Measuring ABCD properties of food system resilience: A methodological approach with Ethiopian case study

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Amid growing global recognition of the need to enhance the resilience of food systems, policymakers are increasingly seeking tools to assess how well these systems can withstand and recover from shocks. Despite this demand, there remains no widely accepted framework for measuring food system resilience. To help address this gap, we propose a generic analytical framework for assessing food system resilience, designed to be flexible and adaptable across diverse contexts and analytical needs. The framework operationalises the capacities that food system actors need to build at different levels to enhance resilience. To illustrate its practical application, we apply the framework to secondary data from Ethiopia, demonstrating its potential for guiding empirical analysis and policy formulation. We conclude with recommendations for aligning indicator selection and data collection with resilience-focused policy goals and suggest future research and implementation directions.

Key words: food system resilience, measurement framework, policy, Ethiopia, indicators

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Preface

The resilience of our food systems is increasingly debated and has become the subject of policy making. We have been observing an increased interest since the Corona pandemic affected global food supplies, and more recently, as the Russian-Ukraine war affected food commodity prices worldwide. After decades of globalisation, we are now facing an era of trade wars and trade restrictions that disrupt the free flow of food commodities between countries - not to mention the effects of climate change on food production.

But speaking of food system resilience, do we know its status, or, in other words, can we measure food system resilience? And if problematic or difficult, how do we then know that our policies to enhance the resilience of our food systems are effective?

Many initiatives worldwide have taken up this challenge, searching for generic indicators to assess the resilience of food systems. While these efforts are very useful to compare food systems as to their status and progress in resilience building, these generic indicators often encounter difficulties in measuring resilience capacities internal to a food system.

This report focuses on this challenge: how should we understand food system resilience, what are useful indicators, how can we measure these and what do they tell us about enhancing food system resilience? We hope that this report is useful for those seeking concrete policy measures and interventions tailored to specific food systems and designed to strengthen their resilience.

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Summary

This paper was written as a contribution to the current global discourse on the importance of enhancing the resilience of food systems. Growing attention for greater resilience in food systems requires policy makers to measure how food systems can withstand and recover from shocks, without long-term negative implications. However, there is not yet a consensus on a framework for measuring resilience of food systems. In this working paper, we explore what has obstructed the development of a measurement framework and propose a generic framework for food system resilience assessment that can be adapted to different analytical and contextual conditions. We extend the conceptual part of the paper by an application of the framework using secondary data from Ethiopia. The results indicate the ABCD framework can be usefully applied to secondary data to explain household resilience to specific types of shocks particularly relevant in Ethiopia, such as illness among household members and increased food prices. We found suggestive correlations between the ABCD capacities and households' ability to uphold their welfare in the face of such shocks. The results can help inform development policy and interventions that can enhance the resilience of Ethiopian households. We conclude this paper with suggestions on how the analytical framework, the selection of indicators and data collection can help design meaningful policy interventions.

1 Introduction: why should food system resilience be measured?

The ability of food systems to withstand and recover from shocks – commonly referred to as 'resilience' – has been gaining more prominence recently. Food system resilience was exemplified by responses to and impacts of the COVID-19 pandemic (Béné et al., 2021; de Steenhuijsen Piters et al., 2021). Across low- and middle-income countries (LMICs), the pandemic increased food insecurity and caused severe disruptions, especially for many small-scale/informal food system actors, who, due to the informal nature of their businesses, were not entitled to access the financial supports (Béné et al., 2021; Bloem and Farris, 2022; Laborde et al., 2020). Approximately 222 million people worldwide faced acute food insecurity in 2022, and the situation is projected to deteriorate further due to conflict, climate shocks and the threat of global recession in 2023 (FAO, 2023a). The need to build resilient food systems has become increasingly urgent amid growing pressures on global trade, including rising regional conflicts that drive volatility in international food and grain prices. For example, the trade in grain and artificial fertilisers has been severely disrupted by the war in Ukraine and related blockades, leading to sharp price fluctuations and undermining food security in countries heavily reliant on imports from Ukraine and Russia, particularly for low-income populations (IFPRI, 2023).

Food system resilience has become an increasing priority for policymakers, and, with that, the need has grown to know how resilient a food system is. While it is clear why we want to assess food system resilience, how to measure it is challenging (Béné, 2020; Ingram et al., 2023; FAO, 2023b; Béné and Devereux, 2023). A food system is a complex network of activities relating to production, distribution, processing, and consumption that connect people to food. Such systems operate at multiple spatial and organisational scales, and span social, ecological and economic relationships (Schipanski et al., 2016). These complex relationships mean that measuring the resilience of a food system is not straightforward and assessing the impacts of interventions aimed at enhancing system resilience is challenging, since interventions are likely to affect not only their specific targets, but also other food system components. Consequently, interventions aimed at enhancing resilience may also result in trade-offs with other outcomes.

Recent discourses, ranging from national debates in times of food crisis to the UN Food System Summit in 2021+2, reveal that many definitions of food system resilience co-exist, hindering clear communication and mutual understanding. Despite—or perhaps because of—its popularity, there is little consensus within the vast resilience scholarship regarding its practical meaning: how resilience can be promoted and sustained, and how it can be operationalised remain contested questions (Béné and Devereux, 2023; Semplici and Campbell, 2023).

To contribute to solving this operationalisation issue and promoting resilience, in Chapter 2 we propose a simple definition that can be adopted by both the scientific community as well as policymakers. In Chapter 3, we explain how this definition helps us to identify four key capacities of food system resilience in the so-called ABCD framework, which can serve as entry points to measure food system resilience at different levels of analysis (Chapter 4). In Chapter 5, we present an application of our framework using a household and community-level dataset available for Ethiopia as a case study. We conclude (Chapter 6) with some suggestions on how to move forward toward a feasible protocol, incorporating the framework for measuring food system resilience in a specific context.

2 Defining the issue: if you can't define it, you can't measure it

In the past few decades, resilience thinking has been applied across various disciplines (such as ecology, economics and risk management) and different definitions exist depending on the discipline for which they have been developed (Tendall et al., 2015). In relation to food systems, resilience thinking has been applied to address the complex interactions between nature and society, with a focus on ensuring human well-being within planetary boundaries (Folke et al., 2016). However, there is confusion and contestation about what the concept of resilience means and how it can be measured. This is especially true for the resilience of food systems, where multiple types of resilience interact (such as agricultural, economic, political and social resilience), raising the question whether a unified conceptualisation of food system resilience is possible.

This dilemma is amplified by the growing number of definitions and terminologies used around resilience, leading to a wide spectrum of interpretations and different metric propositions (e.g., Hoddinott, 2023; Ramanathan and von Braun, 2023). When empirically tested, resilience measurement methods may also yield different results. For example, using nationally representative panel data from Ethiopia and Niger, Upton et al. (2022) compared the performance of three resilience measurement methods, including the Resilience Indicators for Measurement and Analysis approach (RIMA) developed by the Food and Agriculture Organization of the United Nations (FAO), the multi-dimensional index approach developed by TANGO International, and the probabilistic approach of Cissé and Barrett. Upon et al.'s (2022) findings indicate that the three measures produce significantly different outcomes and vary significantly in the households they identify as resilient or least resilient with respect to food security outcomes. This example illustrates the complexity of resilience measurement even at food security outcome level, let alone at food system level. In other words: different definitions of resilience result in different measurements, which, in turn, result in different conclusions and therefore cause confusion among policymakers and other key stakeholders.

Drawing on research that investigated how the term resilience was used over time by different scientific disciplines, de Steenhuijsen Piters et al. (2021) propose a definition that has been used in both the scientific and policy world. This definition does not pretend to be novel or unique, as it has similarities with definitions proposed by, amongst others, Marchese et al. (2018), Ramanathan and von Braun (2023), Hoddinott (2023) and Zurek et al. (2022). Following de Steenhuijsen Piters et al., (2021), we understand food system resilience as *the capacity of a food system to deliver desired outcomes in the face of shocks and stressors*. Given that this is a straightforward and easy-to-use definition, we wish to emphasize the following three considerations.

First, enhancing food system resilience involves a more complex task than just ensuring the stable delivery of food and nutrition security or any other desired outcome. For example, expanding or intensifying agricultural production may positively contribute to food and nutrition security, but may also increase the likelihood of pollution and potential loss of biodiversity. In practice, resilience assessment may maintain the focus on food and nutrition security as the key outcome of a food system, while acknowledging the livelihood and environmental dimension of food systems.

Second, benefits and losses are often not distributed evenly across stakeholders in food systems. As resilience is not an absolute measure, it is important to consider who has the power to define it. The awareness of such interactions and trade-offs is at the core of approaches to describe, diagnose, and develop interventions in food systems. Building on a common conceptual understanding of resilience in food systems is therefore necessary to avoid the concept causing confusion and miscommunication between different stakeholders.

Third, while our definition approaches resilience as a capacity, we also underscore that in practice the judgement of how resilient a food system is can be made based on the degree of stability or, conversely, volatility of its outcomes (e.g. food availability) over the course of a shock period. This perception of resilience is in line with the definition of resilience as recovery (Hoddinott, 2023) or a latent variable for realised resilience or resilience *per se* (Béné et al., 2023). To assess food system resilience, it is important to look at both realised resilience and resilience capacities. Resilience understood as the capacity of a system to respond to unforeseen shocks and stressors can be measured by looking at four capacities or abilities interior to a food system, as explained in the following chapter.

3 The ABCD (and E) of food system resilience

A food system is more than a central food supply chain and consists of multiple components where shocks or interventions can affect the functioning of the system. The way in which capacities protect the system against shocks and stressors vary from specific threats—for example, a dam prevents floods from entering fields—to more general protection against many shock types (e.g., financial buffers). Based on an analysis of existing literature on resilience in different disciplines of science De Steenhuijsen Piters et al. (2021) identified four capacities that show strong correlations with resilient systems. These capacities, when applied to food systems, are presented as the 'ABCD' of food system resilience (see Figure 3.1 below):

- Agency: the ability of people to choose their actions and execute them as they see fit, by utilising their means and capacities to mitigate risks and respond to shocks. Agency puts the attention on the role of human agency at the heart of resilient food systems. For example, in situations of protracted crises, people have developed coping strategies – ranging from informal early warning systems to community seed systems – that contribute to the resilience of their livelihoods.
- Buffering: resources to fall back on in the face of shocks and stressors. Buffering in food systems can be understood in a broad sense: from buffering strategies by subsistence farmers to the creation and maintenance of national food stocks. Creating buffers can be seen as an action in anticipation of a shock or stressor.
- Connectivity: the connections and communication between actors and market segments. Connectivity can manifest both in terms of physical infrastructure (roads, ports, airports) and communication infrastructure (internet access), as well as in terms of the existence of economic, political and social relationships between actors (in the food value chain) and nations (such as trading relationships).
- Diversity: diversity at different scales and in different places, from production to consumption, and from farm level to regional diversity. Resilient systems are diverse systems. Diversity means that the loss of one resource may be compensated by another. A shortage can be mitigated by a surplus elsewhere.

Agency + Buffering + Connectivity + Diversity

Enablers
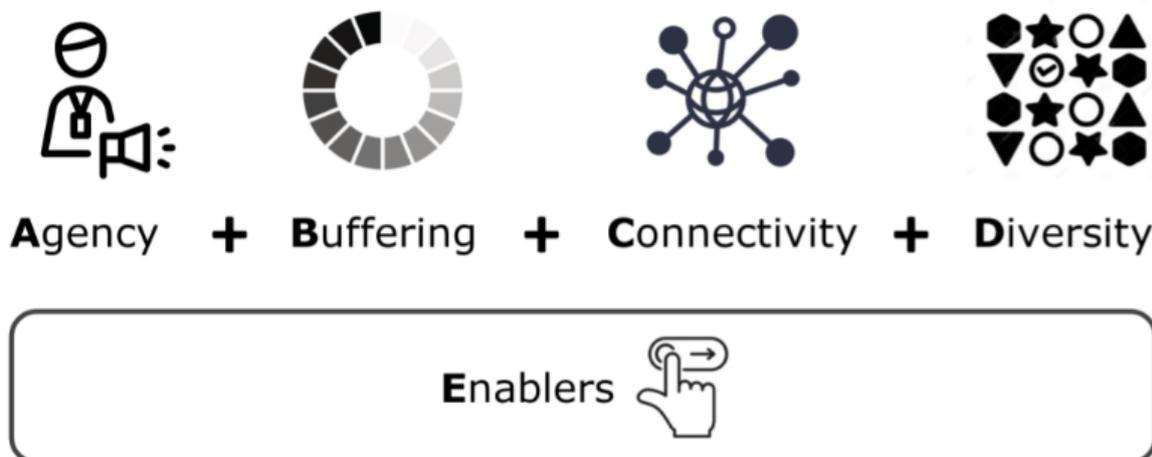
Figure 3.1 *The ABCD of food system resilience building*
Source: De Steenhuijsen Piters et al. (2021).

These four capacities do not operate in isolation and food system actors at different levels can achieve one or more of these by showcasing various resilience capacities. For example, at a household level, having access to informal credit, an indicator of financial and social abilities, can contribute to both buffering and connectivity. All actions and activities to achieve ABCDs may result in higher costs and lower profit, at least in the short term, but increase the overall system resilience.

Recent advances in understanding food system resilience highlight the role of collective resilient capacity and/or emergent properties at the system level (Bené et al., 2023). We therefore added an extension to the ABCD framework: Enablers of food system resilience. Food system resilience capacities need to be developed, maintained, supported and invested in through enablers, which include conducive government policies, and/or measures and investments by public, private or societal organisations. These enablers therefore ensure that actors at a lower level (for example, household level) can build up their resilience capacity. For example, ensuring agency of local farmers requires policies ensuring access to land rights and/or women empowerment, while buffering capacity for households can be strengthened by the establishment of public or third-party warehouse services, or by policies enhancing smallholder farmers' and traders' access to credits. In addition, a public service such as the construction of roads and energy networks can contribute to the ability of households to connect with other parts of the food system and, if the disruption in the economic, social or ecological field makes this necessary, also increase the opportunities for alternative livelihood options. In this way, such a public service contributes to both connectivity and diversity.

We define enablers as policies, regulations, rules and actions taken by national-level institutional actors to support household and community's resilience capacities. Please note that an enabler such as the national government can also be an actor itself: for instance, the national government can also enhance national resilience capacity by maintaining a national food stock. National-level resilience capacities refer to the abilities that a country possesses at its disposal that can be utilised to respond to a particular shock/stressor. In turn, a country's resilience capacity is determined by international agreements and events. The international context is therefore an enabler of national resilience capacity. For simplicity, we exclude the international level in Figure 3.2, which illustrates the role of enablers at different analytical levels where the ABCD framework can be applied.
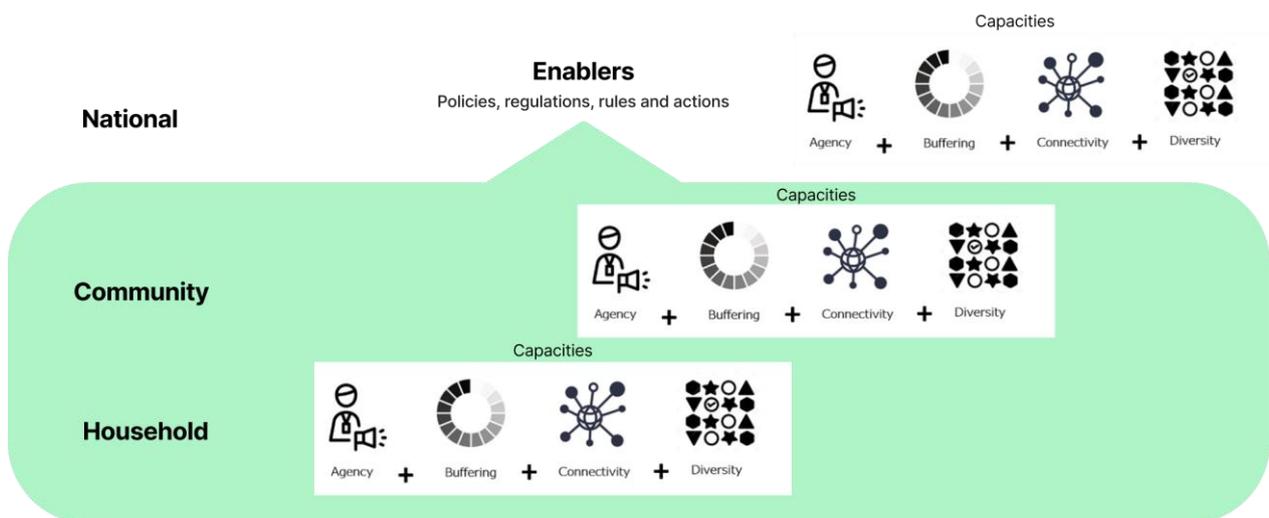

Figure 3.2   *The ABCD of food system resilience and Enablers enhancing resilience capacities of actors at the lower level*

4 Assessing food system resilience

The lack of agreement on the definition of (food system) resilience causes significant confusion over how to measure it. We also observe that many attempts to develop food system measurements get lost in the complexity of the food system, yielding some scientific insights but offering very little user value to policy makers. At the same time, we observe food system resilience measurements that seem to avoid the perceived complexity by focusing on measuring national macro-economic metrics only (FAO, 2023b; Schneider et al., 2023). Although national measurements have their advantage that international comparisons can be easily made (and data is often readily available on national level for some food system outcomes), such high-level averages do not adequately reflect lower-level resilience dynamics and hide contrasts and controversies, including trade-offs among different levels of aggregation. For example, a national effort to increase buffering such as extra grain storage may affect food prices and food security elsewhere. The more localised measurements should seek to reveal these resilience dynamics to understand how and where in the system resilience capacity is distributed, who masters that capacity and who is vulnerable to shocks and stressors.

In this chapter of the paper, we build on the ABCD capacities of food system resilience and propose a framework for measuring food system resilience in four steps. We consider the diverse needs of stakeholders to assess food system resilience at different levels of analysis.

Step 1: Setting contexts and boundaries: Resilience for whom, of what, when, where and why?
Resilience measurement and quantification require researchers to go beyond intuitive understandings of resilience and to be more specific about what resilience means in a particular context (Fontijn et al., 2022). This requirement for further specificity is universally acknowledged within the resilience literature. For instance, Meerow et al. (2016) propose the 'Five Ws' to help stakeholders define resilience in any specific context, which Fontijn et al. (2022) reformulate in the context of food systems in Table 4.1.

Table 4.1   *The Five Ws from Meerow et al. (2016) adapted by Fontijn et al. (2022)*

#	W question	Food system specification
1	Resilience for **W**hom	Whose resilience, which groups (vulnerable or otherwise)? Think of actors or groups of actors at different scales, including consumers, producers, trading companies, local governments, minorities, etc. Note that for instance 'nature' may also be considered an actor.
2	Resilience of **W**hat (outcome?) to **W**hat (shock?)	What is the (minimum level of) desired outcomes of food systems, and what shocks/stressors must the system be able to withstand? For example, the effects of food prices fluctuations on food security may be different from those of weather extremes. What are the responses to such shocks/stressors?
3	Resilience for **W**hen	Over what time scale is resilience evaluated? Is the focus on rapid disturbances or also on slow changes (e.g. due to climate change)? We may for instance consider recovery as soon as possible or across two or three decades.
4	Resilience for **W**here	What spatial scales are relevant? The resilience against weather extremes may be considered in the context of a village, a region, or even across multiple countries.
5	**W**hy resilience	For what purpose do you intend to measure and enhance resilience? One may be interested in resilience because of intended policy measures, or an investment.

The Five Ws concept assumes that resilience can be different for individuals, population groups or food supply chains. This means that any assessment of resilience and the effects of interventions to strengthen resilience must identify who is involved (smallholders, traders, value chains, etc.), to what shock or stressor one is anticipating or responding, and for what purpose. We argue for analyses that consider actors' different perspectives in the food system (see Textbox 4.1 for a theoretical example of applying the Five Ws to informal actors in the food supply chain). For the purpose of measurement, the scale at which resilience is considered also determines the required types of indicators and data. The Five Ws concept implies that resilience assessment should be carried out at household and community level, in addition to country-level analysis.

Textbox 4.1 Applying the Five Ws to informal midstream actors in the food supply chain

The informal economy is significant in many regions of the world. Globally, the contribution of informal businesses to national GDP is estimated at around 60% (ILO, 2018; Ohnsorge and Yu, 2021). The magnitude of the informal sector in terms of employment (including agriculture) varies across regions, but is largest in Africa – which, in 2016, was estimated at 86%, followed by Asia and the Pacific (68%) and Latin America and the Caribbean (53%) (ILO, 2018). Particularly in Sub-Saharan Africa, midstream actors in informal sectors of the food systems provide the vast majority of food to lower income segments of society. As such, they are key actors in enhancing the resilience of food supplies to these consumers. Yet, these midstream actors are not officially registered, have no access to formal government services, and are not consulted when policies are being developed (Marusic et al, 2020; Guarin et al., 2022). This became especially apparent during the COVID-19 pandemic when government measures, such as limiting movement of people and products, unequally affected midstream actors in food supplies and vulnerable segments of consumers (Swinnen and McDermott, 2020; McDermott et al., 2022). By asking the Five W's questions, we would be able to determine several aspects of food system resilience assessment:

Five W's:

1. Resilience for **W**hom
   Informal traders, providers of logistics services, retailers, wholesalers who supply the vast majority of urban poor with food.
2. Resilience of **W**hat to **W**hat
   Food prices fluctuate seasonally and climate change will affect supplies of domestically produced foods. Government measures, such as those taken during the COVID-19 pandemic, impact greatly on these midstream actors involved in food supply and subsequently their customers.
3. Resilience for **W**hen
   Climate change impacts (a stressor) have a longer time horizon compared to sudden government measures (a shock) affecting midstream actors in informal sectors. Governments may decide to eliminate these actors from their locations, which impacts directly on food supplies to vulnerable segments of consumers.
4. Resilience for **W**here
   The food value chains affected are often short, linking local producers to consumers via retailers. Yet, wholesalers may also obtain their supplies from distant suppliers, involving multiple intermediaries spread over a larger region.
5. **W**hy resilience
   The resilience in food supplies of many segments of consumers in Sub-Saharan African food systems cannot be achieved without the involvement of midstream actors in informal sectors of the food system. Yet, their contributions to the food supplies and the economy as a whole are not visible in national statistics, nor are these actors included in consultations or policy dialogues.

Step 2. Measuring food system resilience capacities

As we have argued, measuring the resilience capacity of the whole food system is very complex. Hence, any such attempt needs context and boundaries as described in Step 1. The context could be knowing whether people are secured of their access to critical outcomes, such as healthy food or employment that provides sufficient income for a decent living. These outcomes require food value chains that function well. The focus of measurement of resilience capacity can then be limited to two levels: household level and a higher, collective level, for example, a village or a value chain. However, we acknowledge that answering the questions on national-level food systems is also important and of interest to many policymakers. Our approach, based on the ABCD framework, offers measurement indicators for 3 levels of interest: household, collective (or community)[1] and national levels. Table 4.2 includes examples of indicators of the ABCD capacities at household, community and national levels.

> 'There is often a tension between the nuanced reality of resilience on the ground and the desire for rigorous, quantitative measures.' (Upton et al., 2022; p.3)

The selection of indicators, besides being reliant on the purpose of the assessment, is also subject to data constraints, especially when resilience was not a consideration to guide data collection from the beginning. For example, when household-level data is available from a sample drawn from villages as the enumeration unit, it is more likely that the community-level data is also only available at the village level.

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[1]   We use the term collective level here, because depending on the outcome of the 5Ws, the next higher level (of household level) can be a community (socially or administratively defined coverage), a district (geographical coverage) or a value chain (production-based coverage).

Table 4.2 *Examples of indicators for ABCD properties measuring resilience capacities at different levels of analysis (not exhaustive)*

	Examples of ABCD indicators at household level	Examples of ABCD indicators at collective level	Examples of ABCD indicators at national level
Agency	Gender equity between household members, membership of associations or unions	Business networks, business associations, cooperatives, representation in policy fora	Freedom of speech, freedom to enter into partnerships or associations
Buffers	Household food stocks, savings, home gardens	Warehouses, business networks, saving schemes	National food stocks
Connectivity	Means of transportation, mobile phones	Infrastructure, business networks	Infrastructure, ICT and energy networks
Diversity	Sources of food supply	Supply chains, types of commodities	Trade partners, industrial policy, R&D investments

Agency is the ability of people to choose and carry out their actions as they see fit. This ability is determined by individual capabilities (e.g., health, intellectual abilities) and especially by the relationships with people and institutions in their environment. The latter can be measured by proxies of empowerment or network participation, from which one can derive freedom of action and capacity to act. Membership in associations and business networks, along with freedom of speech, serve as such proxies. Because agency is a concept that depends on the relationships between people and the institutions, regulations and laws that govern a community, agency must be contextualised to interpret the proxies measuring it; numbers can mean different things in different contexts.

The property of buffering—resources to fall back on in the face of shocks and stressors—can be proxied by (food or cattle) stocks, storage facilities and (monetary) savings. Buffering can also mean that people can fall back on socio-cultural (family), business or political networks, and in the event of (threatening) shocks, they can seek support in those networks to absorb them. At this point, buffering is strongly intertwined with agency, in the sense that it can be seen as an outcome of agency. For example, a study on consumption smoothing and risk sharing within households in rural Ethiopia finds that women in poor households are affected more by adverse shocks compared to their spouse, but the wife's relative position is better if customary laws on settlements at divorce are favourable or if they come from a relatively wealthy background (Dercon and Krishnan, 2000).

Connections and communication between actors and market segments are thought to increase resilience capacity as, in many cases, having good connectivity facilitates flows of goods and services (such as information) that mitigate the effects of shocks and boost recovery. Indicators that may be proxies for connectivity include social capital scores (e.g., social cohesion and engagement, community and family networks, and political participation and institutional trust), and infrastructure and market access scores (Legatum Institute, 2023). An Infrastructure and market access score measures the quality of infrastructure that enables trade, and distribution in the market for goods and services; and comprises indicators such as means of communication (e.g., internet), energy, water, transport, border administration, open market scales, import tariff barriers, and market distortions. For example, in a country comparison with Ghana, Kenya scores slightly higher in terms of social capital as well as infrastructure and market access (Figure 4.1).
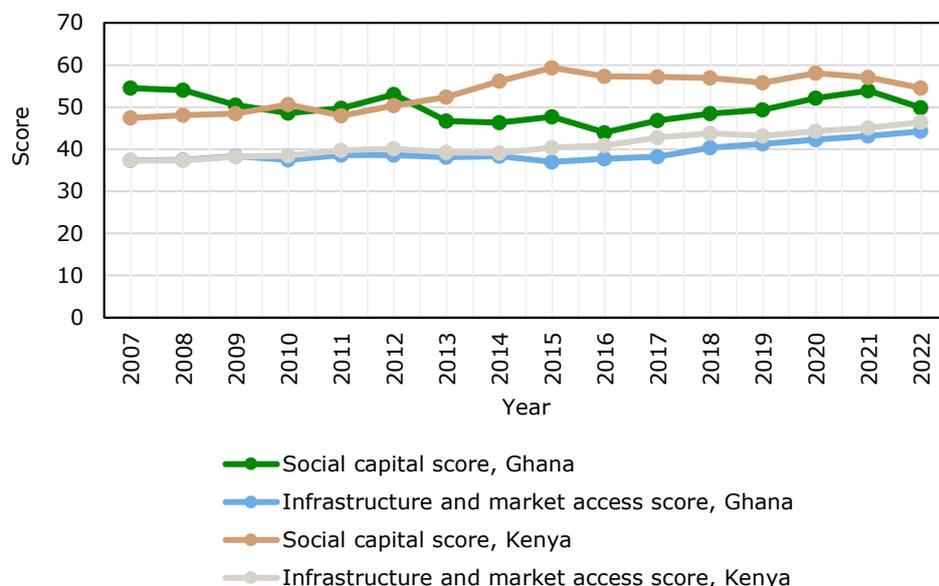
Figure 4.1 *Social capital score and infrastructure and market access score*
Source: Legatum Institute (2023).

The four categories are not mutually exclusive in terms of the indicators that fit under them. For example, being a member of a microfinance organisation, while promoting agency, also directly contributes to buffering capacity and connectivity by facilitating the accumulation of both financial and social capital.

Step 3. Identifying and assessing enablers of food system resilience capacities
Food system resilience capacities need to be developed, maintained, supported and invested in through enablers, which include conducive government policies, and/or measures and investments by public, private or societal organisations. Food system resilience assessments can include qualitative indicators of these enablers which often determine whether the ABCD properties at lower scales in the system have been developed to their full potential.

Table 4.3 *Examples of enablers of food system resilience capacities at national level of analysis (not exhaustive)*

	Examples of ABCD enablers at national level
Agency	Freedom of speech, national gender equity policies, freedom to enter into partnerships or associations, free press
Buffers	Warehouse systems, national food stocks, national food security policy, (micro)finance services by banks or value chain partners
Connectivity	Infrastructure, ICT networks, business networks, border policies, training and extension strengthening business capacity
Diversity	Trade agreements, domestic agricultural development policies, R&D investments

With a focus on enablers of food system capacities, it is critical to bring in the issue of governance into the food system resilience assessment. Governance includes the rules, powers and institutions that coordinate, manage and direct society – not only what we know as 'the government'. Governance of a food system also includes non-state actors such as companies and civil society and how, for example, market rules are made, how traditions influence decision-making bodies, or how social networks provide individual people with agency. Governance actors may have different agendas, strategies and capacities. An analysis of the powers and their role in strengthening ABCD properties provides insights into how and by what (type of) governance people are supported to enhance resilience against food system shocks and stressors.

Step 4. Identifying the resilience status of a food system

The purpose of assessing food system resilience is to know whether the system can continue to produce the current outcomes, now and over time. The outcomes by a well-functioning food system are sufficient, affordable and healthy food that is sustainably produced and provides actors in the food chain with viable and decent livelihoods. Stable, reliable outcomes such as access to healthy food or decent employment opportunities, are important assets to people and households but also to businesses and the economy. Stable outcomes over time indicate that the system has adequate resilience capacity. The contrary is also true: high volatility in outcomes indicates a lack of resilience capacity of the system.

This step analyses whether food system actors' resilience capacities (or lack of them) help a food system to maintain its functions and provide desirable outcomes. The analysis can include proxies of the volatility of food system outcomes over a period of time (for long-term stressor) or before/after an event under investigation (for shocks). For instance, proxies that capture the state of food and nutrition security (such as availability, affordability, access and stability of food supplies) could include fluctuations in crop yields, household incomes or food prices. Decent and fair livelihoods (e.g., employment, gender and social equity) proxies could include fluctuations in economic cycles, and environmental sustainability (e.g., biodiversity, soil degradation, water availability) proxies could include variations in temperature and precipitation. As these are all proxies of food system outcomes, the assessment of food system resilience would therefore need to refer to the system's capacity to respond to the shocks and stressors causing these fluctuations. The fact that attention must be paid to how individuals or groups can mobilise that resilience capacity to anticipate or respond to such fluctuations, is illustrated in Textbox 4.2.

Textbox 4.2 Price volatility and resilience

We take the example of maize and sorghum markets in Ghana - two important food staples for the Ghanaian population. Prices fluctuate throughout the season and years, but generally price instability (measured by standard deviation from the mean) is relatively modest (Figure 4.2). The consequences of price volatility differ depending on consumers' income (many are farming families). Figure 4.2 shows that gross domestic product (GDP) growth per capita fluctuates greatly over time. Ghana has a Gini coefficient of 43.5, implying relatively high inequality in income levels; furthermore, the daily income of approximately 25% of the population is below extreme poverty level USD 2.15 (i.e., people considered to be in extreme poverty) and 49% live on less than USD 3.65 per day (the poverty line derived from typical national level poverty lines in countries classified as Lower Middle Income; see for both figures World Bank, databank). It is clear then that a large proportion of the population will have difficulties buying enough food all year round, which indicates that this segment of society will lack the resilience to withstand shocks and stressors that will impact their food and nutrition insecurity.
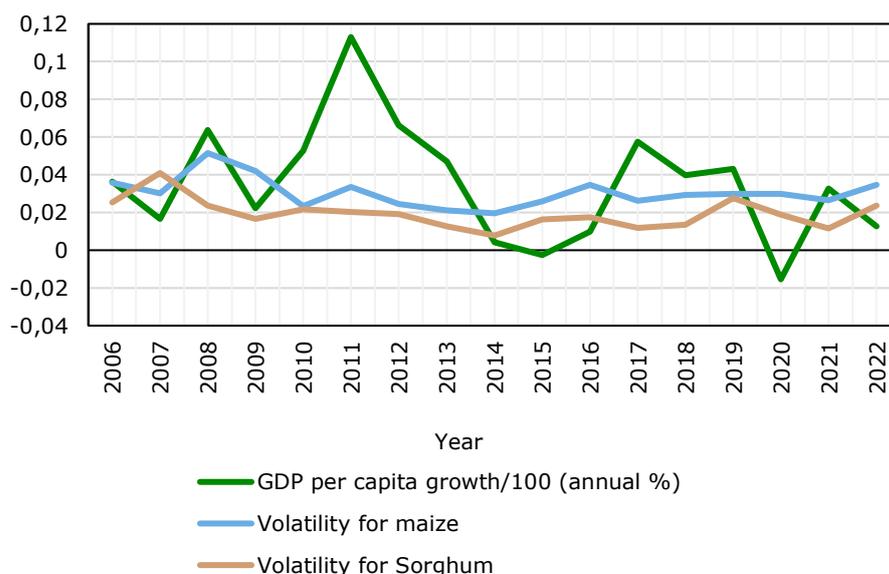

Figure 4.2 *GDP per capita growth/100 (annual %) and volatility in maize and sorghum prices in Ghana*

5 Application of the ABCD framework using Secondary Data in Ethiopia

5.1 Objectives

In this chapter, we empirically test the ABCD Resilience Framework using indicators with the potential to proxy food systems' resilience capacity.

In general, measuring resilience is considered methodologically challenging since assessments and interpretations of resilience could depend on how the questions are framed, i.e., resilience of what, to what, from whose perspective, over what time frame, and for what purpose (Meuwissen et al., 2019). Further, since resilience can be observed at several scales simultaneously, and resilience at one scale (e.g., household) does not guarantee resilience at another (e.g., district) (Béné et al., 2023; Fanzo et al., 2021), this implies the need for contextual and comprehensive data and indicators.

Finding a 'perfect' dataset to illustrate all aspects of food systems resilience may pose a challenge. Collecting primary data for a comprehensive set of indicators at different scales and sample size with sufficient statistical power can be very costly. However, increased availability of nationally representative, multipurpose household and community surveys such as the living standards measurement surveys (LSMS-ISA) by the World Bank and its partners provide opportunities for researchers and practitioners to try to test some aspects of food systems resilience.

In this exercise, we leverage the 2018/19 LSMS-ISA data from Ethiopia with the following objectives:
- To demonstrate the selection of indicators using the ABCD framework for predicting resilience at both household and community levels.
- To examine the application of the ABCD framework using secondary data, identifying caveats, and providing recommendations.

We achieve these objectives by attempting to answer the following questions informed by the Five Ws described above: resilience for whom, resilience of what to what, resilience for when, resilience for where, why resilience (Fontijn et al., 2022):
- How resilient are Ethiopian households and communities, assessed in terms of ABCD capacities? Are there differences in resilience capacities among households of different socio-economic strata?
- What were the primary shocks experienced by Ethiopian households during the period of 2017-2018? Were households' welfare outcomes changed by these shocks?
- Are the resilience capacities of Ethiopian households correlated with their welfare outcomes in response to the most significant shocks?
- What are potential policy implications of our results?

5.2 Methods

5.2.1 Data

The Living Standard Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) is available for 8 countries in Africa: Burkina Faso, Ethiopia, Malawi, Mali, Niger, Nigeria, Tanzania, Uganda, focusing on agriculture, socioeconomic status, and non-farm income activities. Although the LSMS-ISA surveys do not explicitly focus on resilience topics, the questionnaires include inquiries related to household characteristics that can potentially capture the ABCD capacities, as well as questions about shocks and household coping mechanisms including at the community level. The surveys' accessibility also makes them a suitable secondary data source for the objective of this exercise. We test the ABCD framework using the LSMS-ISA, beginning with the Ethiopia data.

The Ethiopia LSMS-ISA, also known as the Ethiopian Socioeconomic Survey 2018-2019, includes a household questionnaire (sample size 6,770 households) and a community questionnaire (sample size 526 enumeration areas, of which 258 are rural and 268 are urban), covering all regional states and two administrative cities, Addis Ababa and Dire Dawa (CSA and World Bank, 2020). However, the sample with full information for indicators of our interest and that was used in this study includes 5,180 households from 525 enumeration areas. Further, for community level analysis, communities that did not experience covariate shocks (i.e. shocks that affect everybody in a particular community or region) were not relevant for our attempt to testing correlations between community level ABCD and community's resilience to shocks. Hence, only 276 communities were included in such community level analysis.

5.2.2 Indicator selection and construction

ABCD capacity indicators
We reviewed the household and community questionnaires and compiled a long list of indicators that can potentially proxy the four ABCD capacities (Appendix Table A1). The indicators include both binary and continuous variables. However, some of the indicators were relevant only for rural households and hence were included only in the analysis of the rural sub-sample.

In the next step, we created a concise set of indicators that are applicable for both urban and rural households for each of the ABCD capacities. Within each resilience capacity dimension, we limited the selection to no more than five indicators from the initial long list (Appendix Table A1). Indicators with continuous variables were normalised with max-min principle[2] so that their values would be unit free and in similar scale (i.e. between 0 and 1) as the remaining majority of indicators which were measured in binary terms. A household's 'score' for each of the four ABCD capacities were the mean of the individual scores of the corresponding indicators in that capacity dimension. Similarly, when considering a group of households (for example those in the same community), the scores for each of the four ABCD indicators were the average (mean) of the indicators at the group level (Appendix Table A2). A few indicators that can proxy for connectivity and diversity were available only for rural households and hence were included in the ABCD scores calculation for rural areas.

Resilience outcome proxy
In the survey, households were asked if they were affected by various shocks in the last 12 months and whether that led to negative welfare changes.

Using the survey data, we illustrate a household's resilience in the face of a shock by the absence of change in five welfare indicators including income, assets, food production, food stocks, and food purchase. In other words, the household experienced at least one type of shock but did not experience a reduction in each of the five welfare indicators. In other words, if a household reported a reduction even in one welfare indicator out of the 5, that household would not be considered resilient in general.

At the individual level, we focused on the three most frequently experienced types of shocks by households in the survey. Even though such information were collected from individual households based on their own experience, it is assumed that they encompass both idiosyncratic shocks (e.g. illness of household members) and covariate shocks (e.g. increased food prices and droughts).

At the community level, the resilience of a community to shocks is demonstrated by the share of households whose welfare was not affected by any kind of shock experienced in the community or enumeration area. The shocks covered are covariate shocks that include: drought/flood/crop disease/pests/livestock disease/human epidemic disease/displacement/ sharp change in prices/loss of key social services.

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[2] Normalised value of $x_i = (x_i - x_{min})/(x_{max} - x_{min})$.

Disaggregation between households and by rural/urban classification

To show variations in resilience capacities across socio-economic strata, we aggregate data based on expenditure quintiles (from the poorest (bottom 20%) to the richest (top 20%) and made additional comparisons specifically between the poorest and the richest quintiles. Further, we perform disaggregation by rural/urban classification.

5.2.3 Relationship between ABCD capacities and resilience outcomes

To examine the relationship between ABCD capacities and resilience outcome indicators, we conducted cross-tabulations and simple pairwise correlations between each of the ABCD capacities (as constructed under Section 5.2.1.1) and the resilience outcome proxy (as constructed under Section 5.2.2.2). The main hypothesis is that higher ABCD capacities are associated with higher resilience outcome.

Given the cross-sectional nature of our data, we refrain from assuming a causal relationship. In addition to resilience capacities, various factors, for example individual and household characteristics, the enabling environment for resilience, and the community's natural geography, can impact resilience outcomes. Moreover, the intercorrelation among the four ABCD capacities further complicates establishing causality.

5.3 Results

5.3.1 Descriptive statistics of ABCD scores

The descriptive statistics of ABCD scores based on household level data are presented in Table 5.1. In general, households appear to score higher on agency than the remaining components, and relatively lower on buffering. Further, except for agency, the mean scores for buffering, connectivity and diversity appear to be slightly lower for the rural sample compared to the full sample (Table 5.1). Potential explanation for these could be that buffer, connectivity and diversity can be measured more objectively and accurately than agency which is in part perception that individuals held about own capacity and likely to be overestimated. Also, agency is determined not just by one's own means and resources but partly by the social capital including communities and their values (Galie and Farnworth, 2019), that can be source of additional capacity for the individual. This is especially the case where formal institutions such as credit and insurance markets are inefficient or non-existent, for example in rural areas of Ethiopia or elsewhere in low-income settings. In those circumstances, social capital - in one form or another - tends to provide practical solutions and increased agency to the individual, resulting in desired outcomes. To mention few examples, social capital contributed to: increased uptake of risky subsidised inputs by cocoa farmers in Ghana (Kos et al., 2023), the adoption of agricultural innovations in Ethiopia (Mekonnen et al, 2018), and the reduction of poverty in various dimensions for ethnic minorities in Vietnam (Pham and Mukhopadhaya, 2022).

The mean values of the community level ABCD scores are presented in Table 5.2 Note that information at community level were collected from a group of key informants (community members) who reside in that community. Hence, such information reflects what is perceived to be common in that community rather than the actual capacity of each household in the community. As a result, the mean values of the ABCD at community level may not be the same as that of the mean values calculated from household level data since the latter is based on information perceived by individual households. For example, at community level, the score for agency is the lowest among other capacities for the full sample (Table 5.2); whereas buffering has the lowest score among other capacities based on data on individual households for the full sample as well as the rural sample (Table 5.1). In addition, the component indicators for household and community-level ABCD capacities are also different from each other, as the questions from the two questionnaires are not exactly the same.

Table 5.1 *Summary statistics of ABCD indicators (household level)*

Indicator	Full sample (n=5180)		Rural sample (n=2062)	
	Mean	Std. Dev.	Mean	Std. Dev.
Mean (A)	0.69	0.24	0.74	0.24
Membership to iddir (0/1)	0.53	0.50	0.62	0.49
Female spouse with land rights to bequeath (0/1)	0.40	0.49	0.60	0.49
Did not have feelings of uncertainty over the future supply of food to the household (0/1)	0.83	0.37	0.82	0.38
Did not rely on less preferred food (0/1)	0.81	0.39	0.79	0.41
Did not face a situation that there is not enough food (0/1)	0.88	0.32	0.84	0.37
Mean (B)	0.20	0.16	0.18	0.17
Cash savings in the last 12 months (0/1)	0.48	0.50	0.31	0.46
Own formal insurance product in the last 12 months (0/1)	0.08	0.27	0.09	0.29
Distance to nearest financial institution (normalised value)	0.07	0.12	0.10	0.10
Temporary job by any household member in the last 12 months (0/1)	0.18	0.38	0.21	0.41
Mean (C)	0.41	0.30	0.25	0.24
Mobile phone owned by any member of the household (0/1)	0.41	0.30	0.45	0.50
Transfers/gifts from friends/relatives (0/1)	0.26	0.44	0.08	0.27
Uses motor-driven vehicles to transport crops or agricultural inputs to/from markets or owns a car (0/1)			0.23	0.42
Mean (D)	0.42	0.25	0.30	0.14
Household has non-farm income sources (0/1)	0.26	0.44	0.14	0.35
Household Dietary Diversity Score (normalised value)	0.58	0.16	0.51	0.15
Diversity of livestock held by the household (normalised value)	N/A	N/A	0.24	0.16

Table 5.2 *Mean values of the community level ABCD scores*

	Full sample		Rural sample	
	Mean	Std. Dev.	Mean	Std. Dev.
A	0.17	0.15	0.24	0.194
B	0.33	0.35	0.11	0.16
C	0.69	0.28	0.53	0.26
D	0.58	0.22	0.45	0.13

5.3.2 Resilience outcome proxy

As noted above, we identified the three most frequently experienced types of shocks by households in the survey including: illness of household members (14%), increased food prices (12%), and droughts (7%). According to Table 5.4, among households that experienced illness of a household member, the welfare of 30% of those households did not change. Similarly, among the households who were faced with increased food prices, the welfare of 17% of them did not change. The corresponding figures for the rural sample show similar pattern of experience to shocks and resilience of households.

Table 5.3 indicates the prevalence of households who were resilient to shocks in this specific context.

Table 5.3 *Experience to shock and the prevalence of households (%) whose welfare was not affected (whole sample N = 5180)*

	Illness of household member (%)	Increased food prices (%)	Drought (%)	Illness of household member but no change in welfare (%)	Increased food prices but no change in welfare (%)	Drought but no change in welfare (%)
Full sample	14	12	7	30	17	4
Rural sample	19	11	10	39	9	5

Further, at the community level, among shocks that made communities worse off, displacement was cited by less than 1.1% of communities in rural areas or the full sample, and increased food prices was the most prevalent and was cited by 35% of communities for the full sample and 19% of communities for the rural sample. The share of population affected by increased food prices was over 76% for both the full sample and the rural sample in those communities subject to shocks (Appendix Table A1).

5.3.3 Household ABCD capacities and household resilience by expenditure quintiles

To begin with, Figure 5.1 shows that each population category scores lower on buffering and higher on agency, in both the full sample and the rural sample (based on the indicators under Table 5.2). These seem consistent with the overall averages presented earlier. In addition, the ABCD scores tend to increase with expenditure quintiles, on average, regardless of the sample under consideration. Since such results are not unexpected, that resilience capacity tends to increase with wealth status, it would be more interesting to explore how might those capacities correlate with certain shocks. But, it is important to note that Figure 5.1 does not depict the relative importance among the four ABCD capacity categories between the two samples since the number of indicators used in the rural sample were not exactly the same as those used in the full sample as described earlier. Rather, each capacity needs to be considered in relation to the specific shock in question.

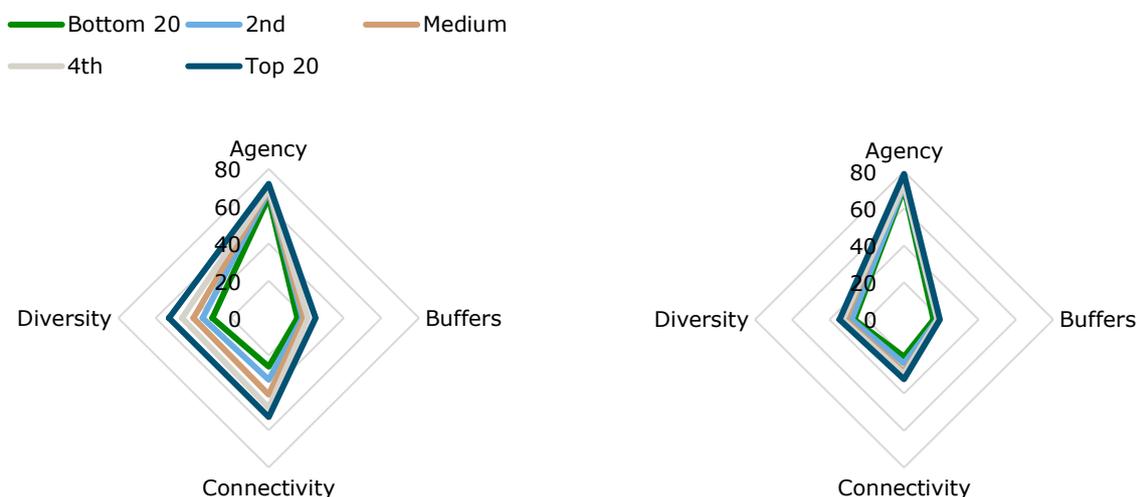For the rural household sample, scores were lower for Buffering, Connectivity and Diversity than Agency.

Figure 5.1   *ABCD scores across expenditure quintiles (full sample and rural household only sample)*

The household's resilience to each of the shocks described above—i.e. illness, food prices, and drought—were mapped against agency, buffering, connectivity and diversity, respectively. First, results of pairwise correlations suggest that agency was strongly correlated with buffering and diversity but not with connectivity (Table 5.4), and buffering, connectivity and diversity were strongly correlated to each other. Furthermore, a household's resilience to illness of a household member was positively correlated with agency; and a household's resilience to increased food prices was positively correlated with connectivity and diversity. Surprisingly, a household's resilience to drought was negatively correlated with agency, connectivity, and diversity. It is not clear whether this is a statistical artifact since the share of households who actually experienced drought was seven percent and four percent of those households stated their welfare did not change. A similar summary table of pairwise correlations for the rural sample is presented in the annex Table A4.

Table 5.4 *Pairwise correlations among ABCD capacities and resilience outcome indicators*

|	Agency	Buffers	Connectivity	Diversity	Illness of household member but no change in welfare	Increased food prices but no change in welfare	Drought but no change in welfare
Agency	1						
Buffers	0.0615*	1					
Connectivity	-0.0086	0.1805*	1				
Diversity	0.0711*	0.1819*	0.2279*	1			
Illness of household member but no change in welfare	0.0556*	0.022	0.0235	0.0022	1		
Increased food prices but no change in welfare	-0.0255	0.0284	0.0865*	0.0702*	0.0836*	1	
Drought but no change in welfare	-0.0618*	0.0006	-0.0554*	-0.0662*	-0.0023	0.0129	1

Note: * denotes that correlations were statistically significant at 1% level.

Additionally, as displayed in Figure 5.2, the share of households faced with a shock (especially to illness and increased food prices) but were resilient seems to increase with rising income status (expenditure quintile), signalling potential correlations between agency, diversity and buffering, respectively, and household resilience to the two types of shocks (illness of household members and increased food prices). The potential correlation is indicated by how closely the shape of the pentagon for the ABCD capacity resembles the shape of the pentagon for the resilience indicator. Diversity and connectivity seem to be more strongly correlated with household resilience to the second type of shock (increased food prices). Concerning droughts, the correlation is somewhat challenging to discern in the figure due to the small percentages of households that were faced with this type of shock.

However, it is noteworthy that all four scores exhibit similar patterns with resilience across income categories. The contrast is much clearer when households in the bottom (poorest) quintile are compared against those in the richest (top) quintiles in terms of ABCD and resilience to, for example, increased food prices as depicted in Figure 5.3. That is, those in the higher income categories tend to have higher ABCD scores and higher share of households who were resilient to increased food prices.
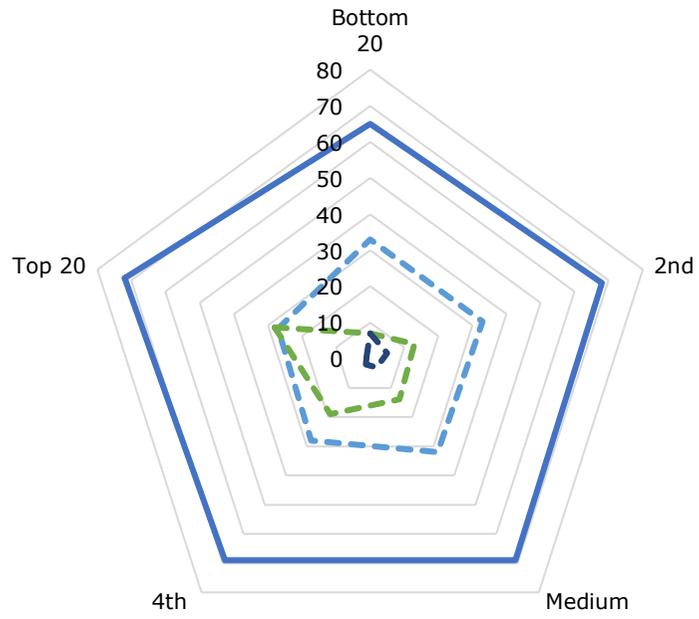
a. Agency
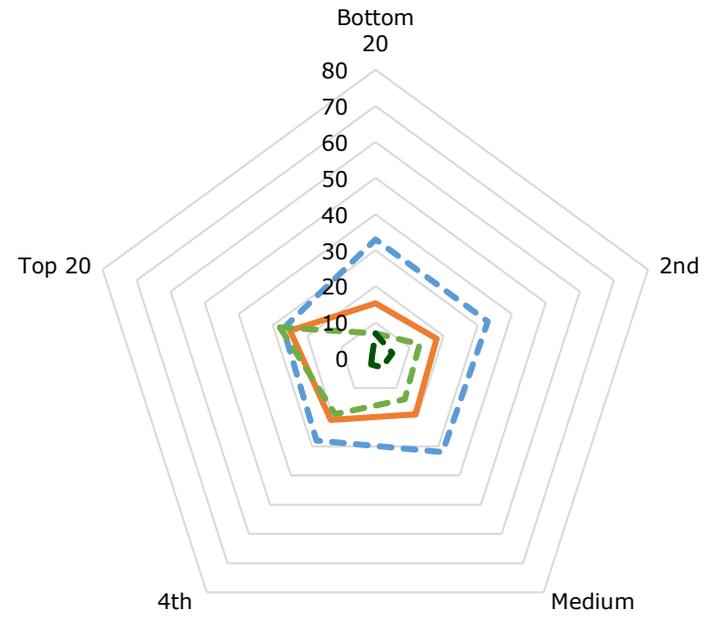
b. Buffer
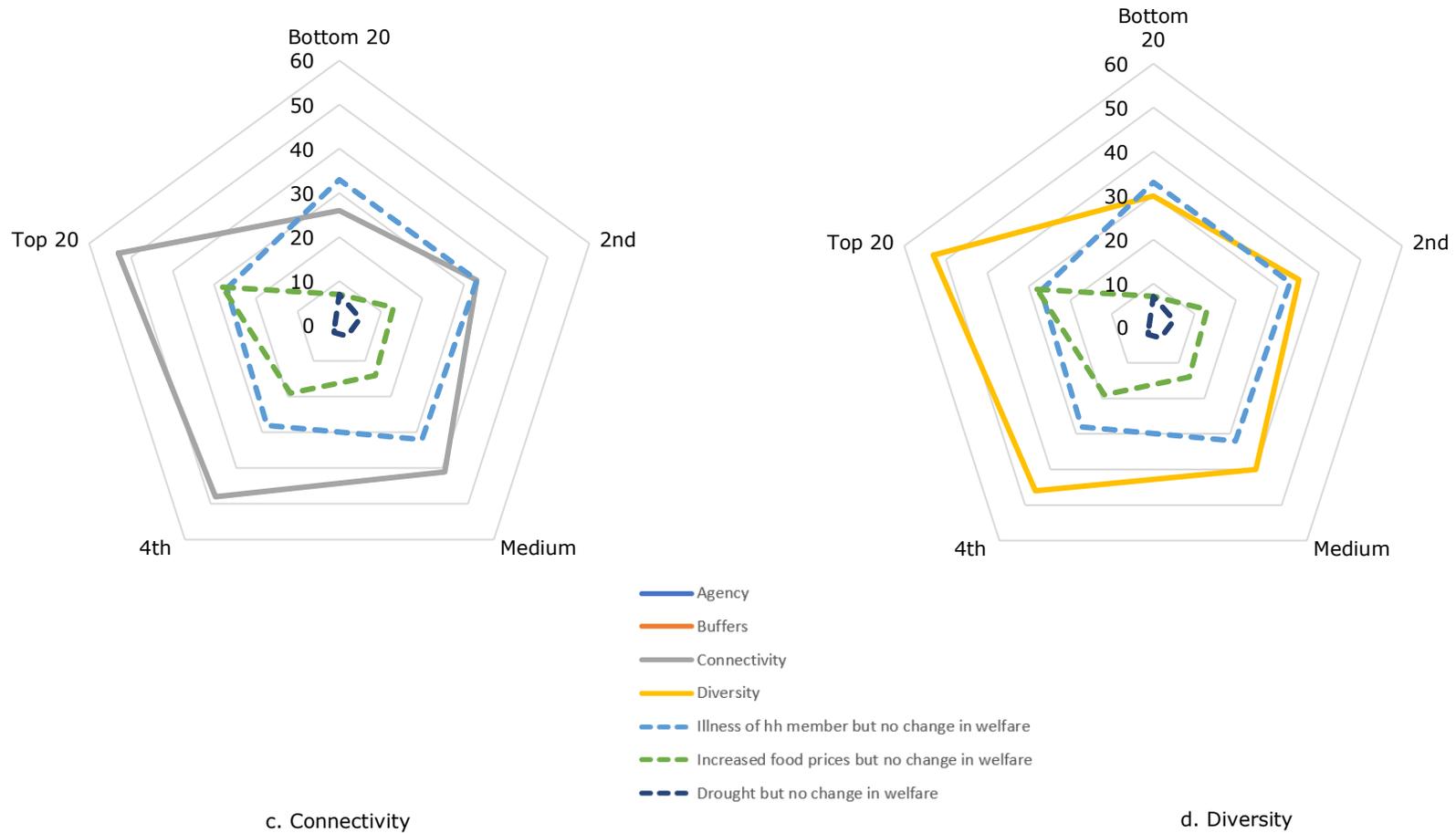
Figure 5.2   *ABCD capacities and resilience to 3 types of shocks, by 4 capacity categories*

Agency and resilience to increased food prices

Buffering and resilience to increased food prices

Connectivity and resilience to increased food prices

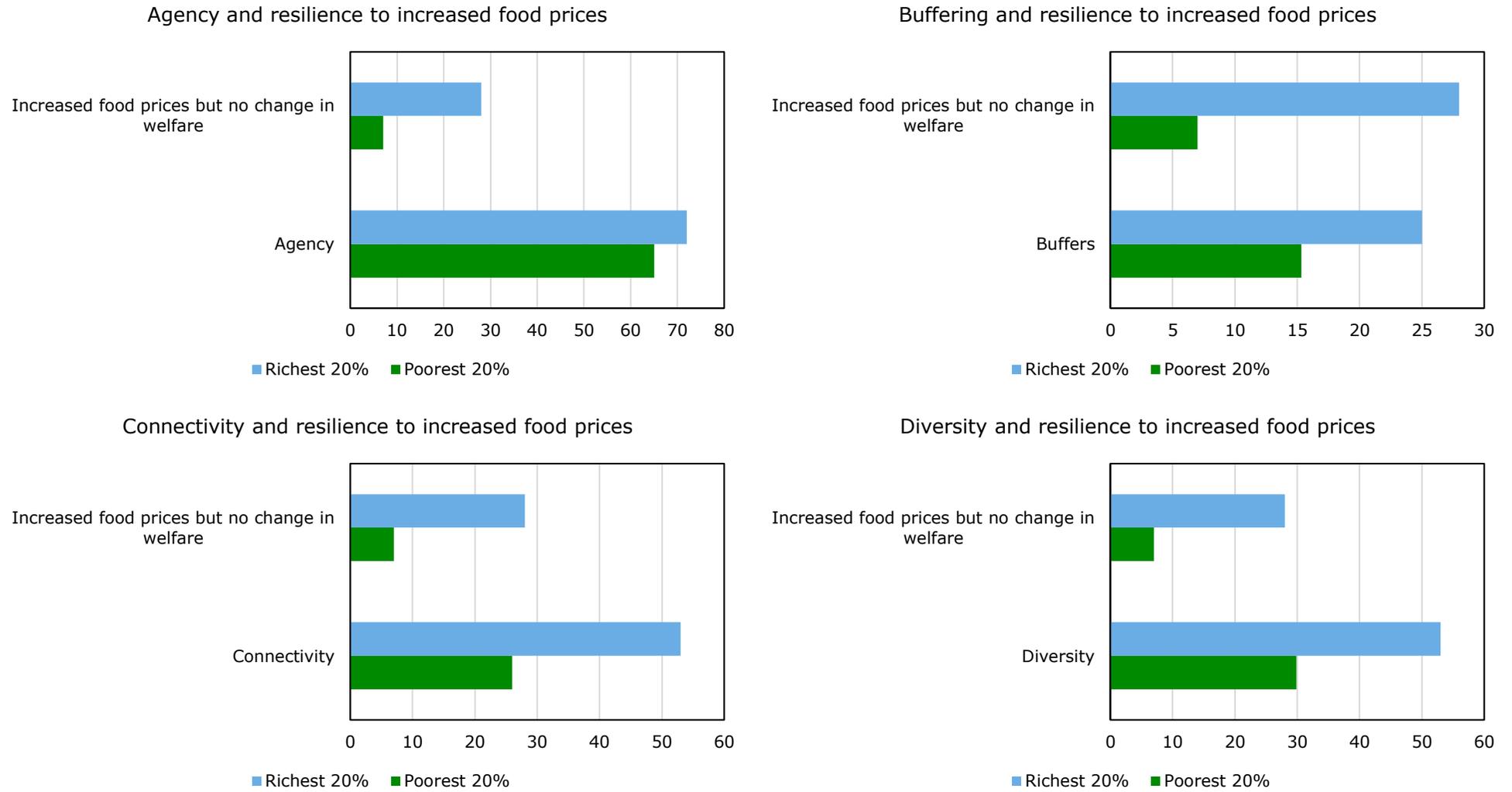

Diversity and resilience to increased food prices

Figure 5.3   *Comparison between the poorest 20% and richest 20% of households by their mean score to ABCD and resilience to increased food prices*

5.3.4   Household ABCD capacities and household resilience by rural/urban

We discussed earlier that rural households tend to have higher score on agency possibly due to social capital. However, to what extent that having such capacity can explain resilience of households to various shocks is not clear. According to Figure 5.4, for example, even though rural households tend to have higher score on agency but lower score on buffer, diversity, and connectivity than their urban counterparts, the share of households whose welfare was unchanged due to illness of household members or drought was higher for rural households. In contrast, the share of households who were resilient to increased food prices was higher for urban households. This may seem surprising since food production is the main livelihood to most rural households in Ethiopia. For example, in 2021/22, 89% of rural households cultivated crops, 89% kept livestock, and 82% engaged in both, with 96% practicing at least one of the two activities (ESS and World Bank, 2023). Nonetheless, the same report indicates that about 44% of rural households experienced moderate or severe food insecurity compared to that of 35% of urban households, suggesting that rural households are more vulnerable to food price increases compared to their urban counterparts. Clearly these results indicate some correlations between resilience of households to various shocks and their ABCD capacities, but the mechanisms through which each of the ABCD capacities work to increasing resilience of households to shocks need further exploration.
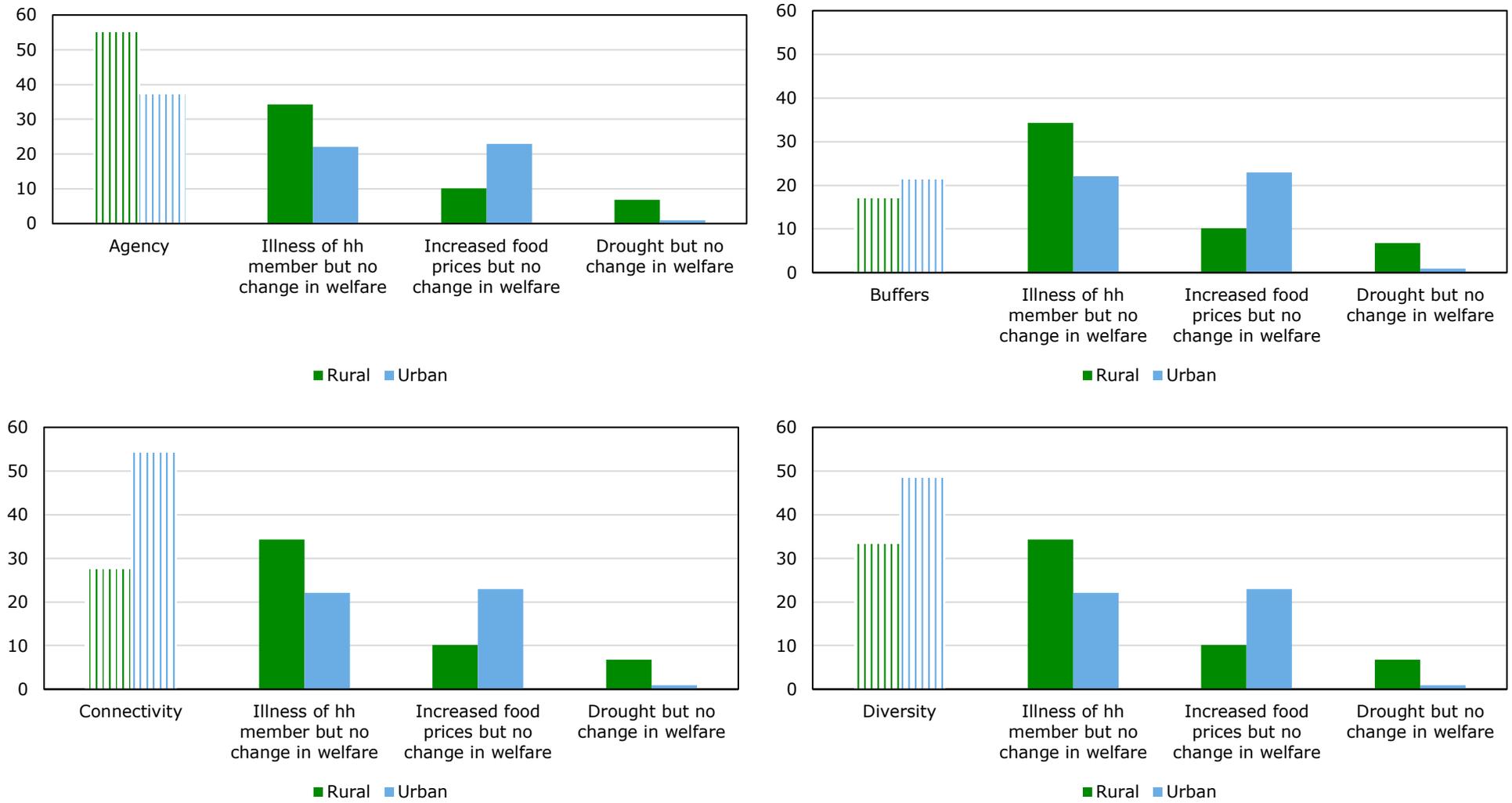
Figure 5.4 *Household ABCD capacities and household resilience by rural/urban*

6   Discussion and conclusions

One common approach by scholars and international agencies to study food system transformation (progress) is by developing frameworks and sets of indicators that allow cross-country comparisons. Such frameworks and sets of indicators are, by default, generalist in nature and have limited applicability for policymakers and development agents at national or sub-national levels. We understand food system resilience as *the capacity of a food system to deliver desired outcomes in the face of shocks and stressors*. This definition highlights the context specificity of food system resilience, as that capacity to deliver outcomes is highly dependent on the actors, activities and drivers that together constitute the food system. National and sub-national policymaking and the design of intervention strategies require tailored diagnoses of the deficiencies in resilience capacities at the levels where impact is anticipated.

We tested the ABCD framework on its usefulness to diagnose the state of resilience of the food system at household level in Ethiopia during 2017-2018. The results appear to indicate the usefulness of the ABCD framework when applied to secondary data to explain resilience to specific types of shocks most relevant to households in Ethiopia, such as illness of household members and increased food prices. We found suggestive correlations between the ABCD capacities and households' ability to uphold their welfare in the face of such shocks.

The results can help inform and guide the design of policy and development interventions that can enhance the resilience of Ethiopian households in the face of various shocks. For example, policies aiming to improve households' agency, such as iddir - informal risk sharing and risk pooling arrangement in the community (Aredo, 2010), gender equity in land rights, and food security, could contribute to increased resilience, particularly against illnesses. Additionally, policies promoting diverse and well-connected food systems could enhance resilience to shocks such as increased food prices. This might involve supporting diverse agricultural practices, transport services, facilitating information and market linkages, income diversification and ensuring access to a variety of food sources. Given the observed patterns among vulnerable groups, there is a need for targeted interventions for the least well-off households.

As a basic exercise, this application has several limitations. Our selection of ABCD indicators, as well as proxies for resilience outcome to shocks, is constrained by the available proxy indicators in the survey. We also do not cover other components of resilience assessment, such as coping/response mechanisms or feedback loops, as it can quickly become too complex. Besides, the secondary data do not capture the recent socio-economic dynamics and internal conflicts in the country, and the broader enabling environment for ABCD capacities.

Policymakers and development agents need well-informed and evidence-based recommendations for interventions targeting specific impacts and beneficiaries. A diagnosis of food system resilience must be processed into clear recommendations of what kind of interventions have high probability of achieving desirable impacts on building food system resilience. Secondary data, especially when using objectively defined measurements, can only partially meet the need for information required to assess the ABCD capacities for this purpose. Moreover, these ABCD capacities should be defined by their contexts and given meaning by the key actors concerned. This is because, for example, by applying three resilience measurement methods on data from Ethiopia and Niger, Upon et al. (2022) find significantly different results across methods regarding households that are identified as resilient or least resilient with respect to food security outcomes. Additionally, indicators to assess them will need to be identified in such a consultative process. A flexible combination of both objective and subjective approaches to the definition and evaluation of resilience can leverage localised knowledge for contextualisation and account for intangible aspects of resilience, while supporting comparability (e.g. in pre-and-post assessment) (Jones, 2019).

We therefore conclude that diagnosing the ABCD of food system resilience will always require a selective process of (SMART) data gathering to complement secondary data available. We propose the following protocol to go from resilience diagnosis to intervention:

1. Setting contexts and boundaries: Clarify the parameters of the assessment: resilience for whom, to what, when, where and why?
2. Defining ABCD capacities: Collaborate with key actors in the food system to understand their understanding and perception of the nature and (relative) importance of ABCD capacities.
3. Identifying Indicators: Develop sets of indicators and metrics for each ABCD capacity by integrating established, commonly used indicators for stakeholder-defined ABCD capacities.
4. Data Collection: Review secondary data and supplement with primary data.
5. Analysis and Visualisation: Examine ABCD capacities and deficiencies by target group (the 'for whom' under Step 1).
6. Intervention Longlisting: Collaborate with key actors to identify plausible interventions in responses to specific shocks ('to what' under Step 1).
7. Intervention Prioritisation: Shortlist interventions based on feasibility, efficiency, effectiveness, acceptability, and sustainability.
8. M&E Protocol Development: Define ambition levels (SMART objectives) for each (area of) intervention and develop a smart M&E plan. Indicators developed under Step 3 are integral to this plan (recognising that the selection of indicators also determines the scope of the monitoring & evaluation of impacts).

Steps 6, 7 and 8 are follow-up actions to the diagnosis made with the ABCD framework and therefore require using other tools to arrive at interventions. A potentially suitable approach to work from an analysis of local capacities to withstand stressors and shocks (that is, using the ABCD framework) to a list of potential interventions, is FoSTRA (food systems resilient assessment approach), an assessment approach originally developed by FAO and WUR, and which is further developed and applied by WUR and partners in Somalia and South Sudan, among others (see Malkowsky and Sopov, 2023). FoSTRA has a strong local, interactive stakeholder approach and aims to strengthen the resilience of the most vulnerable people. When developing Steps 6-8 in the above protocol, the possibilities for integrating the ABCD approach with an interactive tool such as FoSTRA that can help make the step from diagnosis to intervention aimed at strengthening resilience will have to be considered.

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Appendix

Table A1 *Long list of indicators that proxy resilience capacity, household and community level*

	Resilience capacity proxy indicators at household level	Resilience capacity proxy indicators at community level
Agency (A)	Membership to *IDDIR* (informal social group), land rights; share of female spouse with land rights to bequeath; Food Insecurity Experience Scale (FIES) questions on household's access to and control as food consumers	Share of male (female) participating in cooperative/microenterprise project; meetings organised by community members to express community needs to village/political leaders and/or to address their needs through various mechanisms;
Buffering (B)	Cash savings in the last 12 months; access to formal/informal credit; formal insurance; seasonal labor migration; distance to nearest formal financial institution; various indicators of 'Mechanisms for Coping with Shock'; harvested crop in storage*	availability of bank/microfinance/ATM/insurance agent/ Saving and Credit Cooperative Society (SACCO) in this community or the distance to the nearest one; Access to productive safety net program (PSNP)
Connectivity (C)	Mobile phones; Assistance from a non-household member (binary); use of vehicle/motor transport to bring crops to the market, or to bring seeds from the market, or whether the household owns a car*	Mobile phones; type of main access road; availability of all-weather road in the community; availability of a large weekly market in this community or distance to nearest large weekly market; frequency of a bus or mini-bus stop in this community or nearest station; Publicly accessible notice board in the community Existence of groups (women's group, farmers group, youth group etc.)
Diversity (D)	Income sources (participation in non-farm enterprises); diversity of diets consumed in the household (HHDD); diversity of livestock held by the household*	Diversity of food items sold in the market; share (in %) of the land in the community that is in forest and not used for agriculture; diversity of livestock types held by households in the village*.

*Indicator is available only for the rural sub-sample.

Table A2 *Indicators of community-level ABCD capacities*

A	Actions taken to address the community's needs through: mobilising manpower, mobilising financial resources among community members, seeking resources through: local government institutions; regional govt representatives; other influential person; religious organisations; NGO/international organisations; other means. [sum of ten binary values were normalised]. The mean value at community level yields the score for A.
B	Access to financial services available in the community including commercial bank; microfinance; ATM; SACCO; Bank agent; Insurance branch [sum of six binary values were normalised]. The mean value at community level yields the score for B.
C	Access to all weather road (proxied by whether vehicles pass on the main road in this community throughout the year, 0/1); availability of large weekly market in the community, 0/1; share of the community with mobile phone (calculated from household level data based on whether any member of the household has mobile phone, % [sum of the three indicators values was normalised]). The mean value at community level yields the score for C.
D	Number of food items sold in the market and diversity of livestock held by households in the community [values were normalised]. The mean value at community level yields the score for D.

Table A3   *Events that negatively affected communities in the past two years*

Type of event	Number of communities affected by event (Rural)	Percent of communities negatively affected by event (Rural, N=258)	Of those communities, % population affected on average mean	Number of communities affected by event (Full sample)	Percent of communities negatively affected by event (Full sample, N=525)	Of those communities, % population affected on average mean
1. Drought	39	15.1	48.9	58	11.0	52.2
2. Flood	25	9.7	31.8	54	10.3	27.9
3. Crop Disease/Pests	19	7.4	47.8	28	5.3	46.5
4. Livestock Disease	16	6.2	44.4	29	5.5	42.4
5. Human Epidemic Disease	3	1.2	60.0	14	2.7	41.1
6. Displacement Related Development Act	1	0.4	3.0	6	1.1	27.5
7. Sharp Change in Prices	50	19.4	76.4	188	35.8	76.5
8. Loss of Key Social Service(s)	5	1.9	48.0	12	2.3	38.1
9. Massive Job Lay-offs	3	1.2	5.3	26	5.0	16.2
10. Power Outage(s)	1	0.4	6.0	37	7.0	63.6
11. Other Bad (Specify)	23	8.9	58.0	90	17.1	47.4

Table A4   *Pairwise correlations among ABCD capacities and resilience outcome indicators for the rural sample*

	Agency	Buffers	Connectivity	Diversity	Illness of hh member but no change in welfare	Increased food prices but no change in welfare	Drought but no change in welfare
Agency	1						
Buffers	0.0442	1					
Connectivity	0.0962*	0.0940*	1				
Diversity	0.1140*	0.1528*	0.1839*	1			
Illness of hh member but no change in welfare	0.01	0.0451	0.0628	0.0107	1		
Increased food prices but no change in welfare	-0.0589	0.0395	0.0177	0.0295	0.1127*	1	
Drought but no change in welfare	-0.0745	0.0469	-0.0253	-0.0259	0.0112	0.0226	1

Note: * denotes that correlations were statistically significant at 1% level.

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