The ABCD of food systems resilience: an assessment framework

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Introduction

The ability of food systems to withstand and recover from shocks – known as 'resilience' – is increasingly critical. This is demonstrated by the impacts of the COVID-19 pandemic and the Russia/Ukraine conflict, which have been predominantly felt by poor groups in especially low- and middle-income countries. These groups already suffer from unstable livelihoods and chronic food insecurity in business-as-usual circumstances, meaning they are generally insufficiently prepared to withstand further shocks and crises. Moreover, global food systems are under increasing pressure from detrimental environmental impacts (e.g. soil depletion), and climate change is increasing the probability of extreme weather events (e.g. floods, droughts, and hurricanes); adding to the pressure on agricultural yields and the increase in food demand from the growing world population. As such, the ability to assess the resilience of food systems and their most vulnerable groups has become increasingly important in the development and assessment of policy interventions, both by governments and non-governmental organisations.

A framework to rigorously assess resilience in food systems is needed. However, assessing this resilience is challenging, as food systems and resilience are complex and multifaceted concepts. For instance, food systems contain many interdependencies between different stakeholders and their economic and ecological environments[1]. The different attributes that contribute to the resilience of stakeholders or the entire food system do not add up to a single, straightforward index of resilience. Acknowledging this will present decision makers with several trade-offs, in terms of stakes for groups, types of

1 Ericksen, P.J., *Conceptualizing food systems for global environmental change research.* Global environmental change, 2008. **18**(1): p. 234-245.

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shocks to be anticipated, timescales of impact, etc.. Making these trade-offs explicit is important because it conveys the message that interventions will generally affect not only the intended resilience target, but will have repercussions for the resilience properties of other stakeholders or the food system as a whole.

Within this brief[2], we offer a practical assessment framework to support policymakers and impact investors who aspire to strengthen food systems' resilience and/or assess the effects of their policies and investments. By applying this framework, greater insight will be achieved regarding the trade-offs within food systems' resilience that are vital to consider when evaluating interventions.

Challenges in assessing a food system's resilience

To assess the resilience of a food system, five key challenges need to be considered (see below). Our framework aims to address these and provides an ex-ante assessment of intervention's impact on food system resilience.

The first challenge is that there is not a single, unified understanding of food systems' resilience. For example, groups (**w**hom) can show different levels of resilience to various shocks and stressors (**w**hat) at different locations (**w**here) and different time scales (**w**hen)[3]

For a good assessment, it is important to carefully define the food system and its resilience.

A **second** challenge lies in the quantification and measurement of resilience, even when only focusing on one set of answers to the questions above. For instance, consider smallholder farmers in Bangladesh and their resilience against floods in the next decade. If the focus is on food security during and after the shock/stressor, one could choose the maximum decrease in food security during the shock or the level of food security that the system returns to after. The commonly used 'return time'[4] quantifies the time it takes the system to return to the pre-shock state. However, this presents the policymaker with a set of non-trivial questions: does he/she prioritize the severity of food insecurity during the crisis, or recovery speed of food security to pre-crisis levels?

Resilience assessments require careful specification of its temporal component, i.e. time horizon, focus on effects before/after the shock etc.

A **third** challenge is how to identify food system properties that support resilience and how to measure those. Some food system properties offer resilience that is specific to one type of shock, while others provide resilience against a broader set of shocks. For instance, a dike provides specific protection against local floods, while food stocks offer generic protection against local food shortages caused by a multitude of underlying shocks. Resilience indicators capture the presence of food system properties that provide resilience. The literature offers several resilience indicator frameworks[5], which cannot be used 'off-the-shelf' but instead require adaptation and interpretation for each specific situation/food system.

For a specific assessment of food systems' resilience, qualifiable indicators for the system components of interest should be specified.

A **fourth** challenge comes from the fact that the specified indicators will not be expressed in the same units – some will be qualitative, some indicative – and the precise relationship between indicators and food systems' resilience cannot always be quantified. Even when indicators are potentially measurable, data are often not readily available. As a result, the indicators cannot be adequately summarized in a single 'resilience' value.

A useful assessment of food systems' resilience should provide an overview of the different indicators to assess

2 For a more detailed introduction into the assessment framework, see https://doi.org/10.18174/574453
3 Meerow, S., J.P. Newell, and M. Stults, *Defining urban resilience: A review.* Landscape and urban planning, 2016. **147**: p. 38-49.
4 Pimm, S. and J. Lawton, Number of trophic levels in ecological communities. Nature, 1977. 268(5618): p. 329-331.
5 Cabell, J.F. and M. Oelofse, *An indicator framework for assessing agroecosystem resilience.* Ecology and Society, 2012. **17**(1). Hosseini, S., K. Barker, and J.E. Ramirez-Marquez, *A review of definitions and measures of system resilience.* Reliability Engineering & System Safety, 2016. **145**: p. 47-61. Jacobi, J., et al., *Operationalizing food system resilience: An indicator-based assessment in agroindustrial, smallholder farming, and agroecological contexts in Bolivia and Kenya.* Land use policy, 2018. **79**: p. 433-446.

trade-offs, synergies, and overall vulnerabilities.
Finally, the **fifth** challenge is assessing how the intervention will – directly or indirectly – affect the selected indicators. Such forward projection requires an in-depth understanding or assessment of system and human behavior. However, prediction in complex systems such as food systems is difficult, even before considering interventions. Additionally, some resilience indicators will be qualitative ('good' or 'low') which precludes quantitative (model-based) methods of prediction.

An assessment of the impact of interventions on food systems' resilience should acknowledge the difficulty of prediction and projection and should consider alternative future developments.

The ABCD of food systems' resilience

The main purpose of our framework is to guide policymakers and investment planners in assessing the expected impact of an intervention on food systems' resilience. This framework is formulated around four ABCD properties, which provide the starting point to understanding and assessing food systems' resilience. Based on a literature review, De Steenhuijsen Piters et al.[6] grouped important characteristics for food systems resilience under four main properties; Agency, Buffering, Connectivity, Diversity. While these may not be exhaustive, they present an easy mnemonic and span a diverse set of factors that underpin resilient food systems (Figure 1, left panel).
By grounding the assessment in a concise description of the food system, its vulnerabilities, and key actor groups, it is possible to analyze the four properties using qualitative and, if possible, quantitative indicators.
This approach enables an analysis of the plausible effect of an intervention by actor group, and highlights inevitable trade-offs and synergies associated with the intervention.

An assessment framework of food system resilience

The assessment framework constitutes five steps (Figure 1, right panel). Each step consists of a structured inquiry, whose answers serve as building blocks for the following steps. In the ideal case this inquiry involves experts and local stakeholders. Each step is supported by a table, which serves as scaffolding for the inquiry at hand.

The steps will be introduced by following a hypothetical case study. The case study consists of a proposal to introduce crop insurance to support smallholders in a further unspecified low- and middle-income country. Crop insurance is applied in many different contexts, often in combination with microcredit schemes. It is aimed at mitigating the risk of production shocks for both the farmer and lender (supplying credit for inputs, such as fertilizer and high-quality seeds), and is therefore a direct

6 de Steenhuijsen Piters, B., et al., *Food system resilience.* 2021.

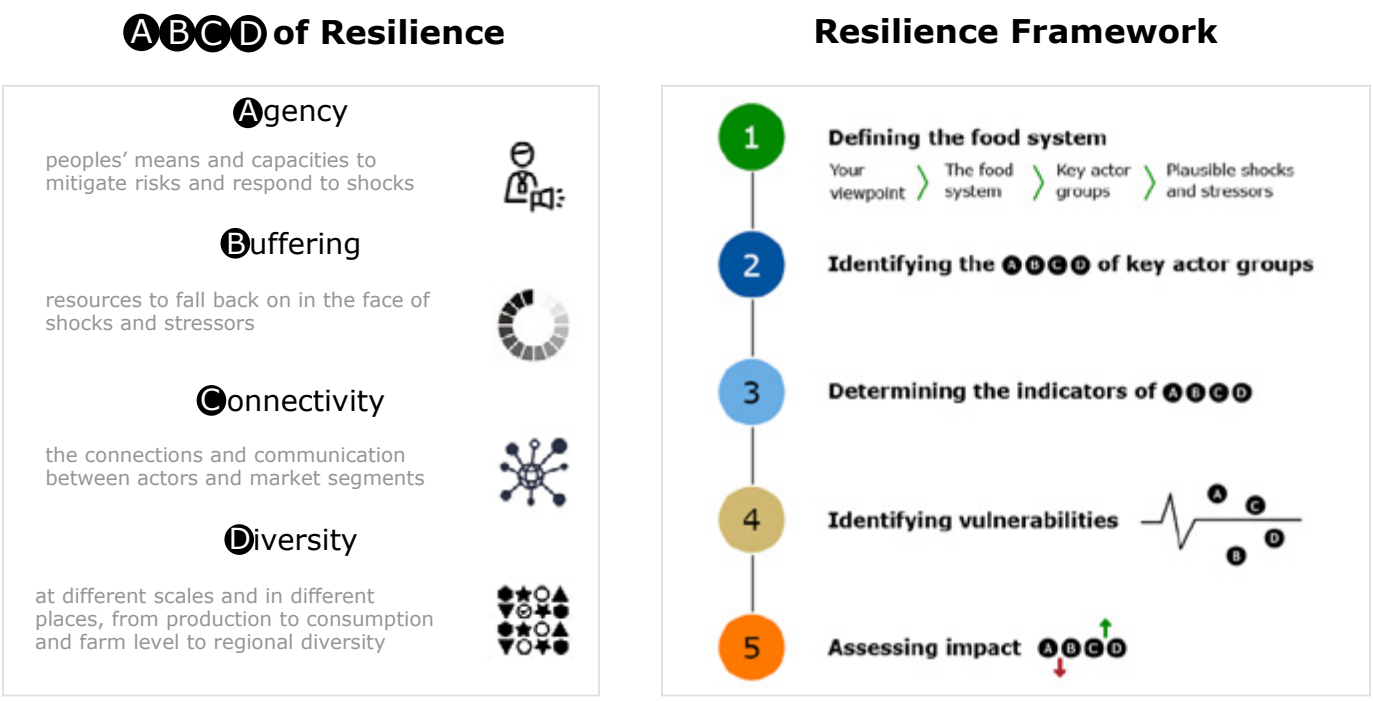

Figure 1 Overview of the resilience assessment framework

Step 1: System definition Index-based crop insurance case study.	
a Viewpoint	A development agency supported by an impact investor introduces crop insurance to protect smallholders against common production shocks, thereby improving their resilience directly, but also promoting the cultivation of high-risk high-yield crops and improving the economic viability of farming. In this case study, the focus is on the resilience effects for different stakeholders.
b Food system description	Smallholders, trade networks, including local traders and their consumers. Region within an LMIC dominated by smallholders. Urban populations or foreign producers/consumers of food are excluded, because food in this case is produced and consumed on a local scale.
c Vulnerable groups	The main identified groups are: 1) smallholder households; and 2) households that depend on food produced by smallholders, since both groups will struggle to source food if local food production decreases. We expect some heterogeneity within these groups in their disposable income, but both groups are, on average, relatively poor with respect to other local groups.
d Relevant shocks/stressors	Productivity shocks: i.e., droughts, floods and pests. Economic shocks, leading to financial issues for the smallholders and/or for the households that depend on their production.

Step 2: ABCD properties per actor group				
	Agency	Buffering	Connectivity	Diversity
Smallholder households	Opportunities for productivity development (investment), social status as a limiting factor	Own reserves (cash, livestock, and food)	Local trade and social relationships	Combine farm income with off-farm income
				Crop diversity
Local households depending on local production	Education and social factors enable job opportunities. Ability to migrate	Household cash/food stocks	Social relationships between households	Diversity of local production across farmers
			Trade with other communities, and large-scale traders	Local job opportunities

strategy to improve the resilience (in the form of buffering) of smallholders. Furthermore, the availability of credit and insurance improves the productivity and profitability of smallholders by allowing them to focus on higher-risk cash crops.

Step 1 delineates the food system and the main vulnerabilities to shocks, stressors, and abrupt changes. Four sub-questions, that address key elements for system analysis and its vulnerabilities help structure this inquiry:

a **What is the point of view from which the food system is evaluated?** The perspective one has on a food system shows which components (actors, institutions, infrastructure, environmental factors, etc.) and scales are emphasized most, and provides a starting point in describing the food system. For example, a food system description and perspective will differ between smallholders and entire countries. After defining the perspective, the food systems outcomes are defined, such as: What does food security imply in this context? Which costs and benefits are addressed, and how? To what extent are livelihood stability and environmental sustainability considered by different stakeholders?

b **What are the important components and actors (and groups thereof) in the food system, and the connection between them? How is the food system bound in time and space?** Boundaries include physical boundaries (countries, regions) and the actors included (such as vulnerable groups), but also the extent of relevant trade relationships.

c **Which actor groups are most vulnerable with respect to food system outcomes, and who are most likely to be affected by the intervention?** This question specifically asks users to identify groups or subgroups that are currently most vulnerable, or for which the intervention is expected to have the largest impact on resilience. Note, this does not preclude less vulnerable or non-vulnerable groups from being included.

d **What are the potential shocks and stressors that are relevant or anticipated for this food system and its vulnerable groups?** This question limits the scope of shocks against which resilience is to be assessed to those relevant for this food system.

One of the most important outcomes of Step 1 in our case study (see table above) is the identification of two actor groups that will be the basis of the following steps. Here, a balance must be struck between exhaustiveness (other actor groups are likely to also be affected by the intervention) and keeping the inquiry focused.

Step 3: Indicators of the ABCD properties for each actor group				
	Agency	Buffering	Connectivity	Diversity
Smallholder households	Profitability/acreage, time to travel to agricultural education center	Average savings and lowest quintile of savings, livestock, food reserves	What percentage of production is traded and to whom (only one-on-one, or one-to–many and many-to-one), distance to market (in space and time), prior use of social relations in food crises	Off-farm income, number of available sources for off-farm income
				Number of crops in cropping system (/year)
Regional households depending on local production	Years of education, social status, gender	Average and lowest quantile of savings and food reserves	Prior use of social relations in food crises	Number of different crops across farmers (/year)
			Existence of trade between other communities (villages) and larger production/trade centers	Number of different job opportunities

Step 4: Vulnerabilities of actor groups for each ABCD property				
Green = positive contribution			Red = negative contribution	
	Agency	Buffering	Connectivity	Diversity
Smallholder households	Low profitability limits other options	Low reserves	Social relationships protect food security during crises	Diverse cropping systems protect against local shocks
				Large dependence on own food production
Regional households depending on local production	Low education limits employability	Low reserves	Social relationships protect food security during crises	Diversity of crops across farmers
			The trade network is local, so high vulnerability against local production shocks	Low diversity in job opportunities

Step 2 specifies the **ABCD** properties of the actor groups identified under Step 1c. For each group, the factors supporting agency, buffering, connectivity, and diversity are specified. Multiple factors per property can be mentioned, as illustrated below for the case study. For instance, smallholder households can have a diverse crop rotation, but also a diverse set of off-farm income sources. Both support resilience. It should be noted that the tables below are not meant to be exhaustive but are merely for illustrative purposes.

Step 3 identifies qualitative or quantitative indicators for the **ABCD** properties per actor group. Here, the indicators for which sufficient data/expertise is available to best assess the current and future status of the **ABCD** properties are listed. Examples for our case study include off-farm income and number of crops in a crop rotation, both of which can be readily accessed through surveys.

Step 4 identifies the vulnerabilities of the **ABCD** properties per actor group. The table below shows that in the crop insurance case, groups can show a mixed score for a **ABCD** property. For instance, smallholder households score low in **A**gency and **B**uffering, high in **C**onnectivity and are mixed with respect to **D**iversity. The use of colors for positive and negative contributions provides a direct qualitative overview of the vulnerability of actor groups.

Step 5: Assessment of the impact of the intervention on each of the ABCD properties for each actor group				
Positive change	Negative change		No change	
	Agency	Buffering	Connectivity	Diversity
Smallholder households	Improved profitability	Crop insurance buffers against production shocks	Social relationships might become strained by increased inequality	Diverse cropping systems protect against local shocks
		Potential to improve reserves		
	Uptake of insurance by richer farmers increases inequality	Uptake of insurance by richer farmers increases inequality and thereby ability to build reserves		Large dependence on own food production
Regional households depending on local production		More/cheaper food makes it easier to build reserves	Social relationships protect food security during crises	Diversity of crops across farmers
			Trade network is local, so high vulnerability against local production shocks	Low diversity in job opportunities

This step highlights the multidimensional nature of resilience for each actor group. Note, that multiple targets for intervention are present. This increases the likelihood of trade-offs within and between groups, since interventions will likely affect several resilience properties of several actor groups simultaneously.

Step 5 assesses the plausible impact of a particular intervention on the actor groups and the **ABCD** indicators identified in Step 3. Changes in resilience, as expressed by the **ABCD** properties and indicators of actor groups, can then be evaluated. From these changes, trade-offs and synergies within and between actor groups can be highlighted and analyzed. Note that a qualitative analysis is the aim here: the weighing of the **ABCD** properties against each other is affected by normative assessment. For example, the introduction of crop insurance for smallholder farmers often has the unintended consequence of increasing inequality within the smallholder group[7], because relatively wealthy smallholders are more likely to buy crop insurance than their poorer counterparts. This increases inequality between farmers not only during a production shock (because of diverse levels of protection), but also in general, because crop insurance supports a shift towards more profitable cash crops. The increase in inequality might decrease the social cohesion of smallholders, thereby affecting their Connectivity negatively.

7 Marr, A., et al., Adoption and impact of index-insurance and credit for smallholder farmers in developing countries: A systematic review. Agricultural Finance Review, 2016.

Conclusion

We have detailed a framework to help assess the impact that interventions have on food systems' resilience. With this framework – centered around the **ABCD** properties of resilient food systems – we identified five main challenges in assessing how food systems' resilience is affected by interventions: 1) the delineation of the system; 2) identification of the factors that support resilience; 3) finding indicators to assess these factors; 4) analyzing the current state of food systems' resilience; and, 5) projecting food systems' resilience into the future. Our resilience assessment framework confronts these challenges by a set of 5 steps that support a structured inquiry into resilience for each particular use case. Following these steps provides insight into the effects of an intervention on food system resilience.

Providing disaggregated views on what and who benefits from an intervention encourages evidence-based decision-making by policymakers, investors, and other key stakeholders. Doing so may also lead to the early identification of unwanted side-effects from interventions, and allow for comparison of different interventions with respect to resilience. Moreover, this approach strengthens the development narrative, which used to be biased towards rendering systems more efficient. However, this can occur at the expense of resilience – so creating a balance between food systems efficiency and resilience may be one of the most prominent trade-offs to consider in future interventions.

We plan to further refine the **ABCD** framework in terms of generic factors that support its components and associated indicators, and support the application of this framework to real-world cases.

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