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COMMENTARY

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# A new convergent science framework for food system sustainability in an uncertain climate

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**Abstract**

The complexity and interconnectivity of food systems and climate requires new thinking and research designs that better address the real-world challenges of securing the resilience and sustainability of human and environmental systems. Central to such an approach is coherent action across sectors and scales. Although inter-and transdisciplinary approaches are widely discussed, no convergence model exists to detect and prepare for food system vulnerabilities emerging from disruptions in climate systems, or to address the contributions to climate change from food system functions. Convergence research is critical to solving these vexing dynamics by integrating knowledge from multiple scientific domains to inform societal action. Here, we present a new convergent science model that incorporates four key components at the global, national and local level. Through the newly created Food and Climate Systems Transformation Alliance, we are now operationalizing, testing and refining the model to promote science convergence for tackling systemic vulnerabilities in the current food paradigm. Globally, funding relating to climate change and food systems transformation needs to pivot to support the levels of ambition, magnitude of need and complexity of challenges posed.

**KEYWORDS**
climate change, convergence, food systems, transformation, vulnerability



## 1 | INTRODUCTION

The multidirectional links among climate change, food systems and human health underpin some of the greatest challenges facing policymakers today. Food systems *alone* account for roughly one-third of global anthropogenic GHG emissions (Crippa et al., 2021). These emissions could push global average temperatures past the 1.5°C threshold of the Paris Accords (Clark et al., 2020). At the same time, environmental shocks linked to climate change are impacting food output which, coupled with political, health and economic shocks, made roughly 12% of the entire world population severely food insecure (FAO et al., 2022). Proactive policy decisions and major investments are needed to improve food system resilience in an increasingly uncertain future. Such decisions, however, require knowledge convergence to guide stakeholder actions.

Science and research findings are often reductionist in nature. Although linkages between dietary choices, climate and human health are increasingly studied, there is limited research on the dynamics among components of food systems, particularly postharvest. For example, how food choices impact climate change, ecosystems, human health and social equity, and how different kinds of evidence guide stakeholders' actions regarding food and climate, are poorly understood. This lack of understanding calls for a more inclusive research agenda and innovation to address the complex pathways needed to transform the technological, political, biophysical, economic and social dimensions of food systems relative to climate change.

Recent global efforts, such as the 2021 UN Food Systems Summit, have taken place against the backdrop of climate change outcomes, including increasing drought, wildfires and floods. This has highlighted that no country possesses a food paradigm that is immune to climate change. Systems-oriented, contextualised solutions must be formulated and effectively scaled to achieve human and planetary food resilience relative to health needs. Hence, there have been growing calls for transdisciplinary, stakeholder-informed approaches that can integrate science issues with complex socio-ecological problems, known as convergence research (den Boer et al., 2021; National Academies of Science, Engineering, and Medicine, 2019).

Despite the demand, given the complexity of food and climate interactions, no current paradigm is sufficiently practical to guide stakeholder responses at a global scale (European Commission et al., 2022). The goal of this article was to present a novel framework to initiate convergence research to enhance food system functionality. This framework fills a critical gap in policy-oriented research to reduce current and future food and climate vulnerabilities. While this framework guides research under a newly formed global convergence research network––the Food and Climate Systems Transformation (FACT) Alliance––our approach may also help like-minded initiatives identify entry points for food and climate actions globally. In view of the increased attention to food systems at the next two UN climate conferences, COPs 27 and 28, the framework could also promote efforts to implement a convergence approach within the food and climate action communities.

## 2 | LIMITATIONS OF PREVAILING APPROACHES

Science plays a central role in developing and scaling solutions to the complex challenges facing food and climate systems. Yet, the integration of actionable research into policy and decision-making is, at present, inadequate (Bednarek et al., 2018). Significant knowledge gaps remain at the interface of climate and food systems research, including disaggregation of and access to data, sustainability metrics and development/applicability of practical solutions (European Commission et al., 2022). Many of these gaps arise from the reductionist approaches of much academic research, which rewards exploration along disciplinary pathways but falls short of generating actionable knowledge.

Although food and climate systems are complex and interdependent, research typically occurs in disciplinary silos. Pathways for pursuing systems-oriented research are poorly explored empirically and poorly coordinated, funded and linked to policy (Tomich et al., 2019). Research can be poorly coordinated across and within disciplines, research departments and institutions (den Boer et al., 2021; National Academies of Science, Engineering, and Medicine, 2019).

A significant impediment to food systems transformation is a misalignment of research with stakeholder needs and a lack of evidence, analyses and data sets that are readily accessible to stakeholders (European Commission et al., 2022). Research priorities are often inadequately informed by the needs of policymakers, business leaders and communities that are most impacted by climate change and other food systems dynamics. At the same time, citizen science is rarely integrated with academic research to develop new insights and remains unlinked to policymaker decisions.

## 3 | TOWARDS CONVERGENCE RESEARCH

Convergence thinking helps tackle vexing, complex scientific and societal challenges at the interface of multiple fields (Morton et al., 2015; National Research Council, 2014). It provides fertile ground for collaborations by merging diverse expertise into networks that are problem-based and solution-focussed (Morton et al., 2015; Peek et al., 2020). Convergence science goes much further than multidisciplinary and transdisciplinary research (Figure 1) that is, it builds collaborations with stakeholders in government, private sector, foundations, nongovernmental organisations (NGOs), not-for-profit organisations and civil society across multiple scales and locations. Such collaborations are essential to identify viable coordinated action at scale (Dubé et al., 2014). In convergence research, policymakers, societal actors and academia develop inclusive partnerships for linking research to action.

We believe that convergence partnerships accelerate the development of innovative and effective policies, services and products. The knowledge, theories, methods, databases and languages of diverse stakeholders enrich the convergence approach. These collaborative platforms support data sharing, and open access to information and subsequent innovation and solutions.

The interlinked nature of food and climate systems means that policy and stakeholder decisions occur across multiple scales (local, national, regional and global), impact multiple socio-economic sectors and create feedback across the system (Watson, 2012). Because of this, convergence research to address food and climate challenges must be iterative, adaptable, multidimensional and responsive to different scales and stakeholder needs (Bednarek et al., 2018; National Academies of Science, Engineering, and Medicine, 2019). Convergence research also calls for longer funding timelines. Extending the typical 3-to-5-year period to at least 10 years enables deep integration across disciplines (in part through sustained working relationships) and facilitates better connections between research outcomes and the development of solutions. Sustained and sufficient funding reduces the need for constant fundraising efforts. It incentivizes researchers to tackle problems of greater magnitude and supports longer term collaborations.

Convergence research requires leaders who look well beyond their disciplines, lead multidisciplinary teams, mediate between organizational cultures, advance new research paradigms and who are committed to developing solutions that can be implemented at scale in the food–climate system nexus.

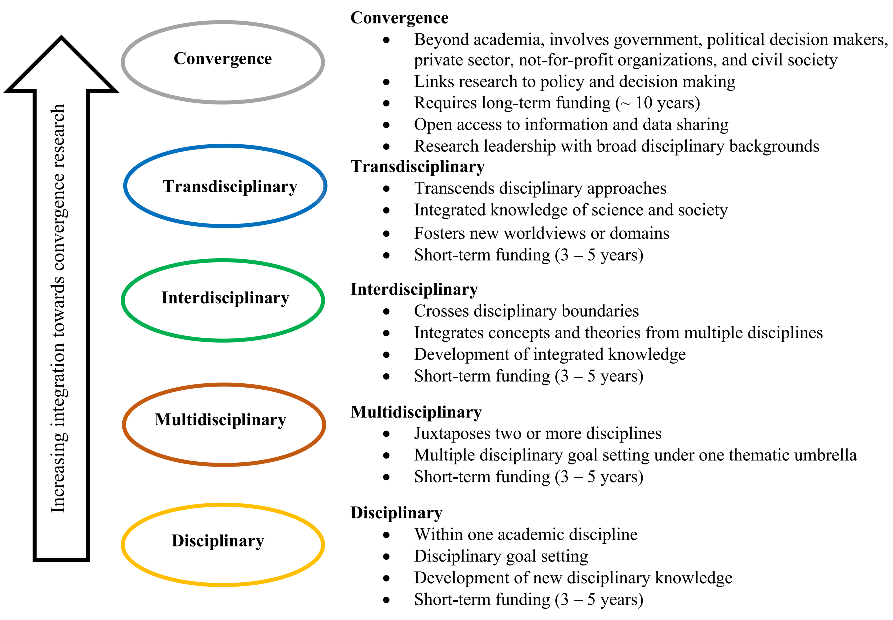


FIGURE 1 Concepts of disciplinary, multidisciplinary, interdisciplinary, transdisciplinary and convergence research (Adapted from Morton et al., 2015 and Peek et al., 2020)

# 4 | THE FOOD SYSTEMS CONVERGENCE RESEARCH FRAMEWORK

This framework was developed through a series of virtual focus groups conducted throughout the summer of 2020 and through consultations with over two-dozen FACT Alliance researchers. The focus groups brought together over 100 academic and nonacademic researchers and stakeholders from diverse organisations including governmental agencies, farmers' groups, NGOs, intergovernmental organisations, donors, agribusiness and charitable foundations.

The framework is adaptable to various strategic planning, policymaking and investment activities across a range of scales and geographies. The iterative approach engages stakeholders around food systems resilience and sustainability challenges to identify socio-ecological and sociotechnical knowledge gaps, and barriers, and opportunities for transforming food systems (Table 1). The proposed framework ensures that research is guided by stakeholder needs and that research outputs are actionable by end-users. Specific methodologic approaches within each component depend on the nature of the research needs (i.e. policymaking, business planning, and investment), scale and geography. The components are distinct but interrelated through an iterative process.

## 4.1 | Component 1: Food systems vulnerability mapping

This component helps identify food system vulnerabilities and potential futures related to current climate, economic, political and social dynamics for a variety of global change scenarios. It adopts a mixed-methods modelling approach as a starting point for stakeholder engagement in Component 2. For example, efforts to transition towards greater resilience and sustainability in wheat production in a particular region are likely to face resistance from vested interests. However, information from trusted intermediaries (see Section 5) demonstrating that climate change will hinder future wheat production may facilitate collaboration on transitioning the incumbent production regime.

## 4.2 | Component 2: Problem articulation, scoping and visioning

This component engages stakeholders in collaborative research on food systems resilience and sustainability challenges. A rapid appraisal approach uses a combined functional–structural innovation systems analysis to identify sociotechnical, socio-ecological and sociopolitical knowledge gaps, barriers and opportunities for transforming the food system of focus (see, e.g. Sixt et al., 2018).

Such an approach guides the collaborative research process and coalition building, while articulating the disciplinary expertise needed for knowledge creation. The activities of this component help elucidate the goals of the policymakers, donors, NGOs, companies or other stakeholders, relative to the broader food system challenges. This step helps identify synergies in related areas that may offer cobenefits as coordinated efforts. It co-identifies an initial suite of technological, policy and programmatic avenues that are necessary for scalable solutions and ensures that the research is funded in ways that meet stakeholder needs.

## 4.3 | Component 3: Action-oriented research

This component fills knowledge gaps and co-identifies the policies, technologies, programmes and business models that can be scaled and implemented to drive food system transformation. Researchers from relevant disciplines pursue projects that respond to knowledge gaps and information needs, jointly identified with stakeholders. Research teams should include multiple disciplines relevant to food systems, including nutrition, safety, health, production and data science. Stakeholders are partners to ensure that the research is appropriately grounded and that recommendations are socially and technically feasible. This ensures that new technologies, business models, policies or programmes are designed for successful scaling or implementation and builds consensus on action.

We do not advocate for a single model for food systems convergence research. The methods needed to conduct food systems research are context-specific. They change with the nature of the activities the research supports (e.g. policymaking and new business models), scale, geography and the stakeholder partners. Effective research includes stakeholders as insiders and coresearchers and is responsive to the context, stakeholder goals, individual partnership preferences and the different stages of the research process (Bieluch et al., 2017; Hendriks, 2021). It must include a robust and diverse network of individual and organizational partners and provide them control of the collaboration processes.

Lastly, action-oriented research in the food–climate nexus requires partnership brokers with broad disciplinary backgrounds who have experience leading teams in social and natural science, engineering, public health, economics, law and management. They should

**TABLE 1** Process for food systems convergence research

| Component | Activities | Methods |
|---|---|---|
| 1. Food system vulnerability mapping | Build public awareness and foster partnerships, nurture multi-actor learning<br>Map climate, economic, political, and social vulnerabilities to the current food system<br>Map future vulnerabilities to the food system under a variety of global change scenarios<br>Present a range of vulnerabilities to foster stakeholder convergence | Mixed-methods climate, socioeconomic, sociopolitical modeling<br>Citizen science data collection to inform modeling approaches |
| 2. Problem articulation, scoping, visioning | Identify systemic barriers to human behavior change and transformation<br>Identify leverage points for driving change, formulate joint visions of solutions<br>Articulate critical knowledge gaps and mix of disciplines and methods for filling them<br>Identify an appropriate mix of stakeholders, knowledge brokers, and community leaders for transdisciplinary collaboration | Combined functional-structural innovation systems analysis<br>Town-halls, focus groups, key informant interviews, surveys, etc. with broad range of stakeholders to prioritize knowledge gaps and research needs |
| 3. Action-oriented research | Prototype promising solutions, test and learn from them at scale<br>Link centrally-organized experiments and global prototyping of solutions<br>Address barriers to climate and food system transitions | Real-world laboratories in rural and urban areas, action research and strategic niche management methods<br>Meta-analysis and benchmark studies to inform change processes<br>Implement policies and guidelines, evidence-based scaling of niche innovation |
| 4. Scaling of food system transformation through impact evaluation and learning | Accompany convergence research throughout the research and action process<br>Address barriers to convergence and partnerships along the way<br>Developing deep understanding of system behavior change to adapt and iterate approaches<br>Change feedback loops at scale | Ex-ante and ex-post impact assessment, modelling, and learning<br>Organizational learning methodologies |

understand how to integrate skills and expertise and how to build consensus on action in partnership with the full range of stakeholders.

### 4.4 | Component 4: Scaling of food system transformation through impact evaluation and learning

Achieving food systems transformation requires a new paradigm. It requires innovative and eclectic means of measuring policy impact, project development, investments and business models. European Commission et al. (2022) may serve as a template in this regard. It calls for a new global network-of-network approach through (1) engaging stakeholders as true partners, (2) increasing coherence among science approaches to address real-world problems and (3) developing novel ways to monitor 'success' focussed on the outcomes of food systems transformations relative to climate and natural systems. The current proposed framework supports goals 1 and 2 through previous framework components (4.1–4.3). The activities that support those goals create pathways for developing novel approaches to monitoring the success of transformation actions.

## 5 | SYSTEMIC INTERMEDIARIES DRIVING FOOD SYSTEMS CONVERGENCE RESEARCH

Successfully connecting convergence research to evidence-informed decision-making requires boundary-spanning activities of systemic intermediaries (Bednarek et al., 2018). Systemic intermediaries are organisations who function within and across networks of actors and institutions to catalyse food systems transitions (see e.g. Kanda et al., 2020). They function as partnership brokers and support evidence-based decision-making and planning through the cocreation, exchange and use of knowledge to identify challenges, potential solutions and to decide on courses of action (Bednarek et al., 2018; Posner & Cvitanovic, 2019). The role of intermediaries in integrating research at different scales (e.g. translating global climate models to regional contexts) and across settings (e.g. applying knowledge about drought-tolerant crops to places where changing precipitation patterns pose new challenges) is critical.

In our framework, we position university-led convergence research networks as the systemic intermediary. In this approach, we acknowledge that while academic institutions generate deep knowledge and have departments spanning multiple components of food systems, they often fall short in spanning disciplinary silos and engaging stakeholders at the conception phase of research (see Section 2). Institutionally, they often prioritise disciplinary reductionist outputs over transdisciplinary collaboration and boundary-spanning roles (e.g. Bieluch et al., 2017). The goal must be that as food systems convergence research expands, university administrations reorient academic culture to value collaboration and boundary-spanning activities more.

## 6 | CONCLUSION

We believe that the convergence framework provided here is urgently needed to support actions essential to transforming food systems in an uncertain climate. Our goals are to improve political, business and cultural choices that integrate food, climate adaptation, ecosystems, human health and social equity. We believe the emerging framework offers a basis for novel forms of collaboration and innovation at a new scale. We call on research funders of all kinds to pivot their attention to support this kind of work as part of their climate mitigation and adaptation agendas.

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### CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

### DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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