CHAPTER 6

Food Systems, Resilience, and Their Implications for Public Action

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Introduction

The last 15 years has seen global food systems subject to two major shocks—the 2008 food prices crisis and the COVID-19 pandemic that began in early 2020. Country-level shocks such as drought and floods continue—in 2020 alone, nearly 34 million people in China and India were affected by flooding (CRED, 2021). While global per capita food production continues to increase, the multi-decade trend of falling numbers of persons considered to be undernourished appears to be coming to an end. There is also increased concern over the quality of

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diets that global food systems provide, and the environmental impacts of the farming practices that provide the food for these diets.[1]

These stylized facts have informed increased use of two concepts: food systems and resilience. This chapter seeks to contribute to efforts that bring these two notions together with a view towards understanding how a resilience lens can improve our understanding of food systems at local and global levels, how resilience can be better measured and assessed, and how this, in turn, contributes to improving food security interventions and policy. It consists of three sections: Building blocks; Linking resilience to food systems; and Implications for public action.

Building Blocks

The last ten years has seen an outpouring of work on the concept of food systems, based on a recognition that because of the multiplicity of factors that underpin food security, a too heavy emphasis on a single component (say production or markets) is insufficient (Reardon & Timmer, 2012). Examples of this work include HLPE (2017), Béné (2020), FAO, IFAD, UNICEF, WFP and WHO (2020), FAO (2021), and Herrero et al. (2021). While these approaches differ in detail, common to many are the following actors—producers; processors; distributors; and consumers—and a view that the objective of a resilient food system is to meet dietary needs in a sustainable fashion (HLPE, 2017). These approaches to food systems are careful to note that there are multiple food products within a food system, each characterized by its own value chain and that there are heterogeneities within each element. Further, distinctions between these elements are not always clear cut—a notable example being households in low-income countries who are food producers, processors, and consumers of their own production.

Just as there are many definitions of food systems, there are many definitions of resilience. These include: (1) Resilience as the *capacity* to withstand or absorb sudden or chronic shock (Béné, 2020; Constas et al., 2014; FAO, 2016); (2) Resilience as *recovery*; the extent to which food

[1] I have benefitted from ongoing discussions about food systems and resilience with Chris Barrett, Andrea Cattaneo, Mark Constas, Marco d'Errico, Rebecca Pietrelli, and Maximo Torero. This chapter has been made substantially better by the detailed comments provided by Chris Béné and Stephen Devereux. Errors are mine.

security (or other measure) returns to its pre-shock state. This conceptualization of resilience hews closely to the use of the concept in ecology and engineering, and to the word's etymological roots (Hoddinott, 2014; Hoddinott and Knippenberg, 2017; Béné, 2020); and (3) Resilience as a *normative condition*; the capacity to avoid adverse well-being states (or achieve a desirable state) in the face of exposure to shocks and stressors (Barrett & Constas, 2014; Cissé & Barrett, 2018).

Central to discussions of resilience are the concepts of shocks and stressors to different actors within the food system. Shocks are events, either positive or negative, the timing and severity of which cannot be precisely predicted in advance. A stressor is a long-term trend that adversely affects a system and increases the vulnerability of actors within that system to shocks. Shocks emanate from the settings (Hoddinott & Quisumbing, 2010)[2]—physical, social, political, legal, and economic—in which actors operate (a covariant shock), or they could be restricted to only one person or household (an idiosyncratic shock) (Dercon et al., 2005). The distinction between covariant and idiosyncratic shocks is not always clear-cut. A drought in only one locality might result in poor, rainfall-dependent households selling assets to richer, non-rainfall dependent households so, although the event was common to both, it adversely affected only the poor. Further, shocks can vary in terms of speed of onset, duration, and intensity. These shocks can affect the settings themselves, household assets, or the processes by which these assets are used to generate income (Hoddinott & Quisumbing, 2010).

Building on these ideas, food systems resilience can be defined as the capacity over time of a food system to sustainably provide sufficient, appropriate, and accessible food to all, in the face of shocks and stressors.

[2] The physical setting refers to natural phenomena such as the level and variability of rainfall, the natural fertility of soils, distances to markets, and quality of infrastructure. The social setting captures such factors as the existence of certain norms of behaviour, of social cohesion and strife. The legal setting can be thought of as the general "rules of the game" in which exchange takes place, which, in turn, is partly a function of the political setting that captures the mechanisms by which these rules are set. Finally, there is an economic setting that captures policies that affect the level, returns, and variability of returns on assets (Hoddinott & Quisumbing, 2010).

Linking Resilience to Food Systems

Two themes underpin this section. First, more is known about the resilience of some (but not all) components of food systems than is commonly recognized. Second, there is relatively little understanding of how the resilience of these components fit together.

Some additional comments about the first theme are warranted. There is a long-standing literature within agricultural economics that examines how (and how successfully) food producers manage risk (see for example, Moschini and Hennessy [2001] for a summary of the older literature on this topic and Tack and Yu [2021] for a more recent review, defined as the possibility of different types of shocks (covariate or idiosyncratic) being realized. Characterizing these ex ante actions is consistent with the notion of resilience as the *capacity* to absorb shocks. Within the literature on the functioning of food markets (distributors, both wholesalers and retailers), there has been a considerable body of research into the extent to which these markets are integrated and why some markets are more integrated than others. As discussed below, such approaches are consistent with the notion of resilience as *recovery*. Lastly, there is a large literature on household resilience, much of which will be discussed elsewhere in this book. This literature will be very briefly summarized. By contrast, there appears to be much less work on food systems resilience (or related literatures such as risk management), the focus of this chapter.

Food Production Resilience

Food production is seen as a core component of food systems (FAO, 2021; HLPE, 2017). However, with the recent exceptions of FAO (2021) and Constas et al. (2021), there is much less explicit work on measurement of food production resilience. In part, this reflects enormous variations in agro-ecological conditions and in how food is produced around the world. As described by Savary et al., "These production units include the large-scale commercial farms of the global North, with their high level of mechanisation and inputs (synthetic and also biological, with highly selected and specialised seed) as well as the small-scale, smallholder farms of the global South, with their large labour force, their crop diversity, the frequent inclusion of livestock in agriculture, and their limited reliance on external inputs" (Savary et al., 2020, p. 695). That noted, consider the notion of resilience as the capacity to withstand or absorb sudden shocks or chronic stressors. Measures of the resilience of food production can either be a summary statistic that captures this ability or as characteristics of the organization, structure, and process of food production that are believed to be associated with the summary statistics. With the important caveat that the ideas below are exploratory, we describe both approaches below.

Before doing so, we briefly set out a conceptual model of food production. The farming unit has endowments of capital and labour. Capital includes physical capital (agricultural tools, livestock), natural capital (land), human capital (in the form of knowledge, skills, and health), financial capital, and social capital (Scoones, 1998). The farmer allocates these endowments, along with purchased inputs, across a series of agricultural activities. (For simplicity, we ignore allocations to non-agricultural activities.) These allocations are based on perceptions of the level and variability of activities returns, as well as their covariance. For example, farmers may decide to grow a mix of crops that embody differing levels of susceptibility to climatic shocks and returns. Crops may be grown in different locations, may be temporally diverse (that is, grown at different times or different crops may grow to maturity at different speeds) or may be intercropped. Once these allocations are made, shocks that threaten crop or livestock production (covariant or idiosyncratic) occur; these are outside the direct control of the farmer. It may respond to these shocks through undertaking compensating or reinforcing actions (for example, undertaking additional weeding in fields affected by a weed infestation; spending more time harvesting a field where production had been atypically high) (Hoddinott & Quisumbing, 2010).

A summary statistic of food production resilience at the national level—or to phrase more precisely, a summary statistic of domestic food production resilience—captures the outcome of these allocations, the shocks and the compensating or reinforcing actions can be measured in physical or monetary terms; it does not attempt to disaggregate or disentangle how the outcome has come about. One such summary statistic is outlined in Zampieri et al. (2020); a simplified version of their approach goes as follows.

Consider circumstances where the shocks adversely affecting food production are so severe, or the ability of farmers to respond to shocks so limited, that the consequence of the shocks is total crop failure. The probability that this occurs is given by F where $0 < F < 1$. We can think of a farm (or locality or country) with resilient food production as the reciprocal of the probability of total crop failure.

$$R = 1/F \tag{6.1}$$

As $F \rightarrow 0$, R rises in value. As $F \rightarrow 1$, R approaches 1 and so an increase in the value of R captures the notion of greater resilience of food production. Next, make the strong assumptions that mean production over time and variations in production over time are both trendless. Following Zampieri et al. (2020), define P as the level of production that occurs when conditions are optimal and allow only two states of the world: one where crop production is optimal and one where crop production fails totally. With these strong assumptions in mind, over time, the mean and variance of food production are given by:

$$\mu = P(1-F) \tag{6.2}$$

and

$$\sigma^2 = P^2(1-F)(F) \tag{6.3}$$

Manipulating these expressions yields:

$$R = \mu^2/\sigma^2 \tag{6.4}$$

Equation (6.4) is the summary statistic. Food production resilience is the inverse of the coefficient of variation of production squared. A higher value for R corresponds to greater production resilience. Note that this is consistent with intuition. Variability in production (the denominator) increases when farmers are less able to minimize the effects of adverse shocks (for example, where farmers lack access to irrigation, there will be greater year-to-year fluctuations in output because of differences in rainfall over time; this increased variability increases the magnitude of the denominator and thus lowers R. Conditional on σ^2, increased production is associated with greater resilience; the intuition here being that at higher levels of production, a given level of variability represents a small fraction of total output.[3]

[3] Zampieri et al. (2020) show how to adapt this approach to circumstances where production is non-stationary or where more than one crop is produced.

We end this section noting the following. First, elements of the conceptual model described above contain characteristics believed to be associated with summary statistics for food production resilience. For example, we should expect that measures of endowments and actions that reduce variability in production will be correlated with increased production resilience. Examples include measures of farming practices that reduce the likelihood of crop failure (for example, intercropping and crop rotation), the availability of irrigation (or more generally, resources that reduce reliance on rainfall and improve water control), and improved availability of inputs (captured, for example, through measure of the thickness of input markets.) Second, as Savary et al. (2020), FAO (2021), and many others have noted, diversification—the choices farmers make about what they grow, where, and when—is seen as one way in which farming can be made more resilient. Diversification indices for what is grown include the Shannon and Simpson diversity indices; as the literature on farm fragmentation shows, these can also be adapted to capture spatial diversity in production (see Knippenberg et al., 2020, for references and FAO (2021) for more recent work on measuring production diversity). However, there is a risk that "too much" diversification might come at the cost of reduced efficiency in production, for example, because of a loss of economies of scale or in comparative advantage.

Second, this measure pertains to resilience of domestic food production. It does not account for international trade. In principle, low domestic production resilience can be offset through food imports, though this does expose domestic food supply to shocks that emanate outside the country. We return to this point when we discuss implications for public action.

Resilience in the Food Processing Sector

Globally, the food processing sector is enormously heterogeneous, ranging from the large meat processing plants employing hundreds of workers to women grinding grain harvested from their own fields. Unlike food security, there are no well-developed, validated metrics for resilience in the food processing sector. Nor, unlike food production or food markets, are there measures that can be adapted to capture aspects of resilience. That said, literatures on supply chains and on recent experiences arising from the COVID-19 pandemic suggest several possible metrics that could be developed to capture resilience within the food processing sector.

The supply chain literature: Aboah et al. (2019) argue that flexibility is a key attribute in the resilience of value chains. Applying their approach specifically to the processing sector, flexibility includes the ability to: re-organize production/processing in response to a shock; obtain raw foods from other sources should disruptions affecting existing suppliers; and tap alternative distribution channels. Relatedly, stock holdings can also play a role by reducing processors' vulnerability to transitory shocks in the supply of inputs.

COVID-19 experiences: Taylor et al. (2020) document the spread of COVID-19 among workers in US livestock plants. They note that such operations are susceptible to the transmission of coronaviruses for several reasons, including that their employees work long shifts in close proximity to coworkers. They also note that in the United States, 12 plants produce more than 50 per cent of the country's beef and 12 other plants are responsible for more than 50 per cent of pork production. Rotz and Fraser (2015) also document increased concentration within the North American food processing sectors. Three examples from their paper illustrate this:

- As early as 1962, the largest 50 processing firms in the United States controlled 70% of market sales
- As of 2015, the four largest processors in the United States milled more than half of all wheat flour
- The three largest US meat packers control 80 per cent of the American beef market.

Given all this, Savary et al.'s (2020) description of how COVID-19 affected the North American food processing sector is not surprising. "Labour shortages have also been an issue for large-scale food processors and suppliers. A growing number of workers are taken ill in food processing facilities where the operational model is not conducive to safe physical distancing. Consequently, a large number of food processing plants temporarily suspended production in Europe and North America" (Savary et al., 2020, p. 704).

Putting these disparate studies together suggests that resilience within the processing sector reflects three considerations: (a) the extent of market concentration within the sector. Countries where food processing is dominated by a small number of firms may be less resilient to shocks that affect their workforces; (b) the availability of substitutes, for example, through imports. While the shocks described by Savary et al. (2020) were disruptive—particularly for meat processing and packaging—the availability of other sources of animal source foods lessened their impacts on consumers; and (c) more speculatively, the degree of labour intensity within the processing sector with greater intensity associated with lower resilience (Reardon & Swinnen, 2020). We do not have good candidate summary statistics that capture all of this.

Resilient Food Markets

There is a vast academic literature on the structure, conduct, and performance of food markets in low-, middle- and high-income countries. This literature rarely speaks directly to the notion of resilient food markets. However, the literature on spatial market integration provides relevant insights.

We begin with an adaptation of the Takayama—Judge model described by Fackler and Goodwin (2001) and Fackler and Tastan (2008) as a point-location model. Geographically separated locations are represented by points or nodes. Assume that no node is connected to another. Within each node, the price of food is determined by local production (supply) and local demand. An adverse shock to supply—say a drought or flood occurs—causing supply to fall. With no means of offsetting this, food prices rise and remain persistently high until supply is restored. In extreme versions of this (and where there are no offsetting increases in wages or income), the result could be famine; see Devereux (1988) and Ravallion (1987, 1997). Seen in this way, these unconnected geographically separated food markets are not resilient—they lack the *capacity* to withstand or absorb sudden or chronic shock and their *recovery*—the extent to which prices return to their pre-shock state—is slow.

Next, we relax the strong assumption that no node is connected to another by introducing a set of transportation routes or links. Links and nodes together constitute a trade (market) network (Fackler & Tastan, 2008). Again, consider a supply shock in one node. The initial effect is to raise prices in that node but, by so doing, prices differ across the two nodes. Traders can exploit this through arbitrage, buying food in the node not affected by the supply shock, then transporting it to and selling it in the node where the supply shock occurred. This has the effect of slowing the rise in food prices in the affected node, allowing them to return to their pre-shock state more quickly. But it also, potentially, causes prices to change in the non-affected node. The extent of the transmission of the exogenous price shock in the affected node to prices in the non-affected node is captured by measures and methods of assessing market integration. These include error correction models, cointegration analysis, and parity bounds models (von Cramon-Taubadel, 2017; Kabbiri et al., 2016; Varela et al., 2012).

With caveats that we return to below, we assert that more integrated food markets are more resilient food markets. In turn, this takes us to the question as to what features influence the extent to which markets are integrated. These fall into four categories: (1) Information flows; (2) Transactions costs; (3) Government regulations on trade; and (4) Market structure.

Knowing that prices differ across markets is necessary for arbitrage to take place (Jensen, 2010). Quantifying these information flows is challenging. A proxy measure used in a handful of studies is some measure of access to communications technology. An older study by Goletti et al. (1995) examining rice market integration in Bangladesh between 1989 and 1992 found that the number of telephones per capita was associated with reduced market integration, a somewhat counterintuitive finding. By contrast, Aker (2010) finds that the introduction of mobile phones reduces dispersion in prices in rural Niger, and Jensen (2007) shows how arbitrage in south Indian fish markets increased after the introduction of mobile telephony.

Transaction costs may also affect market integration. *Ceteris paribus*, these will be higher the farther markets are away from each other, and several studies show this (for example, see Varela et al., 2012). Direct measures of transaction costs are rare, however with Zant (2013) being an exception. Instead, road density and quality can be used as proxies for transaction costs—higher quality roads can be travelled more quickly and can support larger vehicles, allowing for greater economies of scale in transport. FAO (2021) extends the measurement of road networks to encompass two additional ideas: route redundancy (the availability of alternative routes when a road link is broken); and detour costs, the extra costs incurred when a route is closed and the shortest alternative route needs to be taken. Scale economies may also arise when markets are larger (put differently, per unit transportation costs are an inverse function of volume, Jensen, 2010). Some studies capture this idea of scale economies by including measures of the size of the market, population or population density or incomes per capita.

Arbitraging across spatially separated markets will be affected by government regulations on trade as well as the broader legal and policy environment in which trade takes place. The strongest version of these are prohibitions on the movement of food products across administrative borders. Requirements that marketed surpluses be sold to state-owned entities accompanied by the use of fixed, below market procurement prices are another form of intervention as is the use of government buffer stocks (both purchases for and sales to). Dercon (1995) and Rozelle et al. (1997) document that reductions in government involvement in grain markets in Ethiopia and China, respectively, improved market integration. That said, Ismet, Barkley, and Llewelyn (1998) argue that government intervention in Indonesian rice markets enhanced market integration but with the caveat that procurement prices were relatively high. Martin and Anderson (2012) argue that restrictions on movement of food products, specifically exports, was a significant factor in contributing to the rise in global food prices in 2008; noting that once a few countries started to do so, others quickly followed suit resulting in a cascade of export bans and subsequently panic buying by other countries that were dependent on food imports to meet domestic food security needs. Possibly having learned from the policy mistakes made in 2007–08, fewer government-imposed restrictions on food exports; by late 2020, only 13 countries had done so. These affected only a minimal amount of the volume of food traded globally, around one per cent of global-traded calories (Martin & Glauber, 2020) and many of these were subsequently rescinded.

Market structure could contribute to either enhancing or detracting from market integration. As Kabbiri et al. (2016) note, market concentration may allow for economies of scale in the collection of information on prices and on transport, thus allowing such traders to respond more quickly to price differentials. But they also note that traders may have an incentive to sustain market segmentation to keep prices artificially high. Evidence on the impact of market structure on market integration appears to be lacking.

We end with two interrelated caveats. First, the description provided here focuses on domestic markets. Integration into regional and/or global markets can also provide resilience to domestic food markets as well as potentially reducing prices. Just as with domestic food markets, the quality of infrastructure linking markets in different countries along with the regulatory environment—specifically rules and tariffs governing cross-border trade—will affect the extent of market integration; see Brenton et al. (2014) for an example. Second, tensions exist between open and closed food systems. Food markets that are more regionally and globally integrated are more likely to be affected by shocks that occur elsewhere, see Bekkers et al. (2017). Put differently, while integration into global markets that creates *dependence* on imports may result in a less resilient food system whereas *diversification* of food supplies so that they include imports (or the ability to import as needed) may increase food system resilience.[4]

Food Security Resilience[5]

Up to this point, our focus has been on the supply side of the food system. Analyses of food systems, however, also include the demand side; more specifically food security outcomes (see, for example, HLPE, 2017). In contrast to other elements of the food system, extensive attention has been paid to resilience at the level of households as consumers, often described as food security resilience or more generally as development resilience. We summarize four approaches here. Three of these are based on the concept of "resilience as ex ante capacity", the fourth uses the idea of "resilience as a normative condition".

Resilience as ex ante capacity can be thought of as "the capacity to withstand or absorb sudden or chronic shock; cope with temporary disruption while minimizing the damages and costs from hazard; restore after an event; manage or maintain basic functions and structures to become suitable for future situation" (Birhanu et al., 2017, p. 2). In the existing literature, this is operationalized in several ways.

One approach is to build on the Sustainable Livelihoods framework that conceptualizes well-being as a function of five asset categories: financial, human, natural, physical, and social capitals (Scoones, 1998; Quandt et al., 2019). For example, Ranjan (2014) focuses on the roles that social and financial capital play in dealing with drought. Quandt et al. (2019) constructs a series of composite indices across the five asset categories

[4] My thanks to Stephen Devereux for suggesting this phrasing.

[5] This material draws heavily on joint work found in Barrett et al. (2021).

using principal components (Browne et al., 2014). Composite indicators implicitly allow for substitution across asset categories (that is, two households could score at the same aggregate level but hold different types of assets in different quantities). An alternative approach used, for example, by Stanford et al. (2017) argue that households who score highly on each asset category (as well as a sixth that they call institutional capital) are best placed to be resilient. In contrast to the approach taken by Browne et al. (2014) and Quandt et al. (2019), Stanford et al. (2017) make the strong assumption that assets in different categories do not substitute for each other.

A limitation of the asset approach is that it does not account for resources beyond the household, such as infrastructure and social services that might also contribute to resilience (Birhanu et al., 2017, Stanford et al., 2017). A second approach to "resilience as ex ante capacity" seeks to remedy this weakness, the Resilience Indicators for Measurement and Analysis (RIMA), developed by the Food and Agriculture Organization (FAO). An updated version, RIMA-II (FAO, 2016), uses factor analysis to estimate four latent variables, labelled "pillars". One is assets (AST) and as such, is similar in spirit to the approaches based on the Sustainable Livelihoods framework. RIMA-II adds three additional pillars—Access to Basic Services (ABS), Social Safety Nets (SSN), and Adaptive Capacity (AC). Data for all pillars are typically found in standard household and community surveys. These are combined into an overall resilience capacity index (RCI). For example, in d'Errico et al.'s (2018) study of resilience in Tanzania and Uganda, AST has four elements: an agricultural asset index, a wealth index, tropical livestock units, and land. ABS is captured through consideration of an infrastructure index and distances to schools and markets. SSN includes public and private transfers. AC is based on income diversification, education, and income earners' share.

A third approach to "resilience as ex ante capacity" is found in Smith and Frankenberger (2018). They also conceptualize resilience as a latent capacity but use different pillars than those found in RIMA-II. Smith and Frankenberger consider three capacities. Absorptive capacities seek to mitigate the impact of shocks and include the availability of cash savings, access to informal safety nets, assets, bonding social capital (local norms of trust and reciprocity), and the availability of disaster mitigation. Adaptive capacities show the extent to which households can alter their livelihood strategies in the face of changing circumstances—diversity of livelihoods, assets, education, access to information, and bridging and linking social capital all contribute to these adaptive capacities, as does confidence in one's abilities to adapt. Finally, transformative capacity refers to "enabling conditions that foster more lasting resilience. It relates to governance mechanisms, access to markets, services and infrastructure, community networks, and formal safety nets that are part of the wider system in which households and communities are embedded" Smith and Frankenberger (2018, p. 366).

The fourth approach, "resilience as a normative condition" is developed in Barrett and Constas (2014) and Cissé and Barrett (2018). Here, resilience reflects the capacity to avoid adverse well-being states, rather than a capacity itself. Cissé and Barrett (2018) translate this conceptualization into an econometric method, estimating resilience as a conditional probability of satisfying some normative standard of living; for example, a food consumption score.

Implications for Public Action

We begin by noting significant knowledge gaps in our understanding of food systems resilience.

First, although this paper is situated within the literature on food systems, it is important to recognize that there is no one "food system". Food systems differ by commodity and country's income level. There is also likely to be path dependence. Historical circumstances, legal traditions, and the like will all have influenced how food systems have developed. A consequence of all this is that households may be simultaneously exposed to very different food systems. For example, a smallholder Ethiopian farmer might grow maize and coffee. The former being a crop that is produced, processed, and consumed without ever leaving the household, while production of the latter is the first step in a complex value chain that encompasses multiple actors across multiple continents.

Second, we know much more—both conceptually and empirically—about some components of the food system, notably production and consumption, than we do about processing. Even in those sectors where the knowledge base is substantial, there are significant evidence gaps—a notable example being that of limited information on market structure in the distribution and processing sectors.

Third, language used in discourse surrounding food systems and resilience (including that found in this paper) often defaults to words such as households or actors. But households differ by place, race, ethnicity, and socioeconomic status and this can have implications for how different households interact with the food system. Further, as Barrett et al. (2021) note, much of the discourse surrounding food security resilience ignores the crucial role of gender. The chapter by Bryan et al. (Chapter 8 in this volume) discusses this at length.

Fourth, our understanding of how these components fit together is limited. Do all elements within a food system need to be resilient for the system to be resilient? Or can greater resilience in some elements compensate for more limited resilience in others? Questions such as these are relevant to how we prioritize public investments.

Given these knowledge gaps, it would be unwise to make strong statements regarding the implications of applying a resilience lens to food systems for the purposes of contributing to improved food security interventions and policy. Mindful of this important caveat, we note the following.

Adapting the language of United Nations (2020), governments can enhance the resilience of food systems through improved anticipation, prevention, absorption, adaptation, and transformation. While, by definition, the timing of shocks cannot be precisely predicted in advance, it is possible to improve knowledge of when and where they are most likely to occur. The famines of the 1980s spurred investment in early warning systems such as FEWSNET now encompassed within the Integrated Phase Classification (see IPC Global Partners, 2021) are a good example of strengthening resilience through improved anticipation. However, access to this information remains uneven—in many cases, researchers in high-income countries may have better knowledge about when these shocks are likely to occur than do poor people in low-income countries. Investments in information dissemination will better equip all actors within food systems to anticipate and pre-emptively react to shocks before they occur. Better information flows will also enable food markets to function more efficiently. Investments in infrastructure that also facilitate to integrate market infrastructure such as roads are also likely to enhance resilience, improving both absorptive and adaptative capacities. Social safety nets and deepening of financial markets (improving the availability of savings products and insurance) can improve the ability of households to cope or absorb shocks. On the former, there is growing evidence that safety nets that were in place prior to the start of the COVID-19 pandemic were effective in mitigating the pandemic's adverse effects on food security (see Bottan et al., 2021 and Abay et al., forthcoming for evidence on this from Bolivia and Ethiopia); it is less clear that, at least in low-income countries, safety nets that were hurriedly implemented in response to the crisis were effective. This suggests that in a world that is increasingly shock-prone, governments and their development partners need to invest in social protection measures that are shock-responsive. This should include mechanisms that permit the rapid implementation of increased benefit levels to existing clients when needed (vertical expansion) and the ability to incorporate new beneficiaries into existing programmes (horizontal expansion) (Devereux, 2021). It also suggests that moving towards standing or rights-based social safety nets might be advantageous. Finally, governments can undertake investments in adaptation and transformation and/or undertake actions that incentivize the private sector to make such investments. That all said, it is less clear what government actions should be prioritized. Should they focus on protecting individuals and households from the likelihood that shocks will occur, on minimizing the impacts on income generation or maintaining consumption levels through, for example, social safety nets.

A theme in much of the work on resilience is the beneficial effects of diversification. But there is a tension between diversification and gains from specialization. How can public action reduce this tension, for example, through improving access to financial services such as savings and insurance (both public and private)? Relatedly, what role does diversification within food systems play in making them more resilient. For example, are systems with multiple value chains more resilient? As noted above, in high-income countries, certain parts of the food system (such as processing) are highly concentrated. Anti-trust policy and interventions can be used to limit excessive concentration but at the potential cost of loss of economies of scale.

Tensions exist between open and closed food systems. The last 40 years have seen horrific famines in Ethiopia and North Korea. While both had multiple and complex causes, both were exacerbated by limited intra- and international market integration. For example, during the 1972–74 famine in Wollo, Ethiopia, limited road networks outside the major cities were a significant factor in preventing food from reaching drought affected areas (Devereux, 1988); during the 1984 famine, grain prices in drought affected areas rose by 2.5 times their pre-drought levels (Cutler, 1991). By contrast, severe flooding in 1998 covered, at one point, 75 per cent of Bangladesh but famine was averted because of policy changes that allowed food to be imported from India (del Ninno & Dorosh, 2001).

That said, as noted above, open food systems expose countries to shocks that occur elsewhere. So here, the policy trade-off is one between an open system that reduces the likelihood that really bad outcomes such as famines occur but potentially increases susceptibility to more frequent, but possibly less severe, shocks.

Finally, it is important to note that public action can be a means of enhancing resilience, but it can also be a source of shocks; for example, where governments unexpectedly intervene in food markets. Such actions can be a source of shocks in themselves; further, such actions may create disincentives to investment in food system resilience.

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