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Food Systems Innovation to Nurture Equity and Resilience Globally (Food SINERGY): insights from the Food SINERGY network

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Abstract

The international collaboration network *Food Systems Innovation to Nurture Equity and Resilience Globally* (Food SINERGY) unites food system experts concerned with the confluence of environmental, geopolitical, economic, and public health stressors that weaken food systems and increase inequalities. In March 2023, Food SINERGY participants from universities, research institutes, food policy advocacy groups, Indigenous networks, farmers' associations, consumer organizations, social enterprises, and non-governmental organizations from around the world met in Mont Orford, Québec, for a forum to revisit food system structures across local-to-global scales and to identify key junctures for transformation. This article summarizes the network's discussions in the context of the existing literature. Key knowledge contributions include the importance of diversification throughout the food system for cultivating resilience; the value of food sovereignty in promoting equity across scales; the reconciliation between food sovereignty and equitable trade; the need for consonance between policy environments at different scales to enable positive societal actions; the pioneering role of food system innovations that challenge conventional political and economic structures, with emphasis on agroecology; and the need for critical self-reflection around knowledge production and knowledge use to better serve equitable food systems. These discussion outcomes provide insights for actors seeking to transform food systems in support of equity and resilience.

Key words: resilient food systems, equity, food sovereignty, equitable trade, food policy, agroecology

Introduction

The global Covid-19 pandemic, armed conflict, political disruptions, and numerous climate change-driven phenomena have, unfortunately, given us multiple opportunities to test the resilience of the global food system in recent years (FAO et al. 2022; United Nations Environment Programme 2022). We have seen both stronger points and points of collapse. For example, even when pandemic restrictions upended market chains, farmers with highly biodiverse production in Colombia, Nepal, Ecuador, Costa Rica, and Guatemala demonstrated their resilience by consuming their own foods as well as sharing them with others in their communities and networks (Gómez Serna and Bernal Rivas 2020; Adhikari et al. 2021; Lyall et al. 2021; Little and Sylvester 2022; Rice et al. 2023). In some locations where unprecedented heavy rains coincided with pandemic disruptions, biodiverse production also buttressed farmers against the effects of crop losses and impassable roads (Túquerrez 2022). Such stories of resilience stand in stark contrast to situations elsewhere. Perhaps nowhere has the interaction of globalized environmental, economic, geopolitical and public health disruptions been as evident as in Somalia. Russia's invasion of Ukraine meant that Somalia lost 90% of its wheat supply just as the country grappled with its worst drought in decades, ongoing armed conflict, remaining fallout from the pandemic, and rising global food prices. The confluence of these factors sent Somalia into

Box 1: About the Food SINERGY network and its methods for producing knowledge

The Food SINERGY network is led by the Canada Research Chair in Nutrition and Health Inequalities (CIENS). Individuals were invited to join Food SINERGY according to a snow-ball approach, wherein individuals were selected for their expertise in a diversity of food system-related subjects as well as their representation of diverse sectors and geographical regions.

The Food SINERGY in-person forum and preceding online workshops utilized activity-based, participatory facilitation methods to support productive discourse. Activities were designed with the help of a communication facilitation expert and included, among others, an open-response survey for pre-identification of key subjects; a mapping exercise of food system subjects and key actors; paired walking discussions; "1-2-4-all" group discussions; "open-space" group discussions; "soft-shoe-shuffle"; and moderated plenary discussions. Spanish language translation was provided to promote inclusivity. Forum activities and discussions were documented by a visual artist and a team of seven notetakers. All forum participants consented to have their contributions documented. Notes were then organized and analyzed using inductive thematic analysis (Hsieh and Shannon 2005).

Analyses produced the subjects and ideas that are presented in this article as the outputs of Food SINERGY's discussions. These ideas emerged out of the participants' professional trajectories, including their extensive engagement with scholarly literature from across multiple disciplines. Therefore, in this article, the Food SINERGY discussion outputs are scaffolded by literature representing some of the most prominent scholarly sources that have informed the network's perspectives. All authors are founding Food SINERGY members.

a famine that saw an estimated 43 000 people die in 2022 alone, half of them children (Wise 2022; WHO and UNICEF 2023). While Somalia's circumstances are exceptional, they may be a harbinger of what is to come, particularly in a scenario where resources are increasingly depleted, nutrition and health disparities are broadening, and climate change brings new curveballs that affect the food system (Shukla et al. 2019; Willett et al. 2019).

Just as the disruptions of recent years have thrust the consequences of inequitable, fragile food systems into the global spotlight, they also present an opportunity to critically revisit and transform the structure of food systems. This interest propelled the development of the international collaboration network *Food Systems Innovation to Nurture Equity and Resilience Globally* (Food SINERGY). The network was formally launched in March 2023 with a 3-day forum in Mont Orford, Québec, two pre-forum online workshops, and multiple small-group meetings. These inaugural activities united food system experts from 13 universities and research institutes as well as from 21 food policy advocacy groups, Indigenous networks, farmers' associations, consumer organizations, social enterprises, and non-governmental organizations (NGOs). Participating individuals were located in 14 countries (Belgium, Brazil, Canada, Ecuador, France, Guatemala, India, Italy, Lebanon, Mexico, Moldova, Romania, Ukraine, and the United States), and the geographical scope of their collective expertise extended to many more locations. Box 1 provides further information on Food SINERGY and the activity-based discussion methods used for generating knowledge outputs.

This article summarizes the knowledge generated by Food SINERGY discussions to date, with a focus on critical junctures for advancing equitable, resilient food systems. We situate the discussion points in the existing literature to reflect that the Food SINERGY network's expertise emerges from, and is embedded in, an extensive and evolving body of knowledge.

We begin by contextualizing the need for transforming food systems, then we move into a discussion on what constitutes food system resilience and how a food sovereignty focus can better support equity. Next, we present three avenues that Food SINERGY identified as key to creating equitable, resilient food systems. The first of these avenues, *transformation across scales*, discusses how resilience can be built across the local-to-global spectrum by simultaneously supporting food sovereignty and equitable international trade, as well as through seeking consonance across scales. The second, *learning from stories of resilience*, discusses how a diversity of innovations are challenging the conventional political and economic discourse around food systems, and highlights agroecology as a promising integrated innovation. The third, *knowledge for transformation*, presents the need for critical thinking around how we produce, mobilize, and ultimately use knowledge in order for it to better serve equitable, resilient food systems. We conclude by summarizing key learnings.

Why do we need to transform global food systems?

Multiple geopolitical, economic, environmental, and public health stressors have made access to nutritious foods less equitable both between and within countries. For example, as food prices soared to record highs in 2022, the world's poorest countries saw their food import bills increase by nearly $5 billion (IPES-Food 2023). Ultimately, many of these countries were unable to produce or import enough food to feed their populations, contributing to record levels of acute food insecurity affecting 258 million people in 58 countries (FSIN and Global Network Against Food Crises 2023). Wealthy countries were not spared from the pandemic's effects; in Canada,

household food insecurity reached an all-time high, as did food bank visits (Li et al. 2023).

Such stressors also affect within-country equitable access to nutritious food. In numerous countries, the domestic impacts of the Covid-19 pandemic varied according to gender, age, socio-economic status, and employment conditions (Picchioni et al. 2022). In particular, women-headed households, informal workers, and young adults who relied on daily wages were most likely to face severe food insecurity (Picchioni et al. 2022). Moreover, populations who were already at higher risk for nutritional deficits not only consumed smaller quantities of food due to the pandemic's economic effects, but also shifted toward less healthy diets, with more people eating ultra-processed foods, rather than fruits, vegetables, and fresh foods (González-Monroy et al. 2021; Naughton et al. 2021). In 2021, a staggering 42% of the global population was unable to afford a healthy diet (FAO et al. 2023).

The connections between the food system and environmental change are especially concerning. The food sector is currently responsible for about a third of the total greenhouse gas emissions that drive climate change (Shukla et al. 2019; Crippa et al. 2021), and is also the largest cause of biodiversity loss, deforestation (Díaz et al. 2019), freshwater overconsumption, and waterway pollution from nitrogen and phosphorus fertilizers (Rockström and Karlberg 2010). Without systemic changes, emissions from the global food sector alone could make it impossible to limit warming to 1.5 °C and difficult to realise even the 2 °C target (Clark et al. 2020). Therefore, rethinking our global food system will be necessary to meet climate targets set out by the United Nations Sustainable Development Goals (SDGs) and the Paris Climate Agreement (Willett et al. 2019; Rockström et al. 2020). At the same time, it is also essential to rethink food systems to adapt to and mitigate the effects of specific pressures such as heat stress, droughts, flooding, salinization, desertification, ocean acidification, pests, and infectious disease, all of which are projected to increase in the future as a result of climate change (Shukla et al. 2019). This is all the more pressing given the links between climate change, resource pressures, and geopolitical conflict, including armed violence (Hsiang et al. 2011).

Two connected and deeply entrenched barriers to systemic transformation are the asymmetric, highly concentrated power dynamics in global markets (Clapp 2006; Swinburn et al. 2011) and the pervasive momentum toward agricultural intensification (IPES-Food 2016, 2017). Crop intensification based on mechanization and heavy use of synthetic pesticides and fertilizers was the predominant strategy for feeding the growing global population over the past century. While this came at the expense of habitats, soils, agrobiodiversity, and farmer health (Sherwood 2009: Holt-Giménez et al. 2021), in 2009, the Food and Agriculture Organization (FAO) estimated that the world already produced more than 1½ times enough calories to feed everyone (Holt-Giménez et al. 2012). Despite such caloric bounty, close to a third of the world's population (29.6%) faces moderate to severe food insecurity, with nearly one in 10 individuals (9.2%) experiencing hunger. These figures highlight a backward slide in the global goals to end hunger (FAO et al. 2023).

Meanwhile, the global burden of hidden hunger, referring to micronutrient deficiencies, is estimated to be even worse than that of chronic hunger (Gödecke et al. 2018). To understand this failure, it is helpful to examine the types of calories that are produced through agricultural intensification. Global markets have pushed a global dietary homogenization, wherein only three products (corn, wheat, and sugar) account for almost 50% of calorie consumption, while 10 products account for 80% (these are, in decreasing order of importance: corn, wheat, sugar, rice, soybean oil, beans, palm oil, cassava, beer, potatoes) (Falconi et al. 2017). This homogenization comes at the expense of the variety of foods needed to sustain nutritious and culturally diverse diets, and the associated production patterns displace biodiversity in the agricultural ecosystem (Herforth et al. 2019). While continued investment in these products will continue to increase caloric production, it will not resolve micronutrient deficiencies or inequitable food distribution and will more likely augment obesity and diet-related chronic diseases (Herforth et al. 2019), adding to a growing double burden of under- and overnutrition (Shrimpton and Rokx 2012).

Agricultural and dietary homogenization is largely the result of productivist global market dynamics that prioritize short-term profits and ignore externalities to human health, equity, or the environment (Herforth et al. 2019; Hendriks et al. 2023). Aiming to stay afloat in this globalized economic setting, many countries embark on a "race-to-the-bottom" in which they lower their export prices to compete with each other. As a result, regions that prioritize commodity exports over meeting domestic food demand, such as Latin America and the Caribbean, experience ever-worsening "caloric unequal exchange", meaning that they have to export a much greater volume to import a monetarily equivalent amount (Falconi et al.2017). Doing so, these countries feed the world at the expense of their own population's food security and nutrition, their own natural resources, and their own ecological stability (Falconi et al. 2017). It is tragic and ironic that, while an estimated 3.8 billion people around the world live in households that rely on agriculture, forestry, and fishing (FAO 2023), these same people are collectively the most food insecure, malnourished population group on the planet (Berdegué and Fuentealba 2011; FAO et al. 2023). Hence, hunger and malnutrition prove to be problems of inequality and inequitable relationships in different food system components and across scales (Holt-Giménez et al. 2012; Falconi et al. 2017; Herforth et al. 2019).

Looking ahead, it is certain the global food system will continue to face unpredictable disruptions from both short-term and long-term stressors (Shukla et al. 2019). Long-term stressors such as climate change and biodiversity collapse are especially concerning because we have yet to see the full consequences of what has already been set in motion (Wu et al. 2015; Lafuite and Loreau 2017; Ding et al. 2020). For example, climate change inertia means global mean surface temperature peaks 25–30 years after emissions are released, so in any emissions reduction scenario, there is a certain amount of warming that is inevitable in the coming decades (Samset et

al. 2020). This adds to the urgency of food systems transformation.

Food system resilience

Food systems represent socio-ecological systems that include biophysical and social elements that are interconnected through feedback mechanisms (Tendall et al. 2015). They encompass, but are not limited to, the activities of producing, processing, packaging, distributing, retailing, and consuming food, as well as the related societal, economic, political, institutional, and environmental processes of these activities at different scales (Ericksen 2008*a*, 2008*b*; Tendall et al. 2015). Analyzing food systems often involves examining the determinants, or drivers, of how food system activities are performed, as well as their outcomes (Tendall et al. 2015).

The concept of "systems resilience" originated in ecology theory with respect to a system's capacity to withstand or adapt to predictable and unpredictable disturbances over time to continue fulfilling its functions and provide favourable outcomes (Hoddinott 2014; Tendall et al. 2015). Tendall and colleagues draw on this history as well as on the concept of food security (discussed later in this article) to define *food system resilience* as "the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances" (Tendall et al. 2015). They propose resilience as complementary to sustainability, clarifying that sustainability "has been broadly defined as the capacity to achieve today's goals without compromising the future capacity to achieve them", whereas resilience incorporates "the dynamic capacity to continue to achieve goals despite disturbances and shocks".

For the Food SINERGY network, the focus on resilience reflected the need to respond to increasingly perilous and frequent disturbances driven by climate change and resource depletion, including both their explicitly environmental manifestations (e.g., storms, droughts) as well as related social, economic, and political phenomena (e.g., climate refugees, conflicts over resources). Ecological theory around resilience emphasizes the importance of diversity (e.g., of species, of functional groups) for promoting productivity and stability (Holt-Giménez et al. 2021). Similarly, to construct resilient food systems, diversified strategies must be implemented to build stable redundancies and stopgaps into the food system, such that if one strategy fails, others can quickly and effectively fill the gap before negative consequences occur to planetary and human health and well-being.

Equity through food sovereignty

The Food SINERGY network emphasized the importance of system *transformation*, noting that sustainability should not "sustain", and resilience should not "bounce back to", an inequitable and underperforming food system. In that both resilience and sustainability are tied to outcome-driven goals, they theoretically preclude the possibility of enhancing systems with undesirable outcomes and are inherently transformative. Even so, there exists a danger that notions of resilience in food policy discourse can be co-opted to a reductive focus on productivity and economic growth, at the expense of equity. As Holt-Giménez and colleagues warn, "without attention to relations between small scale farmers, institutions, scientific practice, markets and state power, without addressing the broader context of sovereignty of land, resources and knowledge, resilience building will be ineffective at best" (Holt-Giménez et al. 2021). For this reason, the application of diversity as a cornerstone of resilience must be applied as a cross-cutting element (IPES-Food 2016), referring to, among others, diversified trade arrangements, diversified market supply, diversified production, as well as social, cultural, and ecological diversity. While diversification is important, it is not enough to secure equity on its own, as it does not rectify power imbalances (Holt-Giménez et al. 2021). Therefore, Food SINERGY identified food sovereignty as an organizing and guiding concept to promote equity in food system resilience.

Food sovereignty is a concept popularized by Via Campesina, an international network of peasant farmers, Indigenous Peoples, landless workers, pastoralists, fisherfolk, and smallholder farmers. In 1996, Via Campesina defined food sovereignty as "the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems" (Via Campesina 2007). This declaration further described specific applications of food sovereignty for rectifying imbalances around human rights, economic power, and resource use[1]. Since Via Campesina articulated the concept, food sovereignty has become central to the political discourse of peasant associations, Indigenous Peoples, and numerous civil society organizations around the world (Jarosz 2014). While the meanings of food security and food sovereignty are closely intertwined (see Box 2 for an overview), some propose that food security is largely *de*scriptive, offering an end goal, whereas food sovereignty is largely *pre*scriptive, offering not only a definition, but also guidelines on how to get there (Clapp 2014).

Although academic discussions on food system resilience and health equity have drawn more heavily from food security (Tendall et al. 2015; Weiler et al. 2015), Food SINERGY in fact found the integrated approach of food sovereignty to be more pragmatic for equity promotion. For example, food sovereignty asserts not only the right to sustainably produced food, but the rights to democratic management of productive resources (land, water, seeds) and to fair terms of trade. Doing so, the food sovereignty lens enables comprehensive re-

[1] Via Campesina's definition in the Declaration of Nyéléni characterized how food sovereignty places "those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations", "prioritizes local and national economies and markets and empowers peasant and family farmer-driven agriculture, artisanal fishing, pastoralist-led grazing, and food production, distribution and consumption based on environmental, social and economic sustainability", "promotes transparent trade", "ensures that the rights to use and manage our lands, territories, waters, seeds, livestock and biodiversity are in the hands of those of us who produce food", among other aspects (Via Campesina, 2007).

Box 2: Food security and/versus food sovereignty: complementary or oppositional?

Food sovereignty is often presented either alongside, or in opposition to, the term food security (Clapp 2014; Jarosz 2014). Since it emerged in the 1970s, food security has evolved from a focus on supply-side national availability of sufficient food to its current definition: "when all people at all times have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Pinstrup-Andersen 2009; Jarosz 2014). In many ways, the principles of food sovereignty have been back-engineered into this definition of food security, with the word "preferences" later interpreted to imply not only cultural taste preferences, but also agency and empowerment over food decisions, and the term "healthy life" interpreted to encompass a breadth of wellbeing considerations (Mechlem 2004; Pinstrup-Andersen 2009).

For many actors, such as for some of the producer groups that are part of Via Campesina and some of their allies in the academic or NGO sector, the loose integration of food sovereignty concepts into the food security definition is an unpalatable appropriation that places agency over the food system in the back seat to the broader priority of securing food by any means. This opposition has been traced to a history wherein food security emerged out of a largely neoliberal, technocratic and hegemonic discourse, whereas food sovereignty emerged out of a grassroots search for an alternative to that discourse (Jarosz 2014). Yet, this history does not make the terms inherently contradictory. In fact, their conceptual evolution is bidirectional: just as the present food security definition drew heavily from food sovereignty principles, Via Campesina has described food sovereignty as a precondition to food security. The perceived opposition between the two terms is largely due to the conflation of food security with one of the discourses frequently proposed to achieve it—namely, the mainstream, market-driven neoliberal agenda (Clapp 2014).

sponses to interlinked environmental and social equity issues in the food system (Levkoe and Blay-Palmer 2018), such as by drawing attention to how concentration of corporate power has contributed to ecosystem mismanagement, hunger, diet-related chronic diseases, as well as occupational health crises (i.e., pesticide exposure) (Weiler et al. 2015).

Moreover, it is critical to credit the leadership of peasant organizations and of Indigenous Peoples in defining and advancing food sovereignty (Via Campesina 2007; Morrison 2011). While Indigenous involvement in Via Campesina's initial conceptualization was largely limited to Latin America, Indigenous scholars in North America have since proposed "Indigenous food sovereignty", which expands on the initial rights-based focus to also include a culturally embedded responsibility to care for food systems (Morrison 2011) such that Indigenous Peoples could move "beyond surviving to thriving" (Maudrie et al. 2023). In practice, food sovereignty and Indigenous food sovereignty have both proven instrumental for mobilizing tangible food system changes (Levkoe and Blay-Palmer 2018; Delormier and Marquis 2019; Blanchet et al. 2021). Hence, Food SINERGY found that centering food sovereignty is also a means of respecting the perspectives of the groups whose present circumstances and historic trajectories have made them the most intimately knowledgeable of the food system changes that are needed.

Three key avenues toward equitable and resilient food systems

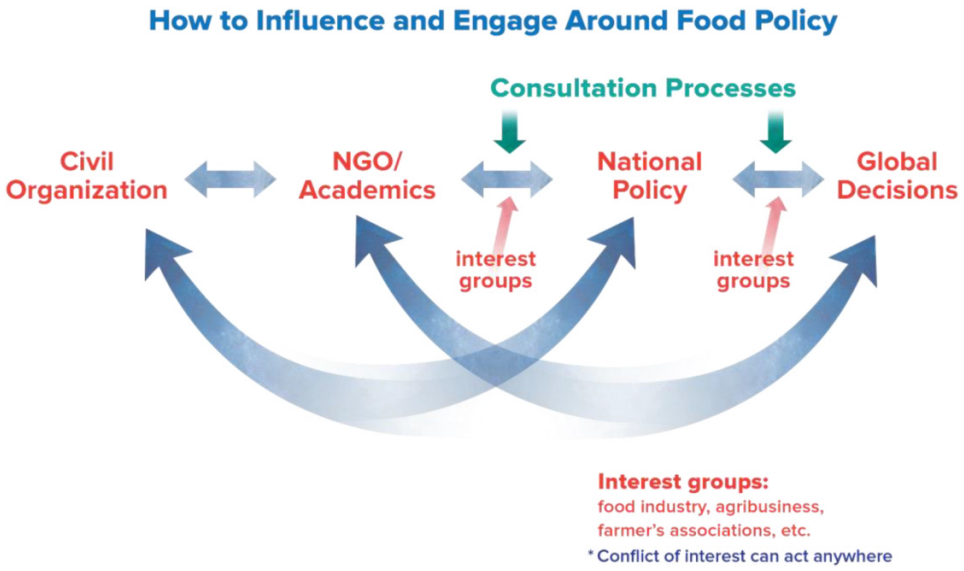
The following three avenues emerged as central themes for Food SINERGY, representing broad consensus from the network's transdisciplinary experts. While they are not exhaustive, they aim to provide insights for actors seeking to transform food systems in favour of equity and resilience.

Avenue 1: Transformation across scales

Food policy experts have pointed out that much discourse to date has focused on local policy or global policy as independent issues, or even placed local and global scales at odds with one another (Murphy 2021; Caron 2022). For example, local food systems have long been promoted because they are better aligned with ecological principles, better support farmer livelihoods, and are more likely to sustain cultural traditions (Feenstra 1997). At the same time, the notion that globalized trade is necessary to feed the planet and respond to consumer demand remains central to international policy, and is a dominant idea in the media and cultural zeitgeist (Phillips 2006); after all, could we drink coffee at a forum in Canada if we depended entirely on the local food system? It is common for local food systems and international trade to be presented as mutually antagonistic, even as evidence supports the need for both in creating food system resilience (Clapp 2015; Burnett and Murphy 2017; Caron 2022). Hence, the Food SINERGY network emphasized the need to reconcile local food systems and international trade, and to leverage complementarities between them to create more resilient food systems.

In regions where resources and climates are favourable for diverse agricultural production throughout much of the year, the argument for favouring local food systems is intuitive. However, in water-stressed nations or in nations with extreme seasonal variability, international trade must inevitably play a greater role. Self-sufficiency, referring to the extent to which countries meet their own food needs through domestic production, is not a binary but rather a spectrum; it follows that countries with differing production environments should have different goals regarding where they fit on this spectrum (Clapp 2015). Currently, the terms of global trade are primarily negotiated through the World Trade Organization (WTO). Thus far, the WTO has largely failed to rectify

Fig. 1. A schema developed during the Food SINERGY forum illustrating the role of different actors in policy-making at different scales.



power imbalances between countries, and many times reinforced them; however, the WTO is more permeable than is often perceived, and its market agreements can still be renegotiated to be more equitable (Clapp 2006; Burnett and Murphy 2017; Falconi et al. 2017; Margulis 2018). For example, in 2013, the United Nations invoked a "right to food" argument to successfully pressure the WTO to adopt a legal waiver, giving countries more control over food stockholding and subsidies to ensure food security (Margulis 2018, 2021). The emergence of the Group of 33 during the Doha Round of WTO negotiations has also challenged the historic power dynamics in global trade, pushing for policies that were more aligned with food sovereignty (Burnett and Murphy 2017). Although the negotiations eventually fell apart, low income countries were largely successful in positioning their needs, and if revisited, their proposals may yield important progress on equitable international trade (Clapp 2006; Burnett and Murphy 2017).

The terms self-sufficiency and food sovereignty have at times been conflated, as has food sovereignty with the concept of local food systems. While these are interrelated, they do not operate in an exclusive space. Just as increasing self-sufficiency does not mean breaking all ties with international trade, food sovereignty is not exclusively within the purview of local food systems (Clapp 2015; Burnett and Murphy 2017). Given that food sovereignty is largely a matter of control in decision-making (Via Campesina 2007), equitable trade agreements can conceivably be designed to protect food sovereignty around the world through many of the same mechanisms that wealthy countries adopt to protect their own food sectors, such as protections for small-scale producers, supply management, commodity agreements, and quotas (Burnett and Murphy 2017). Another key measure is the elimination of corporate patents on seeds to protect farmers' control over the means to production (Via Campesina 2007).

Multiscalar consonance

Transforming food systems across scales begins with a recognition that "local-to-global" constitutes a spectrum with diverse forms of (often overlapping) political subdivisions (e.g., municipalities, provinces, nations, economic zones, political alliances) as well as non-political subdivisions (e.g., cultural regions, linguistic regions, watersheds, ecosystems, among others). By seeking a deeper understanding of how policies operate across a spectrum of scales, it is possible to develop policies that are more equitable and resilient both at one particular level and across multiple scales. A useful approach for doing so is by seeking *multiscalar consonance*, or harmony across scales (Murphy 2021). This policy approach recognizes that each scale matters and that none is expected to operate on its own. While the specific policies (or programs or practices) at each scale can be quite different from each other, they can still interact effectively.

For example, a municipal initiative working to curb depletion of a local water source may operate primarily through local action and local controls, but also find federal guidelines or international declarations helpful in advancing its goals toward water security. The converse of multiscalar consonance is when policies at different scales undermine rather than support each other (Murphy 2021). Unfortunately, international trade agreements have often undermined multiscalar consonance by setting rules for domestic support to agriculture that are at odds with local or national food security interests (Clapp 2006; Murphy 2021). An evidence-based approach to understanding pathways toward multiscalar consonance is key for shifting the food system narratives that feed into policy decisions.

This requires a strong understanding of how decision-making occurs in different governance contexts and across the local-to-global spectrum. A Food SINERGY discussion session produced an illustration (Fig. 1) of common food

policy influence pathways in democratic societies. The illustration proposed that policy-making typically occurs through the confluence of several key bidirectional influence relationships between civil society organizations, NGOs and research institutions, national policy-makers, and global decision-makers. However, all points are vulnerable to the influence of interest groups as well as conflicts of interest, which can disrupt transparency and accountability in democratic decision-making (Burnett and Murphy 2017; Margulis 2021).

At an international scale, multiple actors already have strong potential to impact food systems across the local-to-global spectrum. Several of note include the WTO, the International Monetary Fund, the World Organization for Animal Health, and various United Nations specialized agencies such as the United Nations Conference on Trade and Development, the Committee on Food Security, the World Health Organization, the International Fund for Agricultural Development, the FAO, the Office of the High Commissioner for Human Rights (OHCHR), and the World Food Programme (WFP). These global actors periodically emit key agreements, standards, guidelines, codes of practice, or recommendations that can be leveraged to advocate for national or subnational policies that support more equitable and resilient food systems (Margulis 2021). Several examples of these include the Codex Alimentarius, the SDGs, the United Nations Declaration on the Rights of Peasants and Other People Working in Rural Areas, and the Universal Declaration of Human Rights.

Moreover, these various international organizations also use official and unofficial mechanisms to influence each other's discourse, agenda, and outcomes. In a number of cases, UN organizations have used their legal authority, delegated authority, or moral authority to influence WTO negotiations toward stronger alignment with social mandates, such as when the WFP leveraged its unique role in addressing hunger, or when the OHCHR invoked a human rights legal argument around food security (Margulis 2018, 2021). Importantly, neither the WTO, the UN organizations, or any other international spaces act in a vacuum; all are influenced by both state and non-state actors, including civil society and private sector interest groups, through both official and unofficial mechanisms (Margulis 2018). These interactions constitute opportunities for non-international food system actors to hold influence at an international scale.

Avenue 2: Learning from stories of resilience

Food SINERGY found that the most tangible tool for creating more equitable and resilient food systems is through learning from the numerous innovations that already do so at different spatial scales (Blay-Palmer et al. 2020). At international scales, these include the drafting of shared goals such as the SDGs, United Nations declarations, values-based private sector certification systems (e.g., fair trade, organic), key clauses to international trade agreements, and multisectoral, international collaborations (e.g., the Agroecology Coalition). On national and subnational scales, a vast diversity of innovations include: alternative food networks based on short market chains; benefit corporations and other social enterprises; local certifications such as participatory guarantee systems; public procurement from agroecological farming; school food programs; local, solidarity-based economic systems; civil society organizing around agroecology; local food councils; constitutional mandates for the rights of nature; food labelling regulations; health-promoting taxation strategies, among many others (FAO et al. 2021).

Economic rectification

What the diverse types of innovations listed above have in common is that they present alternatives to, or modifications of, predominant economic tenets that nominally prioritize private property, free market economies, and profit maximization above all else. Over the past two centuries, these tenets have consolidated to form the core of much of the world's economic theory. In parallel, they have garnered extensive criticism, and a growing community of food system actors across the globe (Holt-Giménez 2019), as well as the Food SINERGY network, are calling for their urgent reform.

Such criticism is multifold. To begin with, the exaltation of *private property* has largely neglected to account for negative externalities, such as when agrochemicals applied on private lands contaminate public waterways (Sinden 2007), or when intellectual property laws around seeds undermine farmers' economic, productive, and cultural rights (Kloppenburg 2014). Meanwhile, poorly regulated *free markets* have exacerbated inequalities (Sen 2000), and inconsistent application of free market principles have generally favoured parties who already have more market power. Such is the case when nominally "free" trade agreements nevertheless allow for wealthy countries to subsidize internationally traded products (hence, contradicting free trade principles) and dump them into other countries' markets, disrupting local economies and pushing already strained farmers deeper into poverty (Clapp 2006; Wise 2009). Finally, *profit maximization*, often expressed as commitments to shareholders, has largely condoned food sector business practices that have undercut the livelihoods of farmers, impinged on the health and human rights of processing plant workers, provided unhealthy products to consumers, mismanaged natural resources, or contaminated the environment (IPES-Food 2016). The failures of these three core tenets of market capitalism are increasingly recognized even among business theorists, who are now calling for the fundamental theories of capitalism to be revisited, so that the concept of value better captures the full societal balance of benefits and costs (Porter and Kramer 2018).

There is much to learn from the food system innovations working at different scales to alter market capitalism policies or to mitigate their consequences. For example, the negative externalities of private property norms are being confronted by international agreements, including the United Nations SDGs and the Universal Declaration on Human Rights; while not legally binding, these agreements provide political incentives to enact policies for better resource governance and environmental protections (Murphy 2021). Such international agreements buttress national application of innovative legal frameworks, such as Ecuador's constitutional mandate for the rights of nature (Akchurin 2015), as well as the efforts of

subnational advocacy groups (e.g., Équiterre in Québec, the British Columbia Food Systems Network, El Poder del Consumidor in Mexico). To confront the inequalities associated with free markets, innovations such as antidumping protections, public food stockholding and fair trade certifications aim to create a more equitable international trading arena (Clapp 2006; Mendez et al. 2010; Margulis 2018). Meanwhile, local-scale alternative food networks (e.g., farmers' markets, community-supported agriculture) not only promote more equitable trading relationships between farmers and consumers, but also reduce dependence on the whims of international market economies, buffering both farmers and consumers from the consequences of unfair free trade agreements (Goodman and Goodman 2009; Jiménez 2014; Girard and Rebaï 2020). In turn, profit maximization practices are being challenged by innovations such as national sugar taxation and food labelling policies, which have placed corporate interests aside to support human health (Colchero et al. 2017; Shangguan et al. 2019).

The described innovations do not attempt to expunge market economy tenets wholesale, but rather to rectify key shortcomings by creating conditions for more equitable exchanges, more responsible resource management, and more favourable outcomes to human and environmental health and well-being. Further, these innovations illustrate how multiscalar consonance can support more equitable, resilient food systems. While many of the described innovations are national or subnational in scale, international commitments lend them greater legitimacy, supporting more effective advocacy for the rights of people over profit (Margulis 2021).

At the same time, we recognize that many such innovations have only been partially effective in producing their intended outcomes (Mendez et al. 2010). However, we hypothesize that this is precisely because they are currently "alternatives" to the norm; to produce any outcome at all, they are forced to carve challenging paths through inhospitable political and economic landscapes. These same innovations would likely see much greater returns if they benefited from an enabling political and economic environment and no longer had to navigate at the fringes. For this reason, it is important to learn how these initiatives operate, how they succeeded in positioning themselves within existing food system governance structures, and how these governance structures can realistically be modified. In doing so, equitable and resilient innovations can be scaled to become the conventional, rather than the alternative, food system constructs.

Agroecology

The interest in learning from stories of resilience is not to create a collection of positive, but disjointed accounts; rather, it is to nourish synergies for transforming food systems. A wealth of grounded experiences, social organizing, and research has coalesced around agroecology as an integrated, interdisciplinary food system approach for equity and resilience (Holt-Giménez et al. 2021), and it is an approach that the Food SINERGY network unanimously supports.

Agroecology began as a farming science and practice that treats agriculture as an ecosystem. For example, it applies ecological mechanisms (e.g., nutrient cycling, symbiotic relationships) to improve production without using toxic synthetic pesticides or petroleum-based fertilizers (Wezel et al. 2009; Altieri 2019). As agroecology's momentum increased among peasant and other smallholder farmers (Altieri and Toledo 2011), and as it garnered growing interest among urban consumer groups, research institutes, NGOs, and eventually high-powered international institutions such as the FAO, it evolved to constitute an integrated approach with applications across the entire food system. Recently, an international, multisectoral committee established 13 unifying principles of agroecology: recycling, input reduction, soil health, animal health, biodiversity, synergy, economic diversification, co-creation of knowledge, social values and diets, fairness, connectivity, land, and natural resource governance and participation (IPES-Food 2021).

The application of these principles links to all 17 SDGs (Altieri and Nicholls 2020) and also constitutes a response to the identified concerns with prevailing market capitalism policies. For example, agroecology has been demonstrated to create positive, rather than negative, environmental externalities, such as by restoring biodiversity, cleaning waterways, restoring degraded land, and capturing carbon (Altieri and Toledo 2011; HLPE 2019). Moreover, a growing evidence base suggests that farmers engaging in agroecology-based food systems benefit from greater food security, healthier diets, social empowerment, improved livelihoods, and reduced market dependence (Bezner Kerr et al. 2021; Deaconu et al. 2021*a*, 2021*b*). Meanwhile, consumers obtaining food from agroecological value chains are able to make choices that favour their health and are more consistent with their values (April-Lalonde et al. 2020). The principles of agroecology place economic outcomes alongside, rather than above, social and environmental outcomes (IPES-Food 2021, 2023). At a household scale, this is evidenced by the experiences of farmers who commit to agroecology not necessarily because it raises their household income (though, in many cases, it does (Bezner Kerr et al. 2021)), but because it allows them to work under dignified conditions, strengthen their social capital and assert their cultural values around environmental responsibility. For many, agroecology is a viable alternative to wage labour under conditions that may otherwise create occupational hazards, reinforce social inequalities, or otherwise undermine their well-being (Deaconu et al. 2019; Kansanga et al. 2020; Bezner Kerr et al. 2021).

The livelihoods of nearly half of the global population depend on food production, and most farmers are smallholders (FAO 2023). In this sector, agroecological practices have contributed to resilience in the face of extreme climatic and geopolitical events. For example, in the aftermath of Hurricane Maria in 2017, Puerto Rico was left in a situation of severe food shortage when nominal access to the United States' powerful trade network and humanitarian aid failed to provide a timely response. Yet in some communities, smallholder farmers who applied crop diversification, seed banking, soil conservation, and other agroecological strategies not only supported their own diets, but also contributed to

broader post-disaster food access (Marrero et al. 2022). During the height of the Covid-19 pandemic, studies from multiple countries found that smallholder farmers who applied agroecological principles were more resilient to pandemic-related market disruptions at different scales (Béné 2020; Adhikari et al. 2021; Lyall et al. 2021; Picchioni et al. 2022). For example, in Nepal, rural communities with biodiverse production were not only able to consume their local food during the initial lockdown period, but they were also largely unaffected by international disruptions to agro-input distribution because they used agroecological pest management, soil fertility, and seed conservation strategies (Adhikari et al. 2021). Studies from across Latin America showed how agroecology-based market networks strengthened food system resilience beyond farming communities, with these networks often acting faster than governments in re-establishing supply of fresh foods to urban consumers (Blay-Palmer et al. 2020; Lyall et al. 2021; Tittonell et al. 2021).

In articulating the unique value of agroecology, the Food SINERGY network further emphasized the importance of agroecology's farmer-to-farmer dissemination, the agency of peasant organizations in its conceptual evolution, and its centrality within peasant farmers' practical approaches toward food sovereignty (Altieri and Nicholls 2012). This applied and theoretical buy-in among the populations that are most vulnerable to food system disruptions makes agroecology especially well positioned to yield progress toward equity and resilience.

Avenue 3: Knowledge for transformation

Across disciplines and subjects, the past two decades have witnessed a growing enthusiasm for mobilizing research knowledge to inform better policies and practices, or in other words, for evidence-based decision-making. This has been accompanied by dedicated funds and efforts toward increasing knowledge dissemination efforts, monitoring real-world impact, and linking research findings with education initiatives (Levin 2013). The mobilization of knowledge is fundamentally a social and organizational process, and it is not a one-way street. For example, research topics are often shaped by the interests of governments, private funding organizations, and a vast diversity of other actors. In any field, the mobilization of knowledge is also powerfully impacted by social context (e.g., dominant ideas in society, laws, technology, demographic factors, among others) as well as by organizational structure (e.g., governance, interest groups, legal constraints, among others) (Levin 2013). Hence, examining *knowledge* constitutes a critical exercise for understanding how food system transformation can occur.

A useful entry point is through reflection on the narrative used in discussing knowledge. In the literature, we rely on for studying food systems, terms such as knowledge, evidence, and education are often discussed using qualifiers that create a variety of dichotomies, including formal/informal; Western/Indigenous; modern/traditional; institutional/local; scientific/lay; conventional/alternative. Even if unintentional, these dichotomies can be patronizing (e.g., by romanticizing a type of knowledge) or discriminatory (e.g., by devalorizing a type of knowledge). Dissolving the value judgments created by these qualifiers is necessary for knowledge to better serve action (Nygren 1999; Hildreth and Kimble 2002; Booth 2021). Hildreth and Kimble suggest that it is possible to view knowledge in terms of dualities rather than dichotomies; in dualities, nominally opposing concepts co-exist, are equally valued, and there is no hard line separating them (Hildreth and Kimble 2002). For example, a given actor can mobilize both their "institutional" and "local" knowledge to support more resilient approaches to fisheries management. This is consistent with the "Two-Eyed Seeing" approach proposed by Mi'kmaq Elders to reconcile the application of different, yet overlapping, knowledge traditions in research and to create a more complete overall picture (Bartlett et al. 2012).

Related to this, there are calls to broaden the scope of what constitutes data and evidence, to increase inclusivity in engagement with different types of data, as well as to give due credit to different types of knowledge-holders (Simpson 2001; Calderón 2022). Such transdisciplinary practices allow us to recognize, value, and draw on multiple forms of data—from storytelling to lab measurements—to support the evidence base contributing to food systems transformation. At the same time, they empower diverse actors to engage with different types of data, increasing the likelihood of transformative uses. To illustrate promising practices, some Food SINERGY participants drew on their experience with the First Nations Food, Nutrition and Environment Study in Canada; this study conducted data workshops for participating populations, equipping them to use the raw data to understand and act on the specific needs in their communities (Chan et al. 2021).

For food systems research to be transformative, it is necessary to move beyond knowledge production toward knowledge use. Ironically, the understanding of how to do so has not benefited from very much evidence-based research (Levin 2013). However, in recent years, funders such as the International Development Research Centre, the Canadian Institutes of Health Research, and the Global Alliance for Chronic Disease, among others, have invested in implementation science to begin to bridge the gap between research and practice. Implementation science frameworks guide systematic assessment of the methods and strategies (i.e, the who, what, when, where, why, and how) used to integrate evidence-based practices into routine use (Damschroder et al. 2022).

Part of the effort in bringing together research and practice involves recognizing and reconciling the asymmetries between the predominant forms of knowledge production and the vast diversity of ways that knowledge is used. *Knowledge production* has conventionally been oriented around chain-like cause-and-effect linkages and instrumentalist perspectives that assume that decisions are made based on those linkages. In turn, *knowledge use* is typically much less linear, includes a broader diversity of dimensions, and tends to mobilize different actors than does knowledge production (Kahneman 2003; Levin 2013; Natividad et al. 2021). The processes that occur between knowledge production and knowledge use are still commonly referred to as "knowledge transfer", "lay communication", or in French, *vulgarisation*. Food SINERGY forum participants raised the concern that these

terms imply a top-down bestowment of truth and tend to be dismissive of the existing knowledge of the parties on the other end of the "transfer". Moreover, while science is often presented as neutral, it is not. As noted earlier, the production of data is largely moved by the budgets of funders, which are typically motivated by the funders' interests (Levin 2013). Therefore, it is necessary to move away from the positivist notion that "science knows, and science transfers knowledge" and place greater emphasis on the learning process itself, focusing on how to collectively build, share, and use knowledge that is adapted to a given context.

Action-oriented research and education

To support the use of knowledge for food system transformation, Food SINERGY highlighted the importance of action-oriented research through *participatory, transdisciplinary approaches*. These approaches explicitly connect research objectives to action outcomes and directly engage stakeholder populations (Cornwall and Jewkes 1995). Moreover, participatory approaches aim to support the learning processes of all stakeholders, to question and rectify power imbalances, to expand the perspective of what constitutes valuable data and knowledge, and to bridge the gap between knowledge production and knowledge use (Simpson 2001; Wilmsen 2008; Wallerstein and Duran 2010). In turn, transdisciplinary approaches facilitate intersystemic thinking and action. Food systems, water systems, soil systems, energy systems, and health systems, among others, are terms used to delineate organizing constructs, but they are in fact intricately linked and they often overlap. Transdisciplinary research approaches can support the sensitivity needed to respect complex intersystemic interactions, such as the links between trade agreements, livestock production, soil structure, water quality, and human nutrition (Garcia et al. 2020).

Action-oriented research can be complemented by communities of practice, which bring actors together from different sectors, lived experiences, disciplines, and backgrounds to support inclusive, diverse, and productive exchange of knowledge for effective collaboration on a given subject (Hildreth and Kimble 2002). Communities of practice recognize that knowledge is contained not only in documents and databases, but also in the grounded experiences and skills that are generally associated with knowledge use. By blurring the boundaries between knowledge producers and users, communities of practice are recognized for their potential to generate meaningful outcomes (Levin 2013).

Finally, members of the Food SINERGY network, many of whom are educators through organizational programming or in university settings, identified the need to extend the discussion around knowledge into education. In our collective experiences, we have observed that some forms of knowledge are not only undervalued, but altogether absent in many academic institutions. This undermines our interest in creating resilient food systems that are equitable for populations across the planet. As Booth explains, "to generate this sense of a common humanity, learners need not only to have the opportunities within the curriculum to develop global awareness, but to be exposed to ways of learning that harness "the collective dimensions of knowledge" […] required to engage with the uneven impact of globalization and climate change" (Booth 2021). For knowledge to be more equitable, we identified the need to diversify the types of actors serving as educators, create greater cross-over between diverse learning communities, dispel class hierarchies that drive educator–learner relationships, and promote greater bidirectionality of exchange between people acting as educators and those acting as learners in a given setting. Specific examples of how to do this in relation to food systems education might include: hiring farmers to teach university students; creating educational experiences in which rural and urban populations overlap as equals; facilitating reciprocal knowledge exchange activities around agriculture (such as in the Campesino-a-Campesino methodology (Rosset et al. 2011)), in lieu of "transferring" knowledge through agricultural extension agents; including participatory research approaches into curricula; and creating learning opportunities for policymakers.

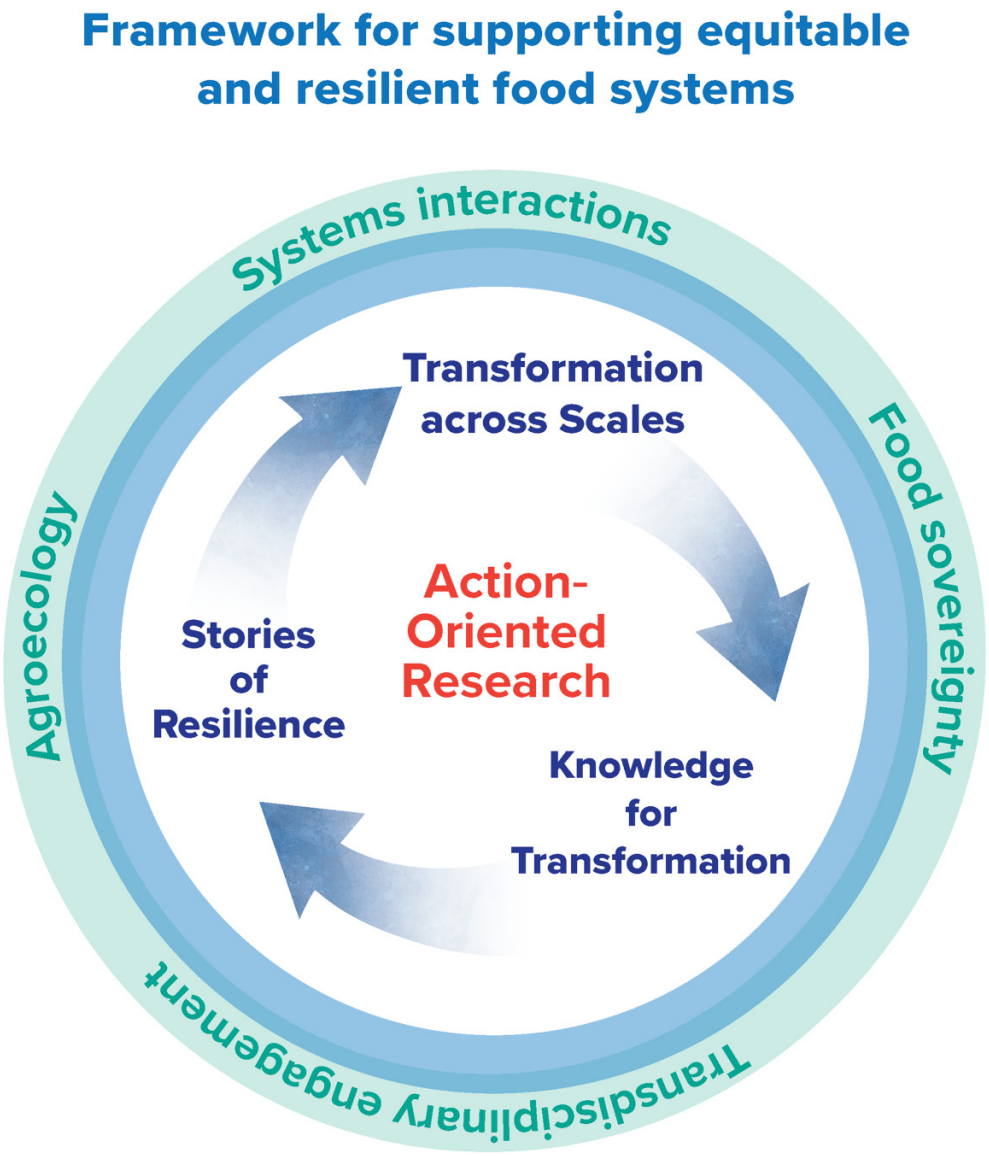
For Food SINERGY, reflection on knowledge and education was fundamental for advancing food system transformation. The forum concluded with the emphatic assertion that research and education must be viewed not only as learning processes, but as active mechanisms for shifting the food system narratives that guide decisions at all scales.

Takeaway messages from the food SINERGY forum

Food SINERGY was convened out of a shared concern over the food system's staggering culpability in climate and environmental change, and its implication in a multitude of social, economic, geopolitical, and public health quandaries. By the same token, transforming food systems has monumental potential to improve the environment, provide just livelihoods, address malnutrition, and reduce the frequency and severity of armed conflict and infectious disease (Willett et al. 2019; Clark et al. 2020; United Nations Environment Programme 2022; IPES-Food 2023; United Nations 2023). In terms of climate change alone, transforming the global food system can significantly mitigate future climate change while also making the system more resilient to the consequences of it (Shukla et al. 2019; Willett et al. 2019; FAO et al. 2022). Hence, it is a strategic entry point to pursue integrated solutions for complex, globally shared problems.

Synergy is achieved when an interaction or cooperation between multiple groups, actors, or agents produces a combined effect that is greater than the sum of each of their separate effects. This term speaks to the objectives of Food SINERGY to create transdisciplinary collaborations for food system transformation in favour of interacting and mutually reinforcing, positive societal impacts. We root these objectives in the cautious optimism expressed by diverse food system leaders who sustain that, in the light of uncertainty, new possibilities and pathways are opened (Blay-Palmer et al. 2020) and that we need to challenge the narrative that there is no

Fig. 2. Depiction of how action-oriented research can bring together key themes highlighted through Food SINERGY to support equitable and resilient food systems.



alternative (Lappé 2023). Food SINERGY thus advances the below key points, intended to guide synergies, identify opportunities, and challenge narratives to transform food systems toward equity and resilience. These points are also summarized in Fig. 2.

Food system resilience: Diversified strategies must be implemented to build stable redundancies and stopgaps into the food system, such that if one strategy fails, others can quickly and effectively fill the gap. As a cornerstone of resilience, diversity refers not only to diversified economic and production arrangements, but also social, cultural, and ecological diversity.

Equity through food sovereignty: Development of resilience must be transformative, such that it does not reinforce an inequitable food system. Key to this transformation is food sovereignty, an organizing concept that takes its lead from under-represented voices to provide guidance for addressing interlinked environmental and social equity concerns in the food system.

Transformation across scales: Local food systems and international trade must be reconciled to leverage complementarities between them. Food sovereignty must be supported not just locally, but at all geopolitical scales, and equitable trade agreements must be designed to protect food sovereignty around the world. To do so, it is necessary to seek consonance in policies across different scales.

Learning from stories of resilience: Existing innovations challenge predominant economic tenets and provide viable examples of how to support more equitable exchanges, more responsible resource management, and more favourable outcomes to human and environmental health and well-being. Agroecology stands out as an integrated approach that a diversity of actors, from peasant farmers to international agencies, have identified as key for equity and resilience.

Knowledge for transformation: It is necessary to build equitable and inclusive relationships between diverse types of knowledge, as well as move beyond knowledge production toward knowledge use. Participatory, transdisciplinary approaches provide tangible means for research programs to advance toward these objectives. In learning settings, a greater diversity of food system actors is key. Ultimately, research and education must not only seek to understand how food system transformation can occur, but actively contribute to shifting the food system narratives that guide decisions at all scales.

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