Resilient Food and Land Use Systems: From concept to practice

The Food and Land Use Coalition

Contents

Foreword

In recognition of the increasing vulnerability of food and land use systems (due in part to the lingering effects of the COVID-19 pandemic, the Ukraine war, and protracted conflicts, weather, and climate extremes), this policy brief proposes a typology of measures to build resilience into the sustainable transformation of food and land use systems to ensure continuous functionality of these systems in times of rapid change. The brief builds upon a companion paper commissioned by the Food and Land Use Coalition (FOLU), "Resilience and the Transformation of Food and Land Use Systems" (Sperling et al, 2022), which proposes a set of principles and guiding questions for decision-makers and responds to the need for greater emphasis on food and land use systems in current policy programmes, such as Nationally Determined Contributions under the Paris Agreement.[1,2,3]

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1. Introduction: The shifting risk landscape for food and land use systems

Food and land use systems have been largely successful in providing affordable food for a rapidly growing population over the last century. From 1961 to 2014, global cereal production increased by 280 percent, and in the 1980s deaths from undernourishment fell sharply worldwide.[4,5] However, the world is witnessing a reversal of these trends in recent years, with an alarming growth in the number of people facing food insecurity. 2.3 billion people (29 percent of the global population) were moderately or severely food insecure in 2021 – 350 million more than before the outbreak of the COVID-19 pandemic. Nearly 924 million people (12 percent of the global population) faced food insecurity at severe levels, an increase of 207 million in two years.[6] The World Bank's Food Price Index reached an all-time high in April 2022, and, despite declines in the third quarter of 2022, the index remains almost 20 percent higher than a year ago.[7] It is expected that food prices will remain elevated in the near future due to a reduction in global cereal production, combined with input cost pressures.[8]

This reversal of progress is driven by the growing intensity and frequency of shocks and stresses impacting food and land use systems.[i] Table 1 below provides a non-exhaustive list of such shocks and stressors which can trigger and reinforce one another.

i Shocks are sudden events that impact on the vulnerability of the system and its components. Stresses are long-term trends that undermine the potential of a given system or process and increase the vulnerability of actors within it.

Table 1: Non-exhaustive list of shocks and stresses impacting food and land use systems

Type of shocks and stresses	Examples impacting food and land use systems
Biophysical	**Climate change:** Agricultural productivity today is estimated to be more than 20 percent lower than it could have been without climate change.[9]
	Pollinator loss: Three-quarters of crops require pollination and yet many populations of pollinator species are in sharp decline.[10] An estimated three to five percent of fruit, vegetable, and nut production is lost globally due to inadequate pollination, leading to an estimated 430,000 excess deaths annually from diseases linked to unhealthy diets.[11] Moreover, the near extinction of certain pollinators jeopardizes five to eight percent of agricultural production and USD 235 billion to USD 577 billion worth of annual output.[12]
	Water stress: Increased water demand from population growth has been ranked as one of the top threats, which increase the vulnerability of food systems and reduce adaptive capacity to extreme events.[13] Water scarcity, exacerbated by climate change, could cost some regions up to six percent of their gross domestic product (GDP).[14]
Socioeconomic and political	**Conflict:** Conflict is driving hunger in nearly all the world's main food crises. War leads to greater food insecurity which, in turn, increases the likelihood of unrest and violence.[15]
	Price shocks: A price shock occurs when commodity prices drastically increase or decrease over a short span of time, often as the result of other shocks to the system, for example conflict, supply chain disruptions or drought. Global food price shocks are more likely to have a high impact in middle- and low-income countries due to limited-foreign exchange reserves, their strong global market integration as well as a lack of capacity to borrow and to protect local markets (e.g. because of trade agreements and lack of storage facilities).[16,17]
	Consumer shifts: For example, the COVID-19 pandemic triggered a shift in consumer demand in many countries towards domestically-available products.[18]
Technological	**Damage or disruption to infrastructure:** Damage to critical infrastructure, for example long-term shut-down of bridges, roads, and other food transportation networks, can have significant disruptive impacts on food security.[19]
	Technology shifts: The development and use of emerging technologies across food and land use systems will affect countries' and companies' competitiveness, production and distribution costs, and ultimately the demand for their products and services.[20]

Certain features of food and land use systems have also made them particularly vulnerable to these shocks and stresses. For example, the drive for efficiency in resource use, labour and capital allocation (often linked to efforts by large corporates to maximize profits) have promoted widespread homogenization of production, resulting in the decline of agrobiodiversity at species and genetic level and increasing vulnerability to shocks.[21] Even the globalization of food and land use systems (which on the whole reduces risk through distribution of food from regions of surplus production to net-consumer countries) has led to rising dependency of certain countries on food imports, with dire impacts when there is a breakdown in trade such as during the 2007-08 world food crisis, the COVID-19 pandemic or the war in Ukraine.[22,23] Underpinning this is the fact that food and land use systems are a significant driver of climate change and environmental degradation and yet they are also highly vulnerable to these impacts, ultimately weakening their ability to function in the long term.

The risk landscape of food and land use systems will continue to shift as the biophysical, socioeconomic/political and technological shocks and stresses (Table 1) play out over different spatial and temporal scales and interact in complex ways.[24]

As such, it is critical that recovery from the current confluence of crises does not mean simply reverting to the way in which food and land use systems functioned before these crises emerged; recovery should be seen as an opportunity for adapting and transforming the system to a new state which better delivers sustainability, security, health and wellbeing for people and nature. Efforts to increase resilience and to transform the system to a more sustainable state must go hand in hand, and build upon the successful experiences of farmers, many of whom are already developing and implementing practical solutions on the ground to mitigate and adapt to the effects of climate change and nature loss.

2. Principles for building resilience into the sustainable transformation of food and land use systems

In recognition of the shifting risk landscape, there has been increased attention to the need to build resilience into efforts to sustainably transform food and land use systems. For example, the 2021 United Nations Food System Summit (UNFSS) initiated one of five priority action tracks ("Action Track 5") to build resilience to vulnerabilities, shocks and stress. This included dozens of game changing solutions submitted and assessed by the Action Track 5 leadership group.[25,26] As an example, this has led to the creation of the Climate Resilient Food Systems (CRFS) Alliance which aims to support countries in transforming towards climate resilient food systems, including through facilitating access to finance, technology and innovation and promoting multi-risk management approaches.[27]

Sperling et al. (2022) add to the growing body of literature on resilience, and propose a set of four principles for actors seeking to build resilience into the sustainable transformation of food and land use systems. These principles are summarised below:

A. **Clarify the purpose of resilience thinking:** Resilience is an attribute and not an end goal. Instead, there is a need to clarify the desired resilient outcomes that we want to achieve, such as resilient sustainability, equity, development, or all of the above. If efforts singularly focus on resilience, it is conceivable that resilience measures could reinforce power structures, contributing to enduring inequity, or promote structures that support the exploitation of natural resources and thereby are in conflict with the need to advance sustainability. For example, in efforts to address the food and fuel crisis triggered by the war in Ukraine, several countries considered an increase in biofuel production as a coping strategy. This not only has the potential to exacerbate food insecurity by replacing food crops with fuel crops, it can also drive expansion of agriculture into uncultivated areas, increasing greenhouse gas emissions from land use change.[28]

B. **Ensure a holistic focus:** A resilience building approach that concentrates on a particular hazard type may prove to be ineffective, or worse, may weaken our ability to withstand the impact of other hazard types. Resilience efforts should therefore take a multi-hazard focus (environmental, social, economic, technical) and consider trade-offs between resilience building efforts across spatial and temporal scales, within and across systems. The nexus of climate and nature highlights the need for a multi-hazard focus: e.g. where the planting of fast-growing, non-native monoculture for carbon sequestration or for bioenergy threatens biodiversity and displaces food production, or where hydroelectric dams for generation of clean energy fragment rivers and habitats, isolating species and migration routes and disrupting the flow of nutrients between ecosystems.[29,30] An example of trade-offs between resilience building efforts across temporal scales relates to proposals to increase self-sufficiency of agricultural production in response to the disruptions linked to the war in Ukraine, however, retreating entirely from international trade may add to the volatility of food and land use systems and it may become more difficult to buffer more localized food and land use systems against the impacts of climate extremes over time.

C. **Consider the interplay between efficiency, redundancy and diversity:** While efficiency gains such as advances in precision agriculture or improvement in storage and cold chains can help reduce pressures on land and natural resources and potentially add to the resilience of food and land use systems, a too narrow focus on efficiency may foreclose coping and adaptation options and can make the system vulnerable to shocks (for example where the system is highly concentrated and lacks diversity). Redundancy and diversity in systems maintains a portfolio of options and can act as insurance against shocks and stresses. As such, efficiency improvements in food and land use systems should not only be evaluated against economic criteria alone, they should also be assessed against complementary social and environmental sustainability criteria.

D. **Check enabling conditions:** Resilience building calls for several enabling conditions, including the necessary capacities, coordination, stakeholder engagement, funding and incentive mechanisms. For example, the institutional environment should facilitate systems thinking and resilience building efforts should be informed by comprehensive stakeholder dialogue involving public and private sector and civil society.

Given the ever-changing landscape of risk of food and land use systems, it is important to apply a dynamic and iterative approach to building resilience. This means that resilience building measures must be trialled and evaluated over time to see what works, what the consequences of changes are, what intended or unintended knock-on effects might occur, including effects on linked systems (such as water, energy, labour). This requires careful evaluation and a willingness to adapt and learn under an adaptive management approach. It is especially important to have risk transfer mechanisms which transfer exposure to volatility, using market transactions, from one actor to another which is better able to cope with it (for example through farmer income, yield or pest insurance), and via social safety nets. These should be co-designed by the many actors involved, including farmers, to protect the most vulnerable so that their livelihoods and food security are not put at risk by taking an experimental, learning-by-doing approach.

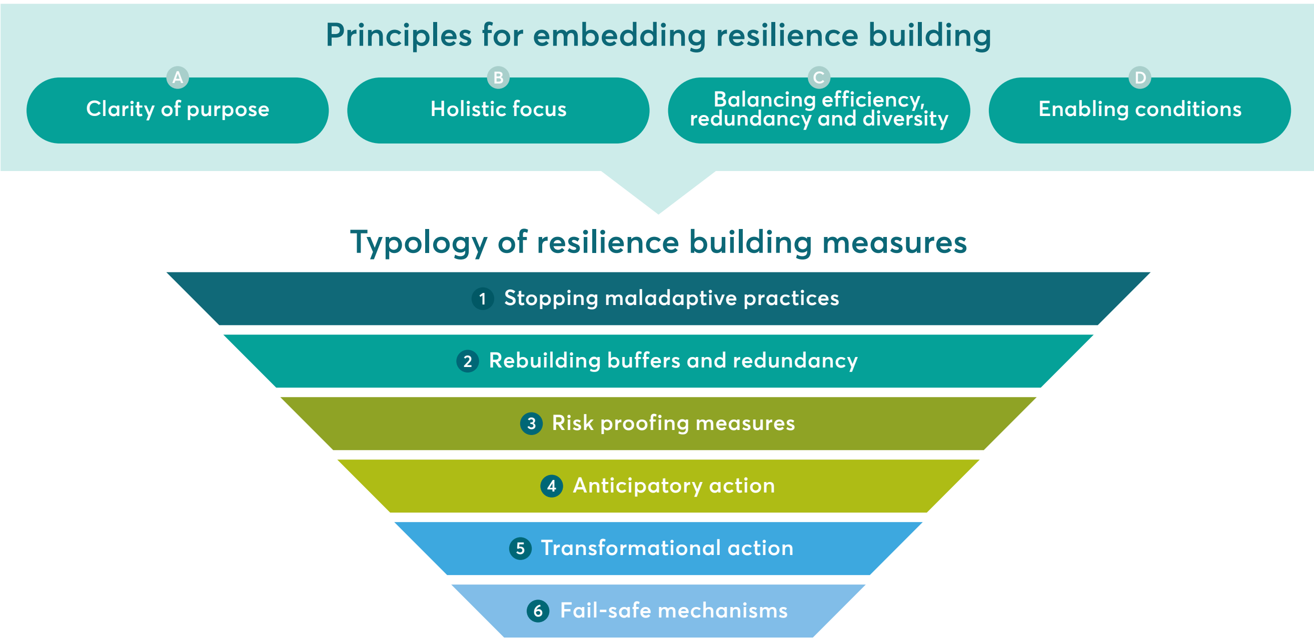
The Annex further elaborates on these principles through a set of guiding questions.

3. A typology of resilience building measures for the sustainable transformation of food and land use systems

Resilience building measures for the sustainable transformation of food and land use systems range from interventions focused on anticipating and reducing risks to those which strengthen the system's absorptive coping capacity (i.e. the ability to withstand a shock), adaptive capacity (i.e. the ability to make incremental adjustments while maintaining the system's core functions) and transformative capacity (i.e. the ability to transform to a sustainable state).

Resilience building measures can be categorized into six broad groups (see the inverted pyramid in Figure 1). The first category focuses on mitigating the environmental impacts of food and land use systems which they are in turn vulnerable to, whereas layers two to six focus on the absorptive coping, adaptive and transformative capacities. Investment is required across all six categories of action to adequately address systemic shocks and stressors.

Figure 1: A framework for building resilience into the sustainable transformation of food and land use systems



Modified from Moench et al. 2014[31]

1. **Stopping maladaptive practices:** The first set of measures are those which avoid the negative impacts to which food and land use systems are vulnerable, such as reducing greenhouse gas emissions and unsustainable use of land and water, and rampant biodiversity loss. These actions form the foundation of building resilience as they maintain the critical systems required for the productivity of food and land use systems over the long term.

2. **Rebuilding buffers and redundancy:** The next category of action targets building robustness and redundancy in food and land use systems. This could include building slack in food value chains, as well as diversifying food sourcing (such as co-development of localized food production and consumption loops and trade to supplement what cannot be produced locally). Moreover, technological innovation can improve the quality of production and reduce food loss and waste to increase the availability of food to reduce the risk of food scarcity.

3. **Risk proofing measures:** The third category comprises risk proofing measures, such as diversifying food production portfolios to reduce vulnerability to stresses (such as pests and diseases), use of drought tolerant or pest resistant varieties, risk proofing of processing, transport and marketing systems against multiple shocks and stresses and restoring ecosystem functions critical to supporting food and land use systems (such as pollination services or flood mitigation services).

4. **Anticipatory action:** A fourth category of action includes anticipatory action in advance of a crisis. This includes climate-informed food and land use systems planning, early warning information in advance of a weather extremes or systems to advise of potential food price shocks, or global transport and trade disruptions, that enable agile response measures to avert an impending crisis.

5. **Transformational action:** A fifth category of action refers to more transformational changes that may be needed to respond to chronic, persistent risks, such as climate change or ecological collapse. This might require wholesale changes to production systems, such as changing of crops or livestock to suit new conditions, or wholesale changes in consumption patterns, such as dietary shifts in response to prolonged scarcity or other pressures.[32]

6. **Fail-safe mechanisms:** At the end of the pyramid are measures which acknowledge that impacts will happen, and that there is a need to limit catastrophic, cascading impacts. These include humanitarian assistance, social safety nets and insurance.

4. Implications

This brief presented a typology to categorize measures to build resilience into the sustainable transformation of food and land use systems. The principles outlined in Sperling et al (2022) enable decision-makers to think about how these measures should be implemented through a set of guiding questions related to A. Clarity of purpose; B. Holistic focus; C. Balancing efficiency, redundancy and diversity; D. Enabling conditions (see the annex of this document).

The ambition of this brief is not to be prescriptive on which actions need to be taken in any specific system or location, but to posit a framework for action for decision-makers (notably policymakers) interested in the resilience of global to local food systems which can be adapted to different contexts through consultation and involvement of farmers. How this might be applied in practice by a policymaker is as follows: the first step would be to identify the shocks and stressors impacting food and land use systems at different scales to understand the main sources of risk. The next step would be to review existing policies and to identify which of the six categories of measures are being implemented and which additional measures need to be embedded into policy. Thirdly, policymakers would consider the four principles and the associated guiding questions for each set of policies (for example, a policymaker would consider whether the package of measures addresses the risks of a single hazard type or whether it manages a comprehensive set of risks and consider the linkages and trade-offs between them). Finally, policymakers would monitor and evaluate the impact of policies (both as they relate to resilience building measures as well as efforts to transform the system to a more sustainable state) and iterate and adapt based on this evaluation.

To further embed resilience thinking into policymaking there is also a need for stronger institutional mandates at both a national and international level, given the global interconnectedness of food and land use systems. In light of the current and projected shocks facing food and land use systems, various actors involved in the historic 2021 United Nations Food System Summit (including individuals from FOLU, the Club of Rome and the Global Alliance for Improved Nutrition) argued for the creation of a multilateral Food System Stability Board (FSSB), akin to the financial stability board created in 2008 in response to the financial crisis, as a means to create a mandate and coordination mechanism to support proactive policy making in support of food system resilience.[33] The proposed FSSB would build on existing structures and institutions such as the Committee on World Food Security (CFS), the Food and Agriculture Organization (FAO), the World Food Programme (WFP), and the World Bank.[34] Such an institution could promote the health and resilience of the global food system, including by addressing issues such as price stability, trade, strategic reserves, and the effects of climate change on production. It could support needed contingency planning, development of robust early warning systems, and policy recommendations to buffer the impacts of future pandemics, climate crises, and food and fuel shocks, in line with the resilience building concepts articulated here and in Sperling et al (2022).

Policymakers also need clearer definitions and therefore metrics to measure the impact of interventions on system resilience when evaluating policy options. There is a growing body of literature on metrics for measuring the resilience of food and land use systems at different scales.[35,36,37,38,39,40] It is critical that these metrics are integrated into long-term pathway development and scenario analysis to inform the assessment of the implications of alternative pathways for the resilience of these systems. In recognition of this, the Food, Agriculture, Biodiversity, Land-use and Energy (FABLE) Consortium – which is part of FOLU and supports the development of the data and modelling infrastructure needed to produce long-term pathways towards sustainable food and land use systems - will work on adding new metrics on resilience in its mid-century pathways to support countries' planning in a context of increased climate and economic shocks. Similarly, these metrics need to be developed in collaboration with farmers to inform the evaluation and continuous improvement of agricultural practices across the world, and also inform strategies to scale up adoption of the most effective practices.

Annex: Guiding questions for building resilience into food and land use systems

Table 2: Principles for building resilience into food and land use systems in a dynamic world (source: Sperling et al, 2022)

Principles	Guiding questions
Clarity of purpose	**Beneficiaries:** Who is being targeted by resilience building efforts? Are the interventions benefitting the most vulnerable stakeholders in the food system? **Scale and time-frame:** What is the scale and time horizon of the envisioned interventions? How are short term and long term objectives balanced? **Sustainability:** Is the resilience focus aligned with economic, social and environmental sustainability concerns? Have you considered trade-offs with sustainability objectives? What are the implications for social and natural capital? Do the interventions contribute to the SDGs? Are they supporting the objectives of the Paris Agreement on climate change? Or: Is there a risk of lock-in, which reinforces unsustainable structures in food and land use systems?
Holistic focus	**Scope:** Is the focus on building social, economic and environmental resilience? Or is the scope more narrowly defined? **Single or multi-hazard approach:** Are resilience building measures focused on addressing the risks of a single hazard type or is a comprehensive risk management lens applied? If the focus is on managing risks of one hazard, does this potentially increase vulnerabilities to other hazards? **Systems-thinking:** Are resilience building efforts targeting a particular component of food and land use systems? Are possible impact pathways across food and land use systems being considered, e.g. are adjustments on the demand side aligned with changes on the supply side? **Cross-sectoral relationships:** Are interdependencies with other systems being considered, e.g. energy and water?

Principles	Guiding questions
Balancing efficiency, redundancy and diversity	**Efficiency:** Is efficiency the primary driver of food and land use systems architecture? Is the emphasis on economic efficiency (e.g. just in time)? To which extent does this also promote efficiency in resource use? How vulnerable is the system to disturbances? **Redundancy:** Are a given food system's components overly dependent on a single or few actor(s) or condition(s), e.g. agricultural inputs such as fertiliser from one supplier; food exports to a single country? How exposed are food and land use systems to changes in this relationship (e.g. breakdown of trade agreement, conflict, geopolitical changes)? How prepared for change are food and land use systems? **Diversity:** How diverse are food and land use systems in terms of production (e.g. crop varieties, farming practices)? How does this constrain or facilitate adaptation to changing economic, social and/or environmental conditions? **General:** Where is greater efficiency, redundancy or diversity needed to reduce the vulnerabilities of food and land use systems in a dynamic world? Are there sufficient buffers (e.g. safety nets) in place to prevent catastrophic system failure?
Check enabling conditions	**Capacities:** Are the necessary capacities in place to assess hazards, vulnerabilities and risks? Are risk mitigation strategies and practices identified, tested and implemented? **Coordination:** Does the institutional environment facilitate systems thinking and incentivize cross-sectoral solutions? Are Ministries of Finance and Planning working closely with key line Ministries, e.g. covering agriculture, water, natural resources, energy, environment and infrastructure to build comprehensive approaches to managing risks to food systems and ensure long-term sustainability? **Stakeholder engagement:** Are resilience building efforts informed by comprehensive stakeholder dialogue involving public and private sector and civil society? Are these dialogues and consultations grounded in a strong science policy interface? **Funding and incentive mechanisms:** Are there sufficient funds to support and maintain risk management practices? Are social safety nets in place to buffer the vulnerable stakeholder groups against shocks to the food system? Is environmental stewardship and sustainability incentivized?

Endnotes

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