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GLOBAL INSIGHTS

Do climate-resilient market systems hold the key to transforming access to nutrient-dense foods?

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The inadequate consumption of nutrient-dense foods (NDFs), particularly fruits and vegetables and animal-sourced foods, contributes to a range of health and nutrition problems. It is important to eat fruit and vegetables to achieve micronutrient sufficiency and to help combat cardiovascular disease and some cancers (Aune *et al.*, 2017; Lim *et al.*, 2012). Animal-sourced foods are a valuable font of bioavailable micronutrients and have been associated with reduced child stunting (Asare *et al.*, 2022; Zaharia *et al.*, 2021).

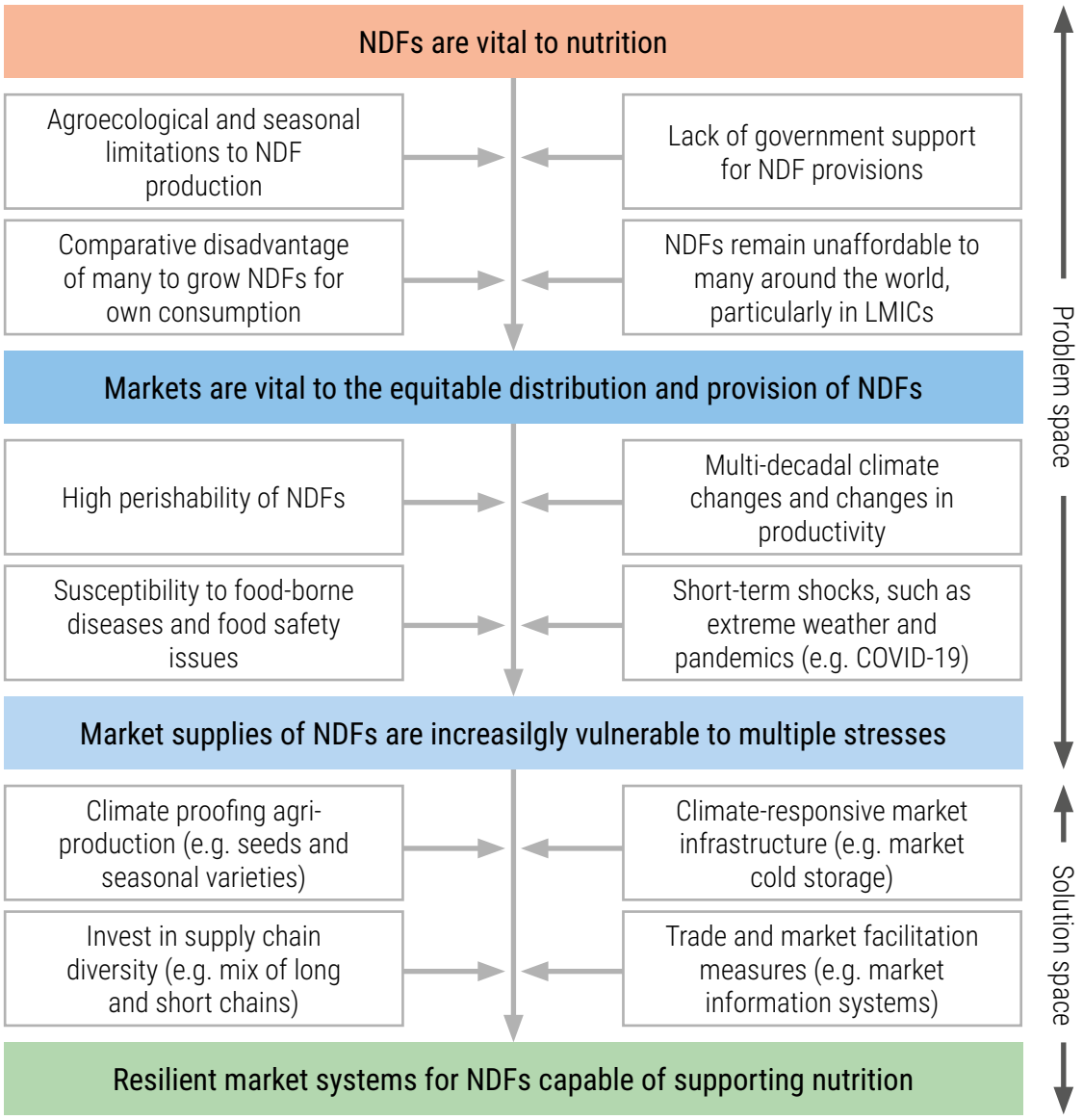
With only eight years in which to achieve the Sustainable Development Goal 2 (SDG 2) targets of "Zero Hunger" and "zero malnutrition", physical and socioeconomic access to safe, desirable and stable supplies of NDFs is still widely regarded as inadequate in much of the world (FAO *et al.*, 2021; GLOPAN, 2020). A recent review by Frank *et al.* (2019) estimated that only 18 percent of individuals in low- and middle-income countries (LMICs) consumed the World Health Organization's (WHO) recommended 400 grams per day of fruits and vegetables.

Market interventions for NDFs

Well-functioning food markets are critical to the equitable delivery of NDFs to LMIC populations. Even in low-income agricultural settings, households have been found to rely heavily on markets to build dietary diversity and improve nutritional outcomes, particularly in lean seasons (Abay and Hirvonen, 2017; Sibhatu, Krishna and Qaim, 2015; Zanello, Shankar and Poole, 2019). The almost exclusive delivery of fruits and vegetables and animal-sourced foods via market mechanisms contrasts with the marketing of staples, which are often subject to public support, for example, in the form of public distribution systems. Furthermore, unlike most staple cereals and pulses, which may be stored for months, the perishability of fruits and vegetables and animal-sourced foods magnifies the importance of efficient transport, storage and market information systems in combating problems such as food loss, price instability and the degradation of food quality (Figure 1).

Government policies for NDFs traditionally focus on upstream aspects, targeting commercial opportunities for farmers, while interventions by civil society predominantly focus on consumer elements (such as home or kitchen gardens, or improving food environments). However, there is growing recognition of the transformative potential of broader, nutrition-sensitive, market-focused interventions that focus on food-system processes between the farm gate and retail food environment (namely, storage and processing, distribution and market infrastructure).

Figure 1. Conceptual framework linking the problem space of vulnerable NDFs and the potential solution space of climate-resilient market systems



SOURCE: Authors' own elaboration.

These interventions ultimately aim to improve the efficiency, equitability and safety of NDF distribution, storage and marketing (Allen and de Brauw, 2018; Cooper *et al.*, 2021; Gelli *et al.*, 2015). Prominent examples include the upgrading of physical (for example, cold storage at market sites and improved inter-market road connectivity) and/or digital infrastructure (such as price information systems), as well as the formalization of food safety standards at markets sites (Figure 1). Market interventions have the potential to impact large numbers of consumers and are inherently scalable, as they facilitate a natural propensity to buy, sell and exchange. Moreover, when designed with consideration for nutrition, they can cut across individual food value chains to boost several NDFs simultaneously.

Resilience in the perfect storm

While markets present potential leverage points for scaling up equitable access to NDFs, it is important to note that they are something of a double-edged sword. The effects of market failure are felt disproportionately by those sections of society most vulnerable to bottlenecks associated with unequal access to technology and infrastructure, geographical and/or economic remoteness, and structural inequalities (for example, women, the economically disempowered and other marginalized groups).

The concept of food-system resilience has gained prominence over the past decade, particularly in relation to the recovery

of food availability and affordability following natural or man-made shocks (Béné, 2020; Béné *et al.*, 2016). The prioritization of short-term shocks reflects the need to recover food security immediately following a crisis, often by providing humanitarian relief. In this context, the COVID-19 pandemic and the effects of associated travel restrictions on food distribution are widely acknowledged to have exposed the lack of resilience at the heart of our food systems (Fan *et al.*, 2021; GLOPAN, 2021; Swinnen, McDermott and Yosuf, 2021).

However, if we wish to transform nutrition beyond 2030, we must also strengthen markets to deal with the creeping changes we are seeing as the Earth's system moves beyond the relatively stable environmental conditions that have supported human development for the past 12,000 years (Rockström *et al.*, 2020; Steffen *et al.*, 2018).

The latest Intergovernmental Panel on Climate Change (IPCC, 2022) and International Food Policy Research Institute (IFPRI, 2022) reports add further weight to the notion of an impending "perfect storm" (Beddington, 2009), involving decadal-scale changes in average temperatures and rainfall patterns, plus increasingly frequent and extreme weather events associated with cascading disturbances such as wildfires and floods. The primary impacts are further magnified by secondary drivers, including (but not exhaustively) projected declines in the yields and nutritional values of fruits, vegetables and seeds in a warmer world (Alae-Carew *et al.*, 2020; Scheelbeek *et al.*, 2018), the intensification of conflicts around food scarcity (Queiroz *et al.*, 2021), and national and international population changes as a result of climate-induced migration (Barnett and Adger, 2007).

Plotting the way forward: climate-resilient market systems

Finding new and sustainable ways to build resilience to the impending perfect storm of intensifying climate-related drivers is vital, given i) the nutritional importance of NDFs, ii) their vulnerability to spoilage, and iii) the implications of market failure for all associated actors. However, empirical evidence for market-actor resilience remains "factually non-existent" (Béné, 2020, p.810). While the Market System Resilience framework of Downing *et al.* (2018) qualitatively links resilience to various behaviours, including cooperation and competition, it prioritizes short-term extreme events over multi-decadal creeping trajectories.

Two systematic reviews provide further evidence of this knowledge gap. First, Meyer (2020) identifies the dominance of studies on the resilience of production (for example, climate-resilient agriculture) and adaptive farmer behaviours following a shock – recommending the need to study resilience beyond the farm gate. Second, in the context of supply-chain resilience to environmental shocks, Davis, Downs and Gephart (2021) find that both the study of perishables and the study of midstream storage, processing and retail dynamics are disproportionately underrepresented relative to staple crop production.

Therefore, a number of knowledge gaps erode our ability to develop climate-resilient market systems to help achieve global nutrition targets by 2030 and beyond. These include understanding the market interventions that help to improve equitable access to NDFs while imbuing resilience against multiple interacting climate-related stresses; exploring how to synergistically combine interventions to maximize resilience in multiple supply-chain segments; and identifying interventions which, when scaled up, may actually contribute to climate change (for example, via greenhouse gas emissions) and subsequently undercut long-term resilience. Given these knowledge gaps, it is not unreasonable to suggest that local food-system actors and policymakers are having to navigate the perfect storm while blindfolded.

To remove the blindfold, and in line with the long-standing concept of social-ecological resilience (Folke, 2006), market interventions must help local actors to anticipate long-term changes (in average temperatures, for instance) and short-term shocks (such as droughts); strengthen market capacity to absorb external (such as climate change) and internal (such as crop productivity declines) stresses; and reorganize markets onto more resilient trajectories following failure.

To this end, the examples in Table 1 are underpinned by two key concepts. First, the influence of interventions must extend beyond physical marketplaces, involving both the upstream processes of distribution and downstream processes of food safety, food loss and consumption choice. The inability to account for feedback loops across food supply chains is known to lead to unforeseen and unintended consequences (Nicholson *et al.*, 2020), such as improving outcomes at one end of the chain (for example, agricultural livelihoods) while degrading outcomes at the other (for example, nutritional outcomes). Therefore, we argue for a "whole-market" approach to resilience, whereby climate-resilient market systems proactively foster synergies and counter trade-offs impacting all actors buying and selling NDFs.

Second, as long established in natural resource management fields (Carpenter *et al.*, 2001), diversity must be about more than production diversity. In a whole-market approach, diversity must aim for equitable access to a mix of short and long supply chains, individual and collective marketing approaches, multiple transport, storage and

energy alternatives, and an emphasis on dietary diversity in consumer policy and programming (Table 1). Building diversity in the market system is a prudent strategy for insuring against growing systematic risk, but may involve efficiency trade-offs in the short to medium term. However, the long-term benefits associated with flexibility and adaptability are likely to be considerable, and governments must prepare to invest and legislate accordingly.

Table 1. Example market-system interventions to boost climate-related resilience and improve accessibility to NDFs in underserved markets and communities

Intervention	Rationale behind intervention	Potential trade-offs and traps
Investing in climate-proof seed varieties and livestock breeds.	Attempt to ensure yield impacts of climate shocks are minimized (currently the area where most resilience focus is concentrated).	Without efforts to maintain crop diversity that adapts to changing climate conditions, there is a risk of monocultures emerging that lock-in production to past conditions.
Establishing price information systems connecting producing villages to market sites and larger wholesale markets to downstream retail markets.	When climate or other shocks cause a deficit in one area and local prices spike, produce can flow from surplus areas in response to price signals.	Information systems should be publicly accessible to improve market transparency for as many actors as possible. Entrance barriers (such as membership fees) may lock out smallholder farmers.
Strategically developing a mix of short and long supply chains for NDFs.	When one or more supply chains fail, other lines of supply can quickly fill the gap.	Access to supply chains may be moderated by farmer size, status and/or other socioeconomic barriers. Additional interventions may be required to ensure market access is equitable
Mix of traditional spot-based market yard transactions, contract farming and online e-commerce platforms.	As above; in addition, by removing the need for market actors to spend multiple hours outside negotiating terms and prices, virtual marketplaces help to reduce heat exposure for both people and perishable produce.	Innovative e-commerce platforms such as "B2B apps" may be less accessible to older and/or less technologically savvy market actors. Further, new marketing pathways may require buyer-seller relationships built up over many years to be broken.
Use climate-resilient infrastructure when upgrading markets, including increased use of shade and ventilation, raised platforms and improved wastewater management. Energy supplies should also be renewable.	As temperatures continue to increase, precipitation patterns change and extreme events become more frequent, climate-proof infrastructure in markets will help farmers, traders and consumers to continue accessing the marketplace.	Upgrades should avoid costing farmers and market actors both directly, for example, by requiring these actors to self-fund infrastructure upgrades, and indirectly, for example, by reducing the capacity of the market. Access to climate-proof infrastructure should not be conditional on overcoming entrance costs.
Market site-based cold-storage development, particularly energy-efficient and clean technology (such as solar-powered) options.	Enables NDFs to be sold to consumers over longer periods by lengthening shelf-life, especially as heat episodes worsen.	Similar to above, cold storage access may be unequal, especially if there are participation costs. Also, unclean energy options will be associated with undesirable greenhouse gas emissions.
Invest in strategies to combat food losses at multiple stages of food supply chains, for example, through better handling, packaging and secure transportation.	As horticultural productivity changes in response to heightened temperatures and extreme events, reducing leakages from the supply chain will be vital to livelihood and food securities.	Access to food-loss strategies should not depend on overcoming unreasonable participation barriers. Similarly, reduction strategies should not be reserved for the urban markets or the supply chains serving the most exclusive consumers.
Improved food safety and quality standards, particularly in retail food environments/markets, for example, covering of produce, improved hygiene practices of retailers, training on avoidance of contamination.	The perceived desirability of food is generally considered a major driver of consumption. Practices that guard against food adulteration and contamination will help to counteract losses in food accessibility generated by declines in productivity and increases in spoilage.	In common with the examples above, existing inequalities must not be reinforced by reserving food safety interventions for urban "elite" consumers and/or international export supply chains.

SOURCE: Authors' own elaboration.

Understanding the climate-resilience of nutrition-sensitive markets will require the increased application of methods capable of handling multiple dependent and independent variables, often connected by feedback loops, such as in-depth qualitative narrative approaches and non-linear simulation approaches, such as system dynamics modelling and agent-based modelling. The last 15 years have seen significant progress in the comprehension of policies and interventions that help to build more nutrition-sensitive and inclusive food systems. However, given the need to preserve nutritional gains made in the lead-up to 2030, as well as to "future-proof" any policies and approaches beyond 2030, we must treat today as a window of opportunity to start exploring the extent to which market-based interventions either reinforce or undermine resilience to projected 21st-century climate stresses.

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