention pathways to gather evidence on suitability in practice and build support for wider rollout. This can mean experimenting with farming models (e.g., agroecological systems), new technologies (e.g., food processing to improve nutritional quality), policy tools (e.g., taxing certain foods), business/partnership models (e.g., blockchain-based platforms for farmer-to-consumer direct sales), and finance mechanisms (e.g., mobilizing private capital through Food Finance Architecture). The development of the organic foods niche during the 1990s is an example of experimentation and learning.[16] Through experimentation, businesses learnt about consumer demand, preferences, and motives. This uncovered the need to educate consumers to justify higher prices and led to positioning organic foods in relation to health and environmental benefits. Supermarkets better understood supply chain dynamics like seasonality and cross-contamination from non-organic foods and identified ways to manage these.

While experimentation in the urban context involves specific geographies and sectors, experimentation in global food systems can have simultaneously vast and micro-local scope, involving diverse stakeholders and places. Transdisciplinary partnerships and governance can help promote agency and enable experimentation in complex food systems by informing who does what, when, and through which means across scales and value chains. There are examples of food-related partnerships and hybrid governance arrangements among fisherfolk organizations in the Philippines and cooperative farming areas in Ethiopia that provide learning about agency, collaborative experimentation, and realizing change.[17]

Next steps

The three lessons for accelerating food system change presented in this paper reflect learning from different experiences and approaches to transition in the broader sustainability context. They can shortcut theory to action in food systems. However, there are more shortcuts to be found. This analysis drew from diverse bodies of knowledge and represents the tip of an iceberg. We see an opportunity for a more comprehensive review of successes and limitations of past sustainability transition efforts through the lens of different disciplines to assemble a knowledge hub that can deepen our understanding and analytical perspectives for food system change. This area of research will help locate pathways for transitions toward more sustainable, healthy, and equitable food systems.

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DECLARATION OF INTERESTS

The authors declare no competing interests.

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