



INTERNATIONAL
FOOD POLICY
RESEARCH
INSTITUTE

IFPRI Discussion Paper 01758

September 2018

Building Resilient Food Systems

An Analytical Review

Karunya Iyappan

Suresh Chandra Babu

Director General's Office

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

The International Food Policy Research Institute (IFPRI), established in 1975, provides research-based policy solutions to sustainably reduce poverty and end hunger and malnutrition. IFPRI's strategic research aims to foster a climate-resilient and sustainable food supply; promote healthy diets and nutrition for all; build inclusive and efficient markets, trade systems, and food industries; transform agricultural and rural economies; and strengthen institutions and governance. Gender is integrated in all the Institute's work. Partnerships, communications, capacity strengthening, and data and knowledge management are essential components to translate IFPRI's research from action to impact. The Institute's regional and country programs play a critical role in responding to demand for food policy research and in delivering holistic support for country-led development. IFPRI collaborates with partners around the world.

AUTHORS

Karunya Iyappan (ki5rb@virginia.edu) was a Summer Intern at the International Food Policy Research Institute, Washington DC.

Suresh Chandra Babu (s.babu@cgiar.org) is a Senior Research Fellow and Head of Capacity Strengthening Program at the International Food Policy Research Institute, Washington DC, and Extraordinary Professor, Agricultural Economics, University of Pretoria, South Africa, 2017-2019.

Notices

¹ IFPRI Discussion Papers contain preliminary material and research results and are circulated in order to stimulate discussion and critical comment. They have not been subject to a formal external review via IFPRI's Publications Review Committee. Any opinions stated herein are those of the author(s) and are not necessarily representative of or endorsed by IFPRI.

² The boundaries and names shown and the designations used on the map(s) herein do not imply official endorsement or acceptance by the International Food Policy Research Institute (IFPRI) or its partners and contributors.

³ Copyright remains with the authors. The authors are free to proceed, without further IFPRI permission, to publish this paper, or any revised version of it, in outlets such as journals, books, and other publications.

Contents

ABSTRACT	iv
ACKNOWLEDGMENTS	v
ACRONYMS	vi
I. Introduction	1
II. A Conceptual Approach to Building Food System Resilience	3
III. Resilience of Food Systems	7
IV. Analytical Approaches and Measurement Issues in Strengthening Food System Resilience	12
V. Key Areas of Interventions for Building Food System Resilience	23
VI. Case Study Approach and Success Stories	44
VII. Concluding Remarks	49
REFERENCES	51

Tables

Table 1. Elements of a food system and corresponding questions to evaluate resilience.....	18
Table 2. Select expected outcomes and key performance indicators of MGDS	29

Figures

Figure 1: Conceptual framework for resilience capacity building.....	5
Figure 2. Components of a food system.....	8
Figure 3. Institutional structure of Disaster Risk Management (DRM) in Malawi	30
Figure 4. Resilience capacities.....	37
Figure 5 District layered approach.....	43

ABSTRACT

In this paper we undertake an analytical review of the extant literature on the building food system resilience. While the concept of food system resilience has become a topical issue in global and national policy discussion, there is little research on how to develop operational procedures to design and implement interventions from the food system and resilience perspective. This review identifies five major entry points to strengthen food system resilience in the national context: policy, institutions, technology, capacity, and governance. Measurement issues and analytical approaches to studying food system resilience are reviewed. We conclude that while there is a large gap in the methodological approaches to study the food system resilience, beginning with the case studies of understanding specific elements of a food system and their role in enhancing resilience would be good starting point for addressing thematic issues, challenges and constraints facing resilience of the food systems.

Keywords: food systems, resilience, capacity building, measurement, analytical review

ACKNOWLEDGMENTS

This work was undertaken as part of the CGIAR Research Program on Policies, Institutions, and Markets, led by the International Food Policy Research Institute

ACRONYMS

ABS	Access to Basic Services
AC	Adaptive Capacity
ACBP	Africa Climate Business Plan
AST	Assets
CASA	Chesapeake Alliance for Sustainable Agriculture
CBO	Community-Based Organizations
CCAFS	Climate Change, Agriculture, and Food Security
CDKN	Climate and Development Knowledge Network
CIF	Climate Investment Fund
CREWS	Climate Risk and Early Warning Systems
CSA	Climate-Smart Agriculture
DoDMA	Department of Disaster Management Affairs
DRM	Disaster Risk Management
EWS	Early Warning Systems
FAO	Food and Agriculture Organization
FIRP	Food Insecurity Response Plan
FMNR	Farmer Managed Natural Regeneration
FotF	Farms of the Future
HRC	Humanitarian Response Committee
ICBDM	Integrated Community-Based Disaster Management Program
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IPPM	Integrated Production and Pest Management Programme
MENA	Middle East and North Africa
MGDS	Malawi Growth and Development Strategy
MVAC	Malawi Vulnerability Assessment Committee
NCDR	National Science and Technology Center for Disaster Reduction
NDRF	National Disaster Response Force
NDRMC	National Disaster Risk Management Committee
NDRMC TC	National Disaster Risk Management Committee Technical Committee
NMHS	National Meteorological and Hydrological Services
PPCR	Pilot Program for Climate Resilience
PSNP	Productive Safety Net Programme
RCI	Resilience Capacity Index
RFM	Risk Financing Mechanism
RIMA-II	Resilience Index Measurement and Analysis II
RSM	Resilience Structure Matrix
SAM	Severe Acute Malnutrition

SDG	Sustainable Development Goals
SSN	Social Safety Nets
TSC	Technical Sub-Committees
UN	United Nations
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
USAID	United States Agency for International Development
WASH	Water and Sanitation

I. Introduction

Building resilience of food systems has become a topical issue given the multifarious sources of shocks that add risks and uncertainty to the food systems and destabilize their system outcomes. Additionally, food system shocks can have implications for other systems that the food system contributes to and depends on. Understanding the analytical approaches and the contributions of research from various spheres is key to identifying the knowledge gaps and to designing a new set of research studies for improving food system resilience. In this analytical review of the extent literature we ask the following questions:

1. How does one go about understanding the areas of intervention in building food system resilience?
2. What are the key elements of the food system that need to be studied for understanding the impacts of shocks?
3. What analytical approaches have been used to identify the intervention strategies to improve food system resilience?
4. How does one measure resilience indicators and use them for policy and programmatic interventions?
5. What pathways have been recognized for the designing program and policy interventions that will lead to better food system outcomes?

Over time, there have been several paradigms that have emerged as pathways to pursue economic growth. These approaches have had varied levels of success in attaining sustainable outcomes. Among these approaches, resilience is now an emerging paradigm in the global development field.

(Humanitarian Policy Group 2018). Countries have significantly scaled up their resilience approaches over the course of several years. Many national agendas are now exploring resilience as a means to achieve food security. In this analytical review, we will deeply explore the implications of resilience on food system outcomes.

By definition, a resilient food system is one that has the “capacity to withstand a shock, to absorb the effects of a shock, and to recover from the shock to its normal or even better state in terms of any lost food security” (Babu & Dorosh 2017, 1). In the wake of the 2015 Sustainable Development Goals (SDGs), there has been an increased demand for policy and institutional approaches that are all-encompassing (UN 2015). Among these proposals, the resilience approach to sustainable development is one of growing significance. Resilience building is emerging as a key strategy used to break away from the cycle of food and nutrition insecurity. In response, building resilience within food systems has become a top goal of the development agenda (Fan, et al, 2014; Babu & Blom 2014).

Food system resilience has several entry points. Within the context of this paper, we will focus on three primary areas: through national strategies, within institutions using sector and sub sectoral approaches, and through initiatives that build resilience at the community and individual levels. Each of these areas contains many resilience strengthening. Such interventions may be derived from five key perspectives: policy, institutional, and technological, capacity, and governance.

In this paper, we will provide a literature and analytical review that explores how these various entry points build food system resilience. This paper is organized as follows. The next section provides a conceptual framework for studying the resilience building issues from a capacity development perspective. Section three highlights various elements of a food system and shows how shocks such as climate change are important sources of vulnerability of the food system. Section four discusses measurement issues and the approaches to studying resilience building within the context of the food system. Section five identifies five entry points for building resilience of the food system: policy, institutions, technological innovations, capacity and governance. Section six reviews select case studies that have addressed the issues relating to food system resilience building. Finally, the last section provides concluding remarks.

II. A Conceptual Approach to Building Food System Resilience

Resilience building has implications on many development goals, particularly sustainability. For example, policy relevant solutions for resilience building interventions address threats in the short term, through relief, as well as the long term, through rehabilitation. In this way, resilience is a pathway for attaining economic growth and incorporates economic components, such as sustainability, into its structure.

The National Resilience Strategy of Malawi is a prime example of proposed solution that builds resilience, and in the process, constructs sustainable food systems. This initiative, created to address the effects of climate change, is a five-year plan that outlines the several programs that Malawi government intends to implement. Each program falls within an overarching category, including agriculture and food security, catchment protection and management, flood control by construction of dikes, dams and river training, enhanced early warning systems (EWS), and social support programmes (Department of Disaster Management Affairs 2016). This multi-dimensional approach to resilience building serves as the key component to Malawi's National Resilience Strategy.

In contrast, the US is an example of a country that engages in relief-based humanitarian assistance. In 2007, the US government spent \$8.34 billion solely on humanitarian assistance (ForeignAssistance.gov 2017). As illustrated, the cost to national economies of relief and rehabilitation is very high. However, such spending without building assets to resist future shocks is neither possible nor sustainable in the long run. Therefore, there is a need to combine resilience building efforts, such as those delineated by the Malawi Resilience Strategy, and relief support, such as the US' foreign aid in humanitarian work, in order to build sustainable and enduring resilience. Such an organizational structure not only builds resilience, but also creates food systems that participate in implementing and engaging sustainable measures. In other words, resilience building and sustainability must complement each other. In doing so, the resilience approach to sustainable development has added value.

Resilience is therefore an essential component to creating long lasting and enduring solutions for the most complex short term and long term global development problems. For example, South Sudan not only faced high levels of food shortage during the famine in February 2017, but also receives little rainfall

during the year and suffers from low cereal production (Babu and Dorosh 2017). The country's food shortage is a short term issue and requires short term resilience initiatives such as immediate food aid. Conversely, its low rainfall is a long term issue and requires long term resilience initiatives such as well-governed agricultural extension services. Resilience interventions must therefore rescue people from short term stresses and enhance long term efforts.

In essence, we have outlined that resilience building must encompass both short term and long term benefits. Countries and regions facing immediate food crises desperately need food aid and targeted relief programs (Babu & Dorosh 2017). Additionally, good governance, infrastructure, capacity building, and other initiatives are very important programs for long term resilience building. In order to capitalize on existing resilience interventions, national agendas must address both short term and long term stresses. In the conceptual framework presented in this section, we will evaluate the specific elements of capacity building for resilience. Then, we will explore why resilience efforts require capacity development in order to ensure the sustainability of food system resilience practices.

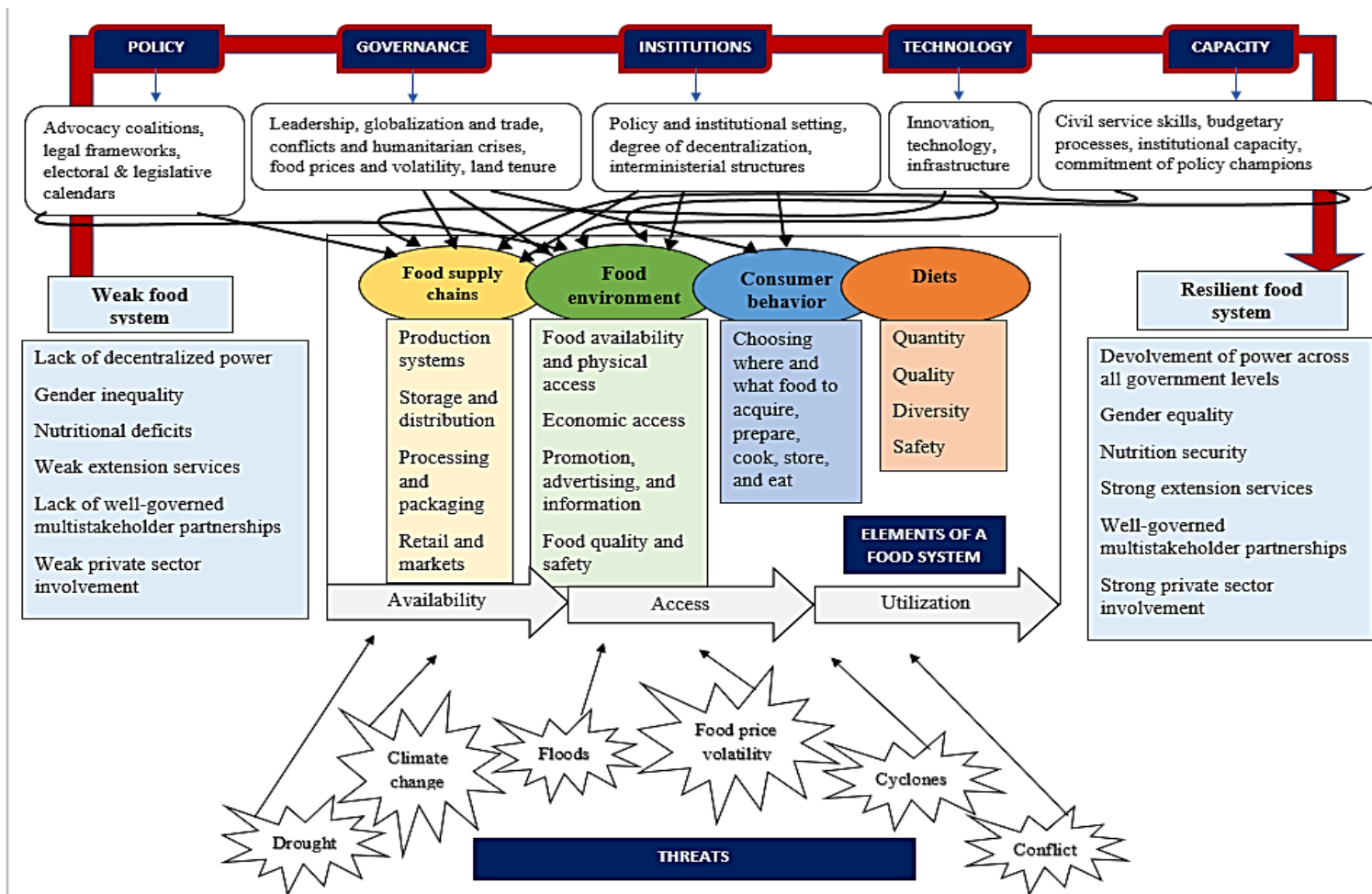
Resilience building

When examining resilience and resilience building broadly, there are many challenges. Firstly, particularly vulnerable populations lack easy access to resilience building activities. Additionally, local, regional, national, and international collaboration is not sufficient, and therefore, hinders resilience enhancement. Next, public-private partnerships require extensive capacity building in order to recognize community resources and plan implementation accordingly. Furthermore, the diverse interests of stakeholders make integration and resolution quite difficult (NRC 2011). In addition, internal conflict and a post-war climates pose more multidimensional challenges to resilience building.

Though the long list of resilience building challenges continues, stakeholders may adopt many capacity strengthening elements to build resilience. Babu and Blom (2014) outline the capacity strengthening activities required to develop a resilient food system. Within this framework, Babu and Blom (2014) recognize that stakeholders must establish capacity at the individual, organizational, and system

levels. An individual's capacity to build resilience lies in one's innate motivation and understanding of a specific scenario (Babu & Blom 2014). Organizational capacity lies in an organization's capability to address how it allocates its resources, adapt and self-renew under changing circumstances, interact with other organizations and entities, and achieve optimal leadership and management (Babu & Blom 2014, Baser & Morgan 2008). Lastly, system capacity refers to the enabling environment. A strong system capacity is characterized by good governance, inclusive policy processes, transparency, democratic processes, cooperation, accessible information, coordination, and evidence-based decision making (Babu & Blom 2014). Figure 1 presents this conceptual framework for resilience building.

Figure 1: Conceptual framework for resilience capacity building



Source: Authors' compilation adapted from Babu & Blom (2014).

The integration of these capacity strengthening activities eventually leads to food system resilience.

However, resilience is a holistic concept. Sectors, such as agricultural, water, technology, and health must create apt communication channels that facilitate collaboration. Resilience building initiatives within food systems must incorporate multifarious key players such as global partnerships for the future of food, the Food and Agriculture Organization of the United Nations (FAO), agroecology departments that produce indicators for agroecology, the Resilience Alliance, the Global Resilience Partnership, measurements of communities of practice, and the Chesapeake Alliance for Sustainable Agriculture (CASA). Multi sectoral coordination among these players enhances the integration of the five capitals of sustainable development; human, social, built or manufactured, natural, and financial (Forum for the Future n.d.). Without proper coordination and communication among the various sectors involving food systems, relevant stakeholders may not be able to enhance capital. Consequently, they will fail to achieve food system resilience.

Such sectoral divides are present and significant in several countries. In 2014, the United States Agency for International Development (USAID) introduced a Multi sectoral Nutrition Strategy aimed at enhancing multisector collaboration within select countries (USAID 2014). Though this deliberate effort directly addresses the general lack of coordination among diverse sectors, program evaluation reveals particular reasons delineating why these sectors are not coming together. For example, the evaluation of this strategy in Bangladesh displays that partners generally lack clarity regarding how their coordination and collaboration efforts contribute to achieving the mission's goal. There is also no formal coordination mechanism in place. Additionally, although there are instances of follow up, there is no established mechanism that governs consistency (de Boer & Aimiwu, 2016). Such sustainability challenges illustrate the difficulties that hinder holistic resilience building.

Though there has been significant research into the concept of resilience, further research is required to gain a more holistic understanding of its implications. Firstly, there is a need to investigate into how evidence is generated and what type of evidence works. Secondly, , there is a need for capacity

strengthening efforts that train policy analysis and program managers to design effective resilience initiatives. Thirdly, relevant stakeholders must completely understand the policy process in order to incorporate resilience evidence into national strategies and investment plans. In other words, policy dialogue is key for developing evidence and building consensus for food system resilience strategies.

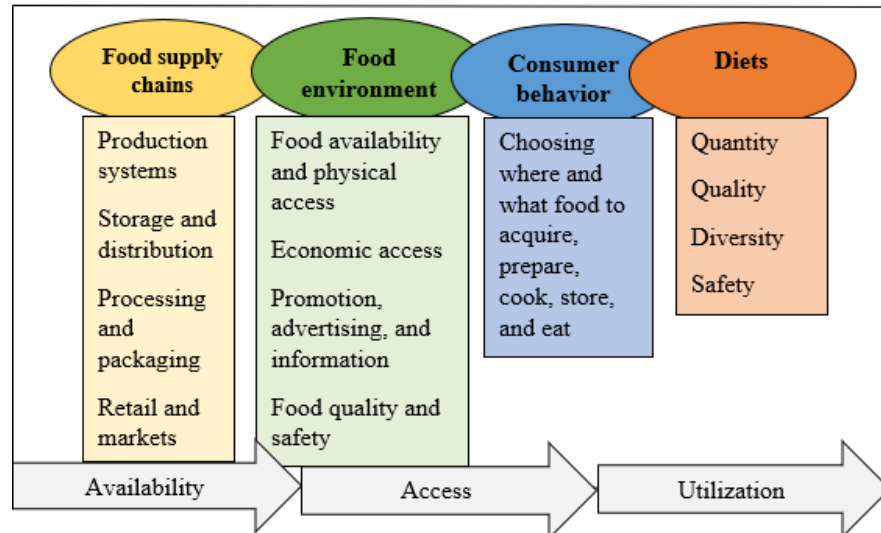
In this section, we identified the importance of resilience building activities in achieving short and long term sustainability. Using this observation, we introduced a conceptual framework that assesses specific institutional efforts that stakeholders may take to achieve resilience and build capital in sustainable development at various levels. Lastly, we recognized some knowledge gaps that exist within resilience building and capacity efforts. These knowledge gaps primarily deal with the lack of a proper understanding of resilience as a concept. In order to address these knowledge gaps, the next section will explore the concept of resilience through a food system perspective. By illuminating resilience through a specific lens, we hope to achieve a better, more specialized understanding of the concept, and consequently fill these knowledge gaps.

III. Resilience of Food Systems

There is a multitude of ways to study, explore, and analyze resilience and resilience building. In this paper, resilience building is studied through a food system perspective. For the purposes of this paper, we define a food system as a process “that transforms natural resources and inputs into food and nutrition outcomes” (Babu & Blom 2014, 1). A food system incorporates several processes including production, processing, exchange, transport, storage, acquisition, preparation, and consumption (Sobal, Khan, & Bisogni 1998; Pinstруп-Andersen 2011; FAO 2013; Babu & Blom 2014). Such a system allows researchers to study the various interactions of several sectors, levels of governance, and types of technology. In other words, a food system perspective takes away from narrow agriculture forms and allows researchers to explore the broader areas of non-farm migration, sustainability, and collective action. Figure 2 below maps out some components of a food system. As illustrated in this figure, the

integrated nature of food systems allows us to examine a variety of components and how each of them may contribute to building robust and resilient organizational structures.

Figure 2. Components of a food system



Source: Authors' compilation adapted from HLPE (2017).

One such organizational structure is the increasing importance of resilience building at the community level. The foundational nature of communities illuminates the importance of building resilience within smaller groups. Food systems, which have the capacity to integrate various levels of government, also have the capacity to build resilience at the community level.. In other words, a food systems approach explores the possibility of devolving resources.. Devolution of power, leadership, institutional reform, and resources are important steps in achieving food system resilience. A food systems approach to resilience building is therefore, largely holistic.

A food systems perspective to resilience also allows for the exploration and expansion of social capital. Food systems contain vast networks of connections among relevant players. Such a structure creates a thriving environment for social capital expansion, a key component of resilience building. The connections and relationships fostered within a food systems setting, created under conditions of trust and unity, create enormous amounts of potential for social capital. In turn, social capital contributes to building and strengthening individual and community resilience in coping, adaptive, and transformative

capacities (Bernier & Meinzen-Dick 2014). In this way, a food systems approach to resilience is a useful way to investigate the effects of productive social capital, created by the innate nature of food systems, in resilience building.

Incorporation of many levels of government and expansion of social capital are just some organizational ways food systems allow for resilience building. The ability of food systems to enhance resilience and resilience building efforts is far more expansive. Food systems experience diverse shocks which have many implications on other aspects of life. In this next subsection, we will analyze this ability of food systems to enhance resilience within the context of a specific shock: climate change.

Food system resilience and shocks from climate change: An illustration

Several global mechanisms have pushed national agendas towards food system resilience building. Global climate change and its effects on national food systems is one such mechanism. The Paris Agreement, created by the United Nations Framework Convention on Climate Change, largely illuminates the implications of climate change. The Paris Agreement primarily strives to heighten the global response to climate change by addressing the rise of global temperatures and strengthening countries' abilities to cope with the burdens of climate change (UN 2015). Its numerous proposals illustrate the commitment of 195 nations to combat global climate change. More importantly, the Paris Agreement displays the commitment that these nations have towards building resilience and achieving sustainable development .

Article 7 of the Paris Agreement is dedicated to declaring the importance of adaptation and its implications on coping with global climate change. Article 7 recognizes the role that resilience building plays in all dimensions of government-- local, national, regional, and international. More specifically, it addresses the capacity of resilience building to not only contribute to a long-term response to climate change, but also provide for the immediate needs of vulnerable communities. Therefore, when specifically analyzing climate change through a food systems perspective, the Paris Agreement emphasizes the importance of food security in the face of the dangerous effects of climate change.

Such an acknowledgement in an international document like the Paris Agreement illustrates the growing importance of resilience building. In recent years, researchers claim that humanitarian aid is not only costly and but also reduces resilience at multiple levels. Meanwhile, other critics claim that the shift towards resilience distracts humanitarian actors from solving short-term, immediate conflicts (Labbe 2014). However, just as Article 7 of the Paris Agreement states, policymakers must seek out methods and programs that integrate both long term and short term solutions (UN 2015). Vulnerable regions must receive the immediate assistance that they require in order to deal with current, short term shocks that threaten food security. Additionally, long term development through resilience building activities is crucial for ensuring long term sustainability.

While global climate change refers to a wider time range, it also comprises of short-term fluctuations that may lead to food crises. This is called climate variability (Savitsky 2017). For example, Zimbabwe's El Niño-induced food crisis in 2015 and 2016 is an example of a food insecurity resulting from climate variability. Climate variability has the capability to create massive destruction to weak food systems. In the context of global climate change, climate variability is a short-term food system issue. Consequently, policymakers must utilize resilience building activities handle climate variability-induced crises. Conversely, issues such as heat waves pose a long term threat within the context global climate change. In fact, over several years, the ratio of record daily temperature highs to record daily lows observed at around 1,800 weather stations in 48 states in the US from January 1950 through September 2009 shows that record daily temperature highs have become significantly more prominent and more frequent as a result of intense heat waves (Climate Communication n.d.). Thus, global climate change poses both short term and long term problems that require context-specific resilience measures.

As a result, global climate change induces multiple food system changes, which lead to demographic and geographic shifts. One example of a geographic shift as a result of global climate change is illustrated in the narrowing of regions best for coffee production, particularly in Uganda.

Food insecurity as a result of global climate change has taken a toll on the way coffee beans grow in Uganda. As temperatures in high-altitude coffee-growing regions rise, the band of the region viable for

strong coffee beans narrows towards the top of the mountain (Calderone 2016). Shade trees serve as one solution to this problem. These trees, which can reduce the temperatures in the coffee canopy by up to 2 degrees Celsius help farmers adapt to climate change and also provide them with additional food and income (Jassogne, Laderach, & van Asten 2013). In this way, shade trees serve as a solution that addresses both long term and short term resilience effects of this climate change-induced geographic change..

In terms of demographic shifts, climate change plays an influential role in migration patterns within the Middle East and North Africa (MENA) region. Literature and analysis on the extent of weather shocks and changes in driving migration is somewhat limited. However, there is a considerable number of studies investigating their impact. A World Bank study conducted by Wodon and Liverani (2014) reveals that the impact of weather shocks and perceptions of worsening climate on migration is positive. In areas that are affected by climate change and consequently have lower agricultural productivity, climate conditions account for 10 to 20 percent of current migration flows, and is expected to increase in the future. Wodon and Liverani (2014) state that climate migration in the MENA region is often a strategy of last resort and most commonly tends to be into large cities within each country. The MENA region's rapid urbanization rate must reflect and adapt to incoming migrants. Policy responses to such migration patterns should consider not only the sending areas, but also the cities where migrants tend to travel to (Wodon & Liverani 2014). The challenges posed by climate-change induced migration have glaring effects on food system resilience. In Nepal, migration as a coping strategy for dealing with extreme climate events has left vulnerable populations with the responsibility to face the consequences of crop failures (FAO 2017). Therefore, effects of climate change-induced migration must be mainstreamed into food and nutrition security policies (Romano & Traverso 2017). Capacity strengthening activities must address adaptation and coping strategies in the face of climate change in various sectors of the food system. Such activities may include introducing stress-tolerant crop varieties, gender-sensitive climate risk management practices, and resource conservation (FAO 2017).

In summary, resilience building through a food systems perspective illuminates a more defined concept of resilience. In this subsection, we explored this observation by analyzing food system resilience within the context of climate change. The Paris Agreement is a key effort that outlines the relationship between resilience, climate change, and food systems. This relationship portrays the importance of studying climate change-induced challenges on building food system resilience. Geographic and demographic shifts, as illustrated by coffee production in Uganda and migration patterns in the MENA region, are examples of challenges that highlight the effects of climate change on food system resilience. However, though we recognize the vitality of this relationship, there are many barriers that prevent us from holistically examining food system resilience. Therefore, before exploring the five major entry points to strengthen food system resilience, we must address the difficulties of studying food system resilience. One of the primary difficulties lies within measurement. Measuring resilience, specifically within a food system context, remains a relatively unexplored challenge. Although we have identified and analyzed the importance of studying resilience building through a food systems perspective in this section, this approach faces many quantitative and qualitative measurement issues. Therefore, the next section will review the existing literature on resilience measurements and how stakeholders have strived to combat this issue.

IV. Analytical Approaches and Measurement Issues in Strengthening Food System Resilience

TEEBAgriFood proposes that a systems approach to agriculture requires a broad, collective term that illustrates the various complexities and interconnectedness of the processes involved with food (TEEB 2018). Eco-agri-food systems is the term used by TEEB to highlight these processes, including ecosystems, agricultural lands, pastures, inland fisheries, labor, infrastructure, technology, policies, traditions, and institutions (TEEB 2018). Consequently, in order to embody this systems approach, evidence must be tailored for food and nutrition security metrics that holistic and multifarious. In an effort to incorporate several dimensions of resilience, USAID's methods of measurement for resilience

evaluate poverty, the need for humanitarian assistance, hunger, and malnutrition (USAID 2013).

However, there is a need to combine a wider variety of resilience elements.

USAID delineates three key objectives of illustrative resilience measures-- increased and sustainable economic wellbeing, strengthened institutions and governance, and improved health and nutrition status. Within these three objectives, USAID combines various initiatives, such as social capital and safety nets, governance, assets, and food access. The objectives of resilience measures and the resulting initiatives illustrate the need for both quantitative and qualitative approaches (USAID 2013). Additionally, resilience analysis is required at multiple scales, such as communities and social, ecological and economic systems (USAID 2013). USAID implies the need for different types of intervention programs according to different types of goals. This observation is an important theme when considering resilience efforts, and requires a deeper review.

First, we start with the categorization of resilience threats. Resilience threats are grouped into risks, shocks, or stresses (PEP-CBMS Network Coordinating Team 2011). Though these terms may sound similar, we suggest that they each require different types of intervention programs. Risk refers to the possibility of a natural disaster, war, or any other event that may eventually lead to a food crisis. As a result, risks may be prevented through program interventions such as EWS. In this way, risks require initiatives that embody preparation and precaution (PEP-CBMS Network Coordinating Team 2011). Shock refers to the presence of a natural disaster, war, or any other event that has already caused a food crisis. In other words, a shock is the present condition of a region which is experiencing the effects of a food crisis. Therefore, shocks require more short term, immediate interventions, such as food assistance (PEP-CBMS Network Coordinating Team 2011). Lastly, a stress is an ongoing pressure on a region experiences food insecurity. This sort of exposure requires more long term, structural changes to its system, such as multi stakeholder partnerships to improve governance (Tinarwo et al 2018).

In addition to the complexity of defining various resilience threats, it is also important to understand and measure the multi sectoral nature of resilience building initiatives. The Climate

Investment Fund's Pilot Program for Climate Resilience (PPCR) supports developing countries build resilience in response to climate change (CIF n.d.). Lessons drawn from this project illustrate the importance of robust coordination across multiple sectors (The World Bank PPCR Team 2015). Multisectoral coordination, specifically among the highest level of government, is the most effective strategy for resilience investments (The World Bank PPCR Team 2015). Additionally, the PPCR observed that leadership of environmental ministries over natural resources and water infrastructure is highly effective. Over all, the implementation of climate change, environment, sustainable development, planning, and coordination committees as PPCR modalities for multi sector coordination is crucial to resilience building initiatives.

This sort of multisectoral approach highlights the complexity of addressing resilience within a development programming framework. Analyzing resilience threats of households and communities requires a broad view of the factors that influence and are influenced by food crises. For example, using household and community poverty as standards to evaluate resilience is useful. More specifically, observing poverty escapes in individual households and the factors that contribute to their escape has many policy implications for resilience.

For example, the USAID report on Resilience and Sustainable Poverty Escapes in rural Kenya (2018) explores why some households escape and remain out of poverty while others escape poverty but fall back into it. USAID strives to understand the factors influencing sustainable poverty escape or resilience, and transitory poverty escape. This report studies resources such as land, livestock, and assets attributes such as household composition and education level; and activities such as jobs and non-farm activities (USAID 2018). This analysis delineates policy implications that address how households may avoid transitory poverty escape and promote food security and resilience (USAID 2018). The policy implications include supporting an agricultural business environment, public expenditure on smallholder agriculture, women's rights for women, ; a skilled workforce with technical and business proficiency, and social protection (USAID 2018). As illustrated by these policy implications, a successful approach to resilience program implementation requires a dedication to multi sectoral initiatives.

The World Bank's Living Standards Measurement Study (LSMS) is another approach used to analyze resilience. USAID's LSMS analysis of Nigeria illustrates the data diversity of the LSMS. In this particular study, the datasets are carefully categorized into either capacities measured or wellbeing outcomes. Then, the datasets within the capacities measured are divided into the three key resilience capacities; absorptive, adaptive, and transformative. Datasets informing wellbeing outcomes are divided into child nutrition, economic status, and food security. These datasets range from access to banking services, use of insurance, and presence of community groups to household expenditures, household asset base, and food consumption score (USAID 2017). Additionally, the LSMS datasets are comprised of panel data, or data collected from the same households over time (USAID 2017). LSMS data sets therefore recognize sources of resilience and how they influence shock-induced households over several years. The next subsection dives deeper into the required characteristics of apt resilience indicators and a possible framework for building such indicators.

Measurement issues and indicators

Resilience is a dynamic concept. It encompasses falling into poverty, becoming malnourished, escaping poverty, and sometimes, falling back into it. These processes show their effects within coping strategies, human welfare, local economies, and several other aspects of a food system (Barrett & Headey 2014). Therefore, measuring resilience holistically and properly is a difficult feat. As explained in the above section, resilience requires measurement capabilities beyond just income (UNDP 2016). It is important to develop frameworks for resilience measurement that understand its dynamic nature. Some areas of interest that highlight the multidimensional nature of resilience are achievements on education, health, nutrition, housing and access to basic services, environment, labor market, assets, care economy, social protection, and citizen security (UNDP 2016).

Barrett and Headey (2014) propose characteristics that identify resilience measurements. Firstly, resilience measurements must occur at high frequencies. In other words, since resilience refers to the strength of a community and its ability to avoid poverty and hunger over time, measurements must be

performed with consistency (Barrett & Headey 2014). Secondly, resilience measurements must evaluate long term stressors that affect the foundation of a community. Thirdly, indicators must be diverse and sufficiently sensitive (Barrett & Headey 2014). Given the all-encompassing definition of resilience, its indicators must integrate information associated with threats, coping strategies, and human welfare through both quantitative and qualitative data (Barrett & Headey 2014). Lastly, measurement tools must be context specific. Indicators must accommodate to the social and political environments of a country in consideration. Collectively, these implications for resilience may be grouped into three overarching categories for good resilience indicators: flexibility, robustness, and diversity.

These goals for resilience measurements meet with a number of technical and logistical capacity challenges; there are many knowledge gaps concerning which methodologies work best (Barrett & Headey 2014). Barrett and Headey (2014) propose a hybrid approach to survey design, one which utilizes and integrates various types of surveys, such as panel and cross-section surveys at both individual and household levels. This system, called a multi country system of sentinel sites, uses a mixture of many data collection sets and seeks to increase the scope of resilience measurement (Barrett & Headey 2014).

FAO's RIMA-II (Resilience Index Measurement and Analysis II) is an innovative quantitative approach to resilience that encompasses many aspects of resilience to illustrate how and why "households cope with shocks and stressors better than others do" (FAO n.d., *RIMA-II*). RIMA-II uses data on household resilience capacity and satellite images to find causal relationships between shocks and resilience (FAO n.d., *RIMA-II*). In this way, the index measures resilience both directly and indirectly. Furthermore, RIMA-II uses the Resilience Capacity Index (RCI) and the Resilience Structure Matrix (RSM), to analyze resilience of various countries and households through 4 key pillars: adaptive capacity, social safety nets, assets, and access to basic services (FAO n.d., *RIMA-II*). These pillars of resilience collectively serve as a framework to better understand the dimensions of food system resilience.

There are several frameworks similar to RIMA-II that categorize resilience components in different ways. Though it is difficult to create an all-encompassing resilience index that presents a

singular number or ranking to assess a country's resilience, it is possible to capitalize on the three characteristics of good resilience indicators—flexibility, robustness, and diversity. We propose that observing resilience through a particular lens will illuminate these resilience indicators' characteristics.s. Analyzing resilience through a specific lens allows us to broadly capture the resilience dimensions, but within a certain developmental context. Given the scope of this paper, using food and nutrition security as that lens is helpful in realizing these capacities for resilience building. In turn, this lens illuminates a systems approach to resilience. A systems approach to assessing food security is fundamental to better understanding the food subsystems. Food systems have many points of entry for resilience building. Some subsystems within a food system include utilization, access, availability, supporting resources and services, and supporting organizations and policies (Zamudio et al. 2014). Consequently, we may be able to create a robust set of indicators at every stage of the food supply chain. In this way, resilience indicators may be analyzed through a food and nutrition perspective at several levels. Building flexible, robust, and diverse indicators will allow governments to observe changes to the food system that have implications on its resilience. Table 1 below illustrates an analytical table, adapted from Zamudio et al (2014) and Tyler et al (2013). In this table, we delineate food system entry points within the context of certain shocks and explore resilience building strategies and questions.

Table 1. Elements of a food system and corresponding questions to evaluate resilience

Nature of shocks	Food system entry points	Research and evaluation themes of food system changes	Potential intervention/outcome changes through questions
<ul style="list-style-type: none"> • Droughts • Natural disasters • War conflict 	Household analysis	<ul style="list-style-type: none"> • Barter • Self-production (subsistence) • Food aid • Safety net and credit 	<ul style="list-style-type: none"> • What proportion of household income goes to food? • Does a household have multiple ways to access food during the year? • Does a household have access to many nutritional sources during the year? • Is food access equitable within the household?
<ul style="list-style-type: none"> • Water • Food prices • Institutional collapse 	Community mobilization through technology innovation	<ul style="list-style-type: none"> • Food prices and markets • Food preparation and storage • Food distribution and retail • Food processing and packaging • Food production 	<ul style="list-style-type: none"> • Is local demand in the market met by the mix of local and imported food? • Are food storage systems equitable and accessible within the community? • Are their technological mechanisms and innovations in place to govern inadmissible behavior?
<ul style="list-style-type: none"> • Organizational governance collapse • Capacity reduction • Structural adjustments 	Institutional innovation	<ul style="list-style-type: none"> • Financial services • Communication and marketing • Energy • Ecosystem management • Supporting other resources and services 	<ul style="list-style-type: none"> • Are natural resources in good condition and equitable? • Does the service have other delivery options? • Are the resource or service processes robust? Does the collapse of one process jeopardize the whole system?
<ul style="list-style-type: none"> • Macroeconomic mismanagement • International trade 	Policy innovation	<ul style="list-style-type: none"> • Disaster recovery plans • Trade rules • Domestic safety • Foreign relations • Extension services • Public service providers • Emergency response plans 	<ul style="list-style-type: none"> • Is there sufficient capacity to identify and anticipate problems? • Is decision making processes transparent and participatory? • Is there capacity to prioritize and mobilize resources? • Are policies and organizations efficiently decentralized to serve the needs of community members?

Source: Authors' compilation based on Zamudio, Bizikova, and Keller (2014), Tyler et al. (2013).

Food Security Portal of the International Food Policy Research Institute (IFPRI) is an example of a comprehensive tool that provides a central location for issues relating to global food security needs. This site recognizes the wide ranging effects and implications that fluctuating food prices have on the global economy and poverty. In turn, IFPRI's Food Security Portal offers tools that illustrate economic changes around the world. Food security is an outcome of resilience as a new paradigm for solving developmental issues. Though the Food Security Portal does not directly address food system resilience, such a resource in the hands of policymakers and international actors serves as a valuable instrument for formulating policies that influence markets, institutional organizations, and the food supply chain overall. Breaking news on commodity prices and politics, a blog that offers insights from renowned researchers, individual country profiles describing context-specific livelihood data, and data sets that monitor price changes, are just some of the most prominent features of this site (IFPRI 2011).

Outcomes of resilience building, specifically within the context of food systems, are multitudinous. Therefore, many categories of resilience indicators enhance understanding of the various food system dimensions. Engle et al (2014) propose a framework that outlines the primary resilience indicators within the context of climate change:

- governance and security
- natural resource systems
- social systems
- economic systems
- built environment or infrastructure (Engle et al. 2014).

Though these categories are tailored for a climate change context, we may draw inspiration from this approach to enhance our understanding of the food systems approach to resilience. More specifically, Engle et al's (2014) categorization of climate change resilience indicators illuminates a systems approach to resilience outcomes that we may adapt for food system resilience indicators. We use this systems approach to propose that there are three key categories for food system resilience measurement-- natural

resource, nutritional, and multisectoral coordination views.. By focusing on these specific dimensions of food system resilience, we hope to illustrate the complexity of resilience, particular within a food systems perspective.

Firstly, using natural resource indicators is a beneficial way to promote food system resilience. Natural resource availability and management are fundamental components to building and maintaining food system resilience. For example, Farmer Managed Natural Regeneration (FMNR) in Niger tells a story of “vulnerability to resilience” (CDKN 2011). FMNR involves the strategic regrowth and management of fallen trees, which ultimately fosters the sprouting of stronger roots systems and seeds. FMNR is a procedure spearheaded by farmers. It is extremely cost effective, empowering, and efficient. In fact, costs for this project’s implementation are around \$10 per hectare, as compared to the \$200 per hectare cost for tree planting schemes (CDKN 2011). It also adds about 100 kilograms per hectare of crop yield. Additionally, FMNR impacts the food security status of around 2.5 million people, as illustrated by their their annual per capita cereal requirements of 200 kilograms per hectare (Reij et al. 2009). Given the success of this program, FMNR practices highlight the importance of investing in local knowledge management and communication. Supporting food system resilience through such local knowledge is empowering and cost-effective, as opposed to spending large amounts of money on expensive infrastructure (CDKN 2011). FMNR has shown to enhance farmers’ resilience to cyclical droughts in Niger. Their expanded income and their ability to harvest trees for food, through edible fruits, leaves, and seed pods, greatly enhance their resilience (CDKN 2011).

However, though these benefits of FMNR are clearly shown in these numbers, there lacks a set of standardized measurements and indicators that properly illustrate the beneficial outcomes of FMNR over time. In other words, there is a need for a larger evidence base that clearly demonstrates FMNR’s contributions to communities, farming systems, partnerships, and sustainability (Francis et al. 2015). Francis et al (2015) describe some overarching FMNR measurements within the context of the three pillars of sustainability; social, environmental, and economic. These measurements embody the impact of FMNR on building resilience. Some social sustainability FMNR measurements include number of

households practicing FMNR, number of women practicing FMNR, number of groups and FMNR land management associations formed and active, and number of partnerships with authorities,. Some environmental sustainability measurements include physical spread of FMNR over farmlands, number of regenerated trees, amount of soil moisture, information on the water table, and pasture growth. Finally, some economic sustainability measurements include yields from crops, number of crop sales, number of fuelwood and timber sales, and conditions of livestock (Francis et al. 2015). Together, these indicators proposed by Francis et al (2015) not only highlight the importance of measuring natural resources for food system resilience, but also emphasize the role of natural resources in improving food system resilience.

Next, nutrition indicators may serve as an important component to measuring food system resilience. Nutrition is a key sector that requires more linkages with agricultural initiatives and resilience building. The silos created between these sectors put food security at risk. Nutrition specific interventions are interventions that refer to the immediate causes of malnutrition. Meanwhile, nutrition sensitive interventions, are interventions that address the underlying causes of malnutrition. Both of these nutrition intervention types are required for food system resilience building (Mwamakamba 2017). Together, these interventions must be integrated into agricultural programs. However, there is a need for proper documentation of best practices and evidence that build a strong nutrition knowledge base. Such a knowledge base that bridges the gap between nutrition and agriculture is largely lacking. Consequently, it becomes difficult to measure the role of nutrition in food system resilience building. Improving monitoring and using nutrition indicators are great ways to initiate stronger linkages between nutrition, agriculture, and resilience. Examples of some nutrition indicators include indicators for dietary diversity, stunting, and causes of malnutrition. EWS may incorporate these indicators, thereby increasing the ability to target households that are more prone to food crises due to their nutritional status (FAO 2014).

Lastly, it is important to properly assess and measure the effectiveness of multi sectoral coordination for any resilience initiative. A common theme that exists in the literature on resilience is the need to integrate all sectors, levels, and stakeholders (FAO 2014). As mentioned previously, resilience is

a multidimensional concept that requires good governance and organization of multi sectoral communication channels. Therefore, the ability to measure the success of multi sectoral coordination is fundamental to the success of food system resilience building initiatives. However, the need for a multisectoral coordination indicator within the context of food system resilience remains somewhat unexplored. Ideally, multi sectoral coordination must recognize the value of coordination within policy processes, engage a diverse group of stakeholders, and establish effective communication channels (Health Policy Project 2014). However, the central question refers to how these capabilities may be measured through indicators. In Tinarwo et al. (2018), the good governance of multi stakeholder partnerships in Zimbabwe was assessed through agribusiness competitiveness. However, one must recall the three main characteristics of resilience indicators. Flexibility, robustness, and diversity are crucial components of any indicator. In this way, multi sectoral coordination indicators must exemplify these three characteristics.

Overall, measurement issues pose an important challenge to studying resilience, especially within the context of food systems. In this section, we observed some analytical approaches to measure and define resilience. Using this knowledge, we conducted review on existing frameworks and categories of resilience indicators that may be adapted for food systems. In particular, we explored the importance of natural resource, nutritional, and multisectoral coordination indicators for resilience. The pursuit of building holistic, all-encompassing indicators illustrates the need for more investigation and research into resilience. In general, the measurement issues and indicators considered in this section refer to the set of challenges that resilience studies face. After specifically observing and analyzing these issues in this section, we now have a more holistic understanding of the concept of resilience and its existing limitations. Building from the literature review presented thus far, we may now address the five key entry points to strengthen food system resilience in the national context: policy, institutions, technology, capacity, and governance.

V. Key Areas of Interventions for Building Food System Resilience

International assistance is an important contributor to strengthening the global economy. In a world where 95 percent of the world's consumers live outside of the US, international trade requires robustness (The White House 2015). The economic power of developing countries is rapidly growing; a, 6 out of the 13 fastest growing economies are in Africa (Michel 2016). Investing in countries that will enhance stability and economic growth in the global economy has many benefits to national donor economies. Such investments improve various themes of a country's economy. In the context of this paper, we will explore the role of key areas of interventions and their contributions to enhancing food system resilience and strengthening national economies. These key areas of intervention are policy, institutions, technology, capacity, and governance. Though these themes are broken up and analyzed separately, they are not mutually exclusive. Instead, these themes are intertwined; they work together to enhance each other. Therefore, stakeholders must strongly consider this interdependence when developing solutions to promote food system resilience.

Policy interventions

In the context of this section, we will consider policy's role in creating resilience within food systems and investigate how policies have direct impacts on resilience building.

Policymakers have approached resilience efforts in a very divided manner for years. The two primary elements of resilience efforts, humanitarian assistance and development assistance, are often perceived as two separate entities that require different forms of aid and funding. Humanitarian assistance reflects more immediate disaster responses. . Humanitarian aid does not entirely commit to reducing vulnerability, thereby leaving communities defenseless against the next crisis. Meanwhile, development assistance is not designed to account for the “gains achieved during humanitarian response” (USAID 2012, 20). USAID's resilience strategy serves as a policy and program guide that outlines the key operational principles necessary to direct efficient resilience initiatives (USAID 2012). More specifically,

by using past initiatives and lessons, USAID develops an agenda for operational change that aptly outlines the programs and efforts required to ensure holistic implementation of resilience building.

In this resilience strategy, USAID highlights the interdependent nature of humanitarian and development assistance, and proposes that there is a need for more collaboration between humanitarian and development agents of policy. A more integrated definition for humanitarian assistance states that humanitarian assistance must not only attend to the immediate needs of crises, but must also “lay the foundation for longer-term development” (USAID 2012, 6). In other words, USAID emphasizes that resilience initiatives require the need to actively layer, integrate, and sequence the both humanitarian as well as development objectives (USAID 2012). USAID’s agenda for operational change delineates four key efforts required to address the gaps in the existing partnerships between humanitarian and development actors. These efforts include joint problem analysis and objective setting, intensified and coordinated strategic planning around resilience, mutually informed project designs and procurements, and robust learning (USAID 2012, 18). This resilience building framework for policy formulation aims at highlighting the need to measure how policy processes can contribute to resilience, the need for institutional resilience, and the need to build capacity for resilience within a policy context. Additionally, it aims to mainstream development assistance into humanitarian efforts.

There are other proposed solutions and strategies that aim to address this policy gap between development and humanitarian assistance. Scenario planning, a method used in developing resilience initiatives, involves devising risk management plans from mapping out various risk scenarios (Ruibal 2017). More importantly, scenario planning is used as a tool to inform policy decisions. Scenario planning is key for the development of effective resilience initiatives. It requires participants to embrace the complexity of resilience. Its innate, proactive structure enhances collaboration between both humanitarian and development actors. Stakeholder engagement is, therefore, a vital component of effective scenario planning (Oteros-Rozas et al. 2015). Collaborative, participatory, and comprehensive scenario planning will greatly enhance the way the framing of policies directed towards resilience building.

Simple organizational strategies may also incorporate resilience into policymaking. The Resilient America project of the National Academy of Sciences explores various resilience priorities such as engaging diversity, creating multi stakeholder partnerships, and communicating risks to the public before engaging in a specific project (Resilient America n.d.). Then, it identifies the several risks that are imposed on these priorities, such as river flooding, droughts, and flash floods. Such a system organizes issues facing select cities in a concise and understandable manner. Consequently, these methods allow for the formulation and implementation of well-informed, context-specific policies.

These examples of policy interventions indicate that policy and strategy development processes must prioritize resilience mainstreaming. Capacity for such mainstreaming must to be built into the policy systems, specifically in developing countries.

Institutional interventions

Adequate capacity of institutions promotes resilience because institutions have the ability to anticipate,, manage, prevent, and rebuild from crises.(Babu & Dorosh 2017). Institutions are composed of several factors that that are multifarious and far-reaching. These factors include, but are not limited to, monitoring and evaluation, assessments of requirements, multisector coordination, and information and communications technology (ICT) (Babu & Dorosh 2017). Structural robustness within institutions is fundamental to moving a country's resilience agenda from relief to long term development. Consequently, this continuous effort leads to effective design, adoption, and implementation of interventions for crisis prevention and recovery (Babu & Dorosh 2017).

One such institutional capacity mechanism for resilience building is the Climate-Smart Agriculture (CSA) approach. CSA is a cross-cutting FAO method that addresses the influential effect of climate change on agricultural systems. CSA's primary goals are to foster climate change adaptation, to increase and expand income and productivity, and to reduce greenhouse gas emissions (FAO n.d., *Climate Smart Agriculture*). These three goals guide the initiative's programs to improve institutional organization at all levels of governance. Rather than enforcing a universal framework for all countries to

follow, CSA introduces an approach comprised of various elements that are molded according to local contexts (FAO n.d., *Climate Smart Agriculture*). Some of these elements include management of agricultural systems that ensures a balance between short term food security goals and long term adaptation, ecosystem and landscape management, and agricultural extension (FAO n.d., *Climate Smart Agriculture*). CSA approaches these elements through expansion of the evidence base, support for policy frameworks, and enhancement of financing options. All of these actions require strong national and local institutions that empower farmers to participate in climate-smart initiatives and share their own knowledge on adaptation (FAO n.d., *Climate Smart Agriculture*).

The climate mainstreaming approach of the CSA method involves many sectors that play key roles in enhancing food system resilience. The analysis of CSA's country profiles, which evaluate a country's extent of climate-smart agriculture, illustrates this very notion. For example, the Philippines struggles from frequent tropical cyclones; in fact, the country ranks the highest in the world in terms of its vulnerability to cyclones (Dikitanan et al. 2017). CSA's country profile on the Philippines allows researchers to observe Philippines' efforts to converge various sectors through climate-smart initiatives. More specifically, programs such as communal stocking, rehabilitation of aquaculture, use of drought resistant varieties for vegetables and water harvesting technologies integrate and promote multisectoral approaches (Dikitanan et al. 2017). These CSA initiatives play an important role in collectively mainstreaming climate change and Climate-Smart Agriculture among several sectors

In addition to the mainstreaming component of CSA, climate-smart initiatives also stress the importance of adaptation and mitigation at the community and local levels. CSA initiatives encourage countries to consider and support local projects and institutions. Implementing practices at the field level holistically incorporates the vast knowledge of local farmers into institutional frameworks.

Taiwan's earthquakes and regular typhoons have spurred community capacity building for disaster resilience. In response to an earthquake in 1999 and a typhoon in 2001, the community of Shang-An implemented the Integrated Community-Based Disaster Management Program (ICBDM), supported by the central government. (Chen & Wang) This project empowered locals to protect themselves against

crises through community autonomy in disaster resilience, integrated planning of disaster mitigation, facilitation of local participation, and institutional management of disaster resilience (Chen & Wang 2010). ICBDM developed strong partnerships among public, private, academic, and nonprofit institutions to provide financial and institutional incentives for the community. Additionally, it promoted community participation through educational workshops, which gathered local residents to learn from each other's disaster experiences and participate in creating community-based hazard maps. The assistance from a team of professors and expert instructors during these workshops built capacity for disaster resilience autonomy (Chen & Wang 2010). This participation process established Shang-An as a learning-oriented community. From these lessons, Chen and Wang (2010) draw a comprehensive framework that illustrates the components of community-based resilience efforts. Successful community-based resilience initiatives are able to identify key community issues; support resource systems; create community consensus; develop an active participation process; construct organizational alliances and partnerships; perform long term community operations; and empower local residents through learning. Shang-An's experience with building community resilience through institutional management at the local level is indicative of a much larger message. It illustrates the ability of community-based resilience to mobilize local residents to build resilience.

Similarly, the importance of local institutional bodies may be observed in Chennai, a south Indian city which experienced devastating floods in 2015 that claimed around 470 lives (TARU 2016). Government authorities like the Fire department and the National Disaster Response Force (NDRF), private enterprises like restaurants and taxi services, Community-Based Organizations (CBOs) like Oxfam, and social media platforms organized several relief efforts. These relief efforts mobilized community leaders and residents during the time of the crisis. However, the 2015 floods in Chennai highlight the city's vulnerability to such shocks. Consequently, they highlight the country's relatively weak agenda toward building resilience in communities. For example, Indian Prime Minister Narendra Modi's 100 smart cities project aims at making Indian cities smarter through IT infrastructure, transport networks, and energy and water management (Ravi 2015). However, national agendas must also consider

resilience as a key factor when building and improving urban cities in India. They must keep the fast pace of urbanization in check in order to face the global pressures of climate change (Ravi 2015). Surat, one of the fastest growing cities in the world, experiences similar pressures of urbanization and migration (100 Resilient Cities n.d.). In addition to such pressures, the city is one of the most climate change-affected cities. In fact, in the past 100 years, Surat has experienced around 23 devastating floods. However, Surat's resilience agenda formulates strategies that emphasize community engagement. For example, Surat builds resilience through improved information and community cooperation. Its methods include vulnerability mapping, enhanced weather and hydrological information, EWS, and institutions for community cooperation (Bugler n.d.). Cities like Chennai must draw from the lessons of cities like Surat. Their experiences in developing resilience strategies that protect their community are very applicable to other weak and exposed cities that endure similar urbanization pressures and natural disasters. Therefore, community-based endeavors that improve communication channels, enhance information, and empower local community members through better institutional organization are fundamental to promoting resilience.

The Malawi Growth and Development Strategy (MGDS) is a key example that illuminates the role of decentralization in resilience efforts. The country's strategy aims at improving productivity, enhancing competition, and developing strong resilience to shocks (Ministry of Economic Planning and Development 2017). Among many other ambitious goals, MGDS emphasizes decentralization of functions across sectors (The Ministry of Economic Planning and Development 2017). Most importantly, MGDS promotes decentralization in order to achieve inclusive and integrated rural development (The Ministry of Economic Planning and Development 2017). Decentralization is a key component of resilience capacity, and such decentralized institutions have the ability to greatly enhance resilience (Babu & Blom 2014). The expected outcomes and the key performance indicators for each of these outcomes are illustrated in the Table 2 below.

Table 2. Select expected outcomes and key performance indicators of MGDS

Expected outcome	Key performance indicator
Improved investment in rural areas	-% of rural-urban migration -Number of rural growth centers constructed -Number of community sports stadiums constructed -Length of rural roads bitumised
Local government, planning, research, M&E and communication improved	-% of local councils with updated local development plans aligned to SGDs -Number of councils with integrated functional M&E system
Improved implementation of complete devolution of functions to Councils	-% of contribution of local revenues to Council annual budget -Number of sectors devolved

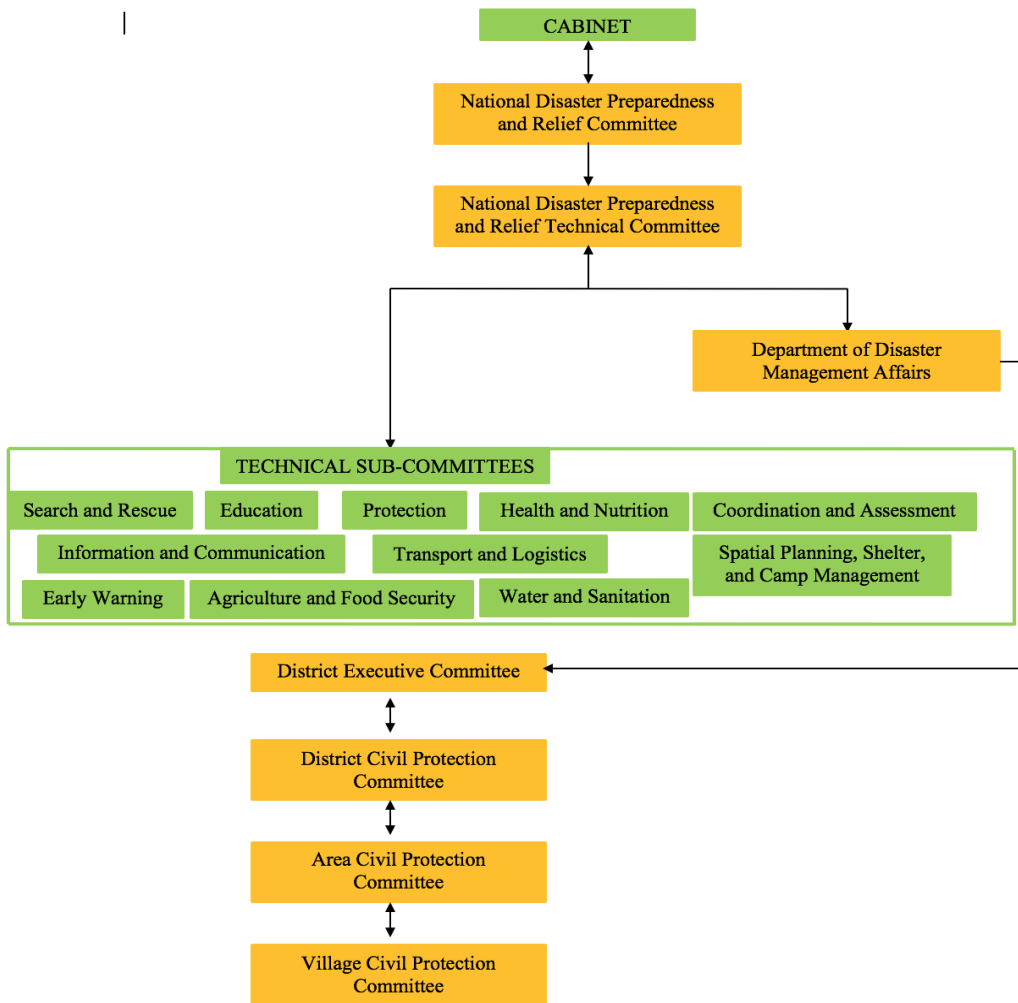
Source: Authors' compilation based on Ministry of Economic Planning and Development (2017).

Note: MGDS = Malawi Growth and Development Strategy.

The importance that MGDS gives to devolving functions to the local level through decentralization efforts highlights the role governments must play in organizing institutions that address resilience. Malawi's national disaster risk management institutional architecture consists of many governing bodies, thereby highlighting the decentralization of power. First, the National Disaster Risk Management Committee (NDRMC) provides policy directions to the Department of Disaster Management Affairs (DoDMA). Under the NDRMC is the National Disaster Risk Management Committee Technical Committee (NDRM TC), which provides advice and technical support, and also serves as the primary mechanism for mainstreaming disaster risk management into sustainable development policies (Government of Malawi 2015). The NDRM TC then breaks down into the National Disaster Risk Management Technical Sub-Committees (TSCs) and the DoDMA. The TSCs are multi-disciplinary committees that coordinate and guide and necessary to implement programs within different sectors. Meanwhile, DoDMA coordinates the implementation of disaster risk management programs (Office of the Vice President n.d.). In other words, the DoDMA serves as the secretariat and oversees all activities relating to disaster prevention, mitigation, preparedness, response, and recovery. Finally, under the DoDMA are decentralized disaster risk management structures that coordinate policy at the city, municipal, district, area, and village levels (Malawi Government 2015). Other stakeholders are loosely incorporated into this institutional

organization as technical support, funding sources, or avenues for public awareness. This structure of Malawi’s disaster risk management institution is illustrated below in Figure 3.

Figure 3. Institutional structure of Disaster Risk Management (DRM) in Malawi



Source: Authors’ compilation adapted from Malawi Government (2015).

Institutional mechanisms are of utmost importance when considering the debate on balancing market system efficiency and resilience. This dilemma is evident in several fields. Evolutionary processes have allowed ecosystems to attain a comfortable harmony between maintaining efficiency and building resilience to environmental shocks. However, in order to develop strategies that mitigate risk without compromising efficiency the market system must invest in research. . Achieving a balance between efficiency and resilience ensures the market system’s strength in the long run. While too much emphasis

on efficiency may lead to brittleness, too much emphasis on resilience may lead to stagnation (Jamsin 2015). Each of these components must, therefore, complement each other. There have been many proposed strategies to confront this issue. For example, within the context of this paper, institutions concerned with food and nutrition security may want to incorporate a risk-driven design into their institutional organization. Such a method would enhance transparency, promote risk-driven decision making processes, and build structural resilience (Oehmen & Seering 2011). However, system level measurement of these institutional mechanisms is a struggle. The success of such institutional mechanisms is ultimately tested by the system's ability to generate favorable outcomes (Willis & Loa 2015). More research is required to better understand and apply frameworks that may help measure the balance between pursuing institutional resilience and maintaining efficiency at the system level.

In essence, decentralization, empowerment at the local level, and multisectoral approaches are key elements of successful institutional interventions that build resilience. In pursuit of these interventions, one must also keep in mind the debate between establishing resilience and maintaining efficiency. The above illustrations indicate that concerted efforts must strengthen institutions that build resilience of the food systems. Yet, there is little or no research relating to how institutional development can contribute to the process of resilience building in general and for food systems in particular.

Technological innovations

Technological innovations have produced drought resistant crop varieties, pest and disease resistant crop varieties, multi-cropping procedures, mixed farming strategies, natural resource management, and precision farming (Knight 2010). With the rise of more climate change-conscious programs and initiatives, many governments are taking part in adaptation technologies that help countries' food systems adapt to environmental changes (Knight 2010). Examples of these adaptation technologies include flood safeguards, weather forecast technologies using satellites and sensors, insurance tools, water purification processes, water recycling, efficient irrigation systems, and sensors (Knight 2010).

Technological mechanisms may enhance food system resilience before, during, and after a shock hits.

Therefore, technological interventions can be used at any point in the disaster timeline to build resilient food system. Consequently, opportunities for building resilient food systems through technology are abundant.

EWS provide farmers and other food system actors with the information required to prepare for and cope with potential shocks affecting their agriculture (FAO n.d., *Early Warning*). Analytical tools help countries monitor risks and issue alerts. At the national level, these alerts help governments, organizations, and other relevant stakeholders prepare mobilization efforts that ensure order. At the local and community level, these alerts provide local governing bodies, individual farmers, herders, fishers, and foresters with the appropriate amount of time and resources to undergo needed precautionary activities (FAO n.d., *Early Warning*). Technology and analytical tools enhance a country's systemic resilience before governments become aware of an impending crisis. Pre-crisis research and data collection reveal a country's preparedness against potential threats.

Recently, integrated analytical tools that combine biophysical data and socioeconomic data are becoming increasingly available. Assessing and mapping vulnerability are effective methods that highlight the key effects climate-related factors may have on a community (Lee 2017, 3). These methods require tools that identify and measure components of vulnerability that may influence the degree of damage a community experiences. Among the various definitions, biophysical and social vulnerability are the main types of vulnerability that provide useful knowledge required to build adaptive capacity (Lee 2017, 3). Therefore, metrics that measure, layer, and analyze the prevalence of these two types of vulnerability in select districts of a country have become increasingly important. Biophysical hazards, such as flooding, daily rainfall, tsunamis, and landslides, are all indicative of a community's vulnerability to shocks (Lee 2017, 4). Similarly, social factors such as population, health care, and income play a vital role in determining a community's degree of exposure, preparedness, and capacity to respond and recover (Lee 2017, 5). Biophysical and social vulnerability serve as important analytical tools that allow for a holistic measurement of a community's vulnerability to shocks. Consequently, governments may better prioritize areas that require resilience building capacities.

In a study by Lee (2017), researchers compiled data from Taiwan's National Science and Technology Center for Disaster Reduction (NCDR) to develop biophysical and social vulnerability indices. For biophysical vulnerability in Taiwan's districts, the key disaster types evaluated were falling rocks, rock slides, debris flows, dip slope, daily rainfall and flooding, tsunamis, and seismic faults (Lee 2017, 6). Social vulnerability evaluation was three-fold; dimension, factor, and variable. The dimensions were degree of exposure, mitigation and preparedness, response capacity, and recovery capacity. Within each dimension were factors, such as response capacity, which address elements such as refuge shelter, disaster disadvantaged, rescue, and health care (Lee 2017, 5). A cross comparison synthesized the information collected from the biophysical and social vulnerability analyses and then categorized Taiwanese districts' vulnerabilities to shock. A similar study in Uttarakhand, India was conducted in response to the state's devastating floods and landslides, particularly in 2013 (Doyle et al. 2017, 3). A landslide hazard assessment prepared a spatially detailed landslide hazard map and assessed social vulnerability using socioeconomic indicators. The models developed in this study used satellite remote sensing to identify several factors. Some of these factors include geomorphic changes that changed the location of rivers, GIS analysis to estimate the hazard of floods, machine learning to estimate the risk of landslides, and statistical analysis to establish a social vulnerability index (Doyle et al. 2017, 57). This sort of biophysical and social vulnerability technology may help in better assessing ways to more specifically improve food system resilience in response to such natural disasters.

These analytical tools that integrate social and biophysical data sets produce a risk-informed evidence base. Consequently, resource allocation and emergency response plans will emerge from policies that are cognizant of socially and biophysically weak districts.

In addition to these integrated analytical tools, adoption of resilient technology through knowledge platforms has become widely popular. CSA has been mentioned previously in this paper as an institutional mechanism that mainstreams climate and resilience. CSA has the ability to increase productivity, adapt to climate change, and reduce greenhouse gas emissions. However, CSA is not only

an institutional mechanism for promoting resilience. It also plays a fundamental role in technological innovation.

CSA proliferates technology adoption through knowledge platforms. CGIAR's research program on Climate Change, Agriculture, and Food Security (CCAFS) implements the "Farms of the Future" project (FotF), an initiative that uses a climate analogue tool to provide farmers with the opportunity to explore their climate futures through farm visits in other locations (Moussa et al. 2013). This climate analogue tool takes climate and rainfall predictions for a particular site and searches for places with similar conditions. By facilitating visits that farmers can take to these farms, FotF empowers farmers to determine their adaptation options based on real models with real world capacity (CCAFS n.d.). By providing farmers with a platform to exchange knowledge on resilience strategies, FotF serves as an influential knowledge platform. Participants observe new technologies adopted by farmers who already experienced their future climate. FotF is therefore a convenient and intelligent channel of communication for climate change adaptability (Nyasimi et al. 2017). A study evaluating the effectiveness of CSA technologies and practices adoption through the FotF model was conducted in Tanzania (Nyasimi et al. 2017). This study evaluates the CSA practices adopted by farmers after participating in the FotF's farm visit, highlights the factors that may hinder farmers from adopting CSA technologies and practices, and maps out the dissemination pathways that farmers use to share information on CSA to their community members (Nyasimi et al. 2017). Results indicate that FotF participants adopted several CSA innovations such as improved crop varieties, agroforestry, scientific weather forecasting, and matengo pits. Significant factors that may have hindered CSA technology adoption include cultural practices, tenure and ownership rights, labor requirements, high investment costs, and the lack of skills and knowledge on how to use the practices (Nyasimi et al. 2017). This study illuminates the influential role government extension services play in providing oral information to community members. Additionally, it highlights the need to establish stronger linkages between extension workers and all community members. The FotF approach serves as an extremely innovative way to promote technology adoption through knowledge platforms.

However, lessons learned from closely evaluating the beneficiary process of the FotF approach outline several areas for improvement.

One such lesson involves the popular adoption of CSA technologies. Results from the FotF implementation study show that while many farmers are aware of CSA technology and practice, a smaller number of farmers are actually adopting them (Nyasimi et al. 2017). Any new technology or intervention requires good social management and proper implementation and evaluation in order to ensure adoption (Pachico & Fujisaka 2004, Hartmann & Linn 2008). Their long term effectiveness requires meaningful interventions that promote sustainable technology adoption (Dunnett, et al. 2018). Factors such as limited supply-led approaches to development and dissemination, low attention given to context and farmers' priorities other than increased agricultural productivity, and lack of acknowledgement of political and institutional frameworks of smallholder farmers hinder productive adoption (Orr 2012). Impact pathways, an approach based on theory of change, may serve as a useful solution to this issue. Impact pathways use the theory of change to inspire a result-based management approach that emphasizes using research outputs as a guide to influence development outcomes within each flagship program of the CCAFS (Alvarez et al. 2014). This approach is accompanied by an extensive learning, monitoring, and evaluation system that traces each impact pathway through annual surveys. In this way, impact pathways may enhance technology adoption and implementation mechanisms for resilience.

Such monitoring and evaluation systems are extremely important when considering the feedback mechanisms that resilience perpetuates. A community's ability to identify, adapt, and recover from shocks promotes institutional rigidity (Bujones et al. 2013). Consequently, reinforcing this positive feedback loop enhances a community's institutions and resources, thereby promoting adaptability and recovery (Bujones et al. 2013). Though all of the themes discussed in this paper contribute to this positive feedback loop, the role of technology is especially noteworthy. Building resilience at the community level requires empowered community members who have access to the political processes. When communities respond well to shocks, they contribute to an enhanced positive feedback mechanism. Moreover, this observation

encourages the creation of tools that are georeferenced and connected to a central monitoring and evaluation system. The ability of community members to participate in activities such as mapping and scenario planning empowers them to voice their concerns regarding sustainability (Hovorka & Auerbach 2010). For example, during Hurricane Katrina, New Orleans community members used Google Earth to georeference data and contribute to geographically-located community announcements (Hovorka & Auerbach 2010). Providing community members with the means to access local data on information systems such as GIS gives them the capability to undergo activities such as structuring scenario and increasing cooperation between the community and government agencies (Hovorka & Auerbach 2010). Such a tool gives community members the agency to get involved in the policy process and build resilience.

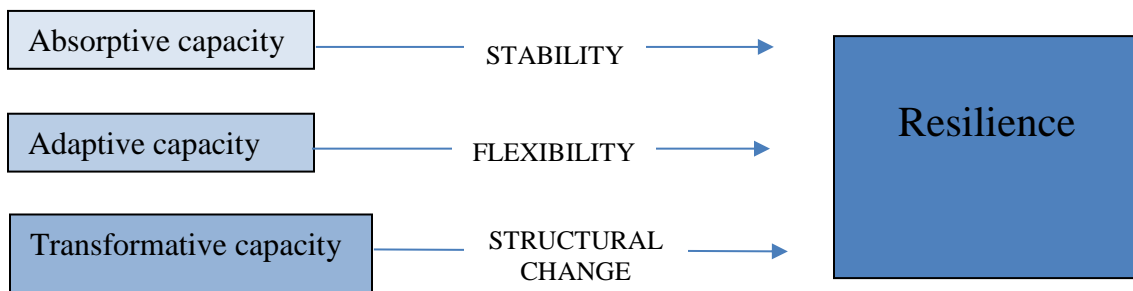
In conclusion, the ability of technological innovations to build resilience before, during, and after threats is imperative to the pursuit for strong food systems. Stakeholders must implement resilience building innovations throughout every process of the food system. A stock taking exercise is essential to identifying opportunities for increasing the contribution of technological innovations in the food system context.

Capacity interventions

Capacity building for resilient food systems enables governing bodies and other relevant stakeholders to undertake activities that prevent, anticipate, prepare, cope, and recover from shocks (Babu & Blom 2014). Capacity building is fundamental to institutional structures that are promote resilience. Capacity building for food system resilience is a learning process, and requires active evaluation of needs (Babu & Blom 2014). Its ability to strengthen capacity at various levels of resilience building allows for not only short term vulnerability reduction, but also long term development (Evans 2011). Capacity building for resilient food systems enables people to access a range of technologies, infrastructures, and choices (Oxfam 2017). In other words, capacity building activities leave community members with the opportunity to pursue agency and empowerment.

Oxfam (2017) recognizes that there are six overarching social change processes that enhance the ability of capacity activities to strengthen resilience. Collectively, these processes serve as the enabling environment for capacity building. The social processes include accountable governing, informing, forward and flexible planning, learning and innovation, securing and enhancing livelihoods, and gender justice and empowerment (Oxfam 2017). Capacities for resilience is broken down into three main types; absorptive, adaptive, and transformative. Though these types are separate, their implications are interconnected. These three types of capacities each reinforce each other at various levels of governance; one capacity strengthening activity most likely has spillover effects across the other capacity types (Oxfam 2017). If capacity building activities actively engage with these processes, effectiveness of such activities is more likely. Therefore, characteristics of capacity strengthening institutions and programs should address these social processes within all three types of capacity. These three resilience capacities are summarized in Figure 4 below.

Figure 4. Resilience capacities



Source: Author's compilation based on Oxfam (2017).

Absorptive capacity involves intentional actions that prevent and mitigate anticipated threats (Oxfam 2017). Its central aspect is stability, which is a key component of resilience. The processes of anticipating, planning, coping, and recovering from known threats provide communities with this capacity to bounce back. Examples of absorptive capacity outcomes include EWS, structures that maintain capital, and

disaster reduction laws that enable community members and the private sector to collaborate and function effectively (Oxfam 2017).

Adaptive capacity is an ongoing process of incremental adjustments that make policy, technology, economic, and natural environments more flexible in terms of accessibility and inclusivity (Oxfam 2017). Its central aspect, flexibility, is an important component of resilience because it delineates that change is unpredictable and requires systems that manage and adjust to changing situations. Examples of adaptive capacity outcomes include sustainable use of natural resources, platforms for stakeholders to share their own forms of knowledge, better access to productive resources, continuous and incremental technological innovations, and policy frameworks that encourage communities to continue adapting to their changing environments (Oxfam 2017).

Transformative capacity refers to a capacity that creates fundamental changes to stop and mitigate the very causes of risks (Oxfam 2017). It calls for structural changes that address the deep, root factors that maintain poverty and injustice. Transformative capacity refers to capacity building activities that strengthen collaboration and informed decision making unbounded by social barriers. Threats serve as opportunities to recognize that the status quo of society is ineffective. They encourage potential to transform unjust practices (Oxfam 2017). Examples of transformative capacity outcomes include gender inclusive decision making within households, institutions that acknowledge the causes of poverty, shared natural resource management; new methods for sharing power, and governance strategies that redistribute benefits (Oxfam 2017).

These three capacities must be strengthened in a more integrated fashion within the context of food systems. Babu and Blom (2014) propose six general characteristics of food systems that are required to build strong and robust food systems. These characteristics include comprehensive monitoring of food security indicators, recognizing food emergencies and food security risks, evidence based policy making and investment planning, decentralized mobilization of communities for food security action, policy analysis and program evaluation, and the ability to create, maintain, and utilize each of these capacities (Babu & Blom 2014, 4). , Furthermore, Babu and Blom (2014) indicate that capacity building for

resilience must occur robustly in the individual, organizational, and system dimensions. In order to implement capacity at these dimensions, stakeholders must closely observe the components of a resilient food system. Babu and Blom (2014) recognize that individual, organizational, and system capacity must occur within the three subsystems of a food system; policy; markets, trade, and institutions; and production. The policy subsystem requires the analytical capacity to design policies that address a country's financial and economic instability to deal with food crises. The markets, trade, and institutional subsystem implements the programs and initiatives brought forth by policies. Finally, the production subsystem is responsible for building the necessary tools, information, technologies, and practices required to properly implement food system resilience activities (Babu & Blom 2014). In short, capacity building for resilient food systems must occur at the individual, organizational and system dimensions within the policy, markets, trade, and institutional, and production subsystems. A capacity needs assessment identifies the capacity gaps, challenges, and weaknesses present at these dimensions within each subsystem. Such a needs assessment should ensure that capacity building activities enhance the three types of capacities within all three food system dimensions as well as subsystems.

When analyzing capacity building for resilience, it is also important to establish effective evaluation mechanisms. Fuller and Lain (2017) perform a meta-analysis of 16 of Oxfam's resilience programs and initiatives in rural communities of 15 different countries. This study is an attempt at illustrating the effects that resilience programs have on absorptive, adaptive, and transformative capacity. Fuller and Lain (2017) use resilience indicators and categorize them into one of the three capacity types. Then, Fuller and Lain (2017) evaluate the impact of Oxfam's resilience programs on the absorptive, adaptive, and transformative capacities of the 15 evaluated countries. Overall results of this meta-analysis indicate that on average, Oxfam's resilience programs have a positive impact across all three capacities (Fuller & Lain 2017). There are certainly a number of limitations of this study. For example, many capacity building activities tend to influence more than one capacity type. Therefore, there are still knowledge gaps concerning categorization of resilience programs as one specific capacity enhancing activity. However, overall, this meta-analysis indicates the generally positive impact that resilience

intervention programs have on enhancing absorptive, adaptive, and transformative capacities. Capacity strengthening of resilience initiatives requires diverse programs that address a wide range of issues.

Governance mechanisms

Governance is an important factor for sustainability and well-functioning systems. The design and implementation of food security and nutrition programmes require apt governance mechanisms that produce resilient outcomes. For example, participatory processes through decentralization and territorialization are important ways to achieve organizational resilience., Processes like decentralization and territorialization enhance cooperation and coordination among various key stakeholders and sectors (Borquez et al. 2016). In this way, governance is a key mechanism to contextualize an environment and collaborate with society (Borquez et al. 2016). The essential goals of good governance are to improve transparency, equality, accountability, effectiveness and efficiency, strategic vision, and responsiveness (Tinarwo et al. 2018). In order to achieve these goals, there are certain mechanisms that may be used. Such mechanisms include inclusive decision making, participatory policy processes, program monitoring and evaluation, evidence-based policy making, multi stakeholder partnerships, and gender mainstreaming and transformation (Tinarwo et al. 2018). Governance within the context of food systems is a growing topic of concern. Addressing issues such as malnutrition requires coordination among stakeholders and sectors to exchange information and achieve a common purpose (Spring 2015).

Often, various organizations and governments concerned with food system security operate in silos. The development of a silo mentality, conditioned by poor management and policies that make cooperation difficult, result in ignorance towards ordinary tasks and overlap in responsibilities among different departments (Fenwick et al. 2009). Such silo mentality is quite evident in the leadership of many relief and resilience efforts. The administrative structure and communication channels of such large scale endeavors do not utilize community knowledge and collaborative interests (Fenwick et al. 2009). Consequently, the governance of such initiatives is compromised.

Malawi's 2016-2017 Food Insecurity Response Plan (FIRP) is a strong example of a country-level initiative aimed at building a resilient food system. An analysis of FIRP illuminates how and why governance mechanisms are an important factor in ensuring successful implementation, monitoring, and evaluation of food security and resilience initiatives.

Malawi's FIRP was implemented in response to the food security and nutrition emergency from July 2016 to March 2017 as a result of devastating floods (DoDMA 2016). The Government of Malawi partnered with the UN and NGOs to implement humanitarian efforts within 7 clusters; food security, agriculture, water and sanitation (WASH), nutrition, protection, education, and health (DoDMA 2016). These efforts aimed to reduce the number of people in food insecurity, reduce severe acute malnutrition (SAM), improve farmers' access to agricultural inputs, strengthen surveillance and prevention of disease outbreak, and improve monitoring mechanisms (DoDMA 2016). Of the 6.5 million people in need of humanitarian aid, FIRP strived to target all of them. Therefore, with the help of the UN, donors, international NSOs and other development partners, Malawi was to launch its largest humanitarian response in the country's history through FIRP (Babu et al. 2018).

Babu et al. (2018) conducted a comprehensive process and institutional review of the FIRP program. This study analyzes the governance mechanisms that exist in Malawi's policy processes within the context of the introduction, formation, implementation, and evaluation of FIRP.

The institutional architecture of FIRP, though properly mapped out, was hindered by unproductive and inefficient governance methods. For example, the overall coordination body was overseen by the Humanitarian Response Committee (HRC), which was chaired by the Principal Secretary of DoDMA (Babu et al. 2018). However, further evaluation recognized that there are several capacity constraints within the DoDMA that played a significant role in its inefficiency. Low human capacity and funding challenges were among the many hindrances that DoDMA suffered from. FIRP also struggled with improper governance over community-based targeting to identify beneficiaries, the principle household-level targeting method. Though giving agency to the community seemed like the right step towards decentralization and devolution of power, there was relatively little incentive to involve other community

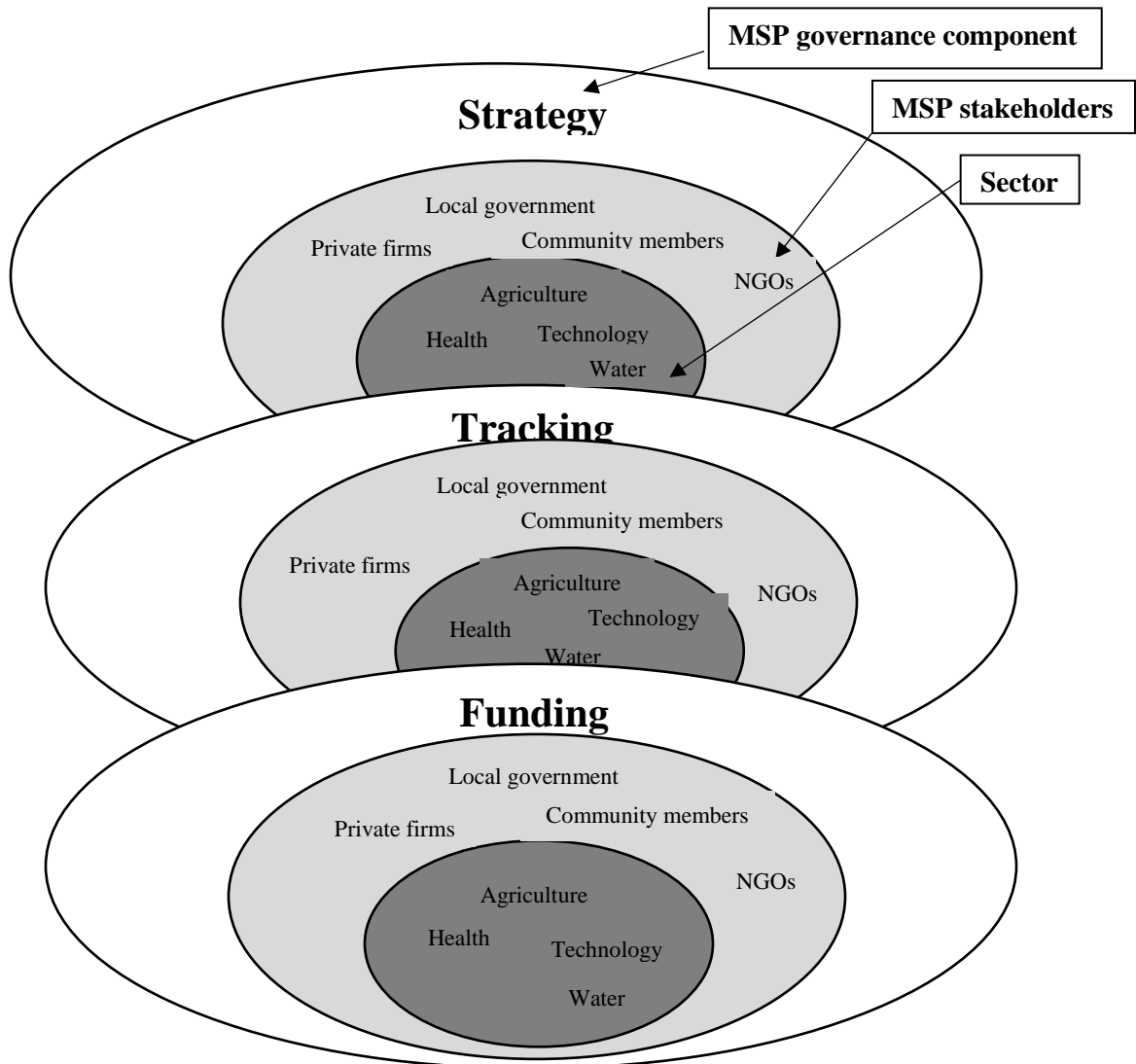
members in a decision making process organized by traditional local leaders, thereby debilitating the process. There was also a general lack of trust between development partners and the government when considering financial accountability and funding. Additionally, a significant time lag existed between the declaration of a food crisis by the President and the beginning of relief efforts implementation. Such inconsistencies, in addition to others, highlight the need for institutions and mechanisms in place that enhance governance of such a large scale humanitarian effort (Babu et al. 2018).

Lessons drawn from FIRP shed light on the fundamental nature of governance to promote resilience. Firstly, enthusiasm and commitment from political leadership at the highest level as well as leadership within institutions such as DoDMA is crucial to ensuring that the humanitarian response is effective. The lack of this sort of effort in Malawi is illustrated by development partners' need to nudge the government on several occasions to take action, thereby resulting in several time lags. Second, the Malawi Vulnerability Assessment Committee (MVAC) requires more transparent and accurate information provision. The lack of reliable and confident information sources when declaring an emergency and throughout the food crisis process resulted in confusion and insufficient details. Additionally, Babu et al. (2018) recognize the need to develop local capacity for implementing interventions, rather than giving that responsibility to NGOs (Babu et al. 2018).

A properly governed multi sectoral approach is a central concept to enhancing resilience. Nutrition, health, agriculture, water, education, and technology efforts must coordinate their programs so that all sectors benefit. Therefore, in order to achieve such collaboration, it is important to use systems thinking when approaching resilience. A systems approach to achieving food system resilience recognizes maps, and governs the various actors involved in the food system process (Spring 2015). Some activities that apply this concept to resilience building include performing situation analyses for the causes of poverty, creating network maps for each sector involves in order to understand the roles of each stakeholder, assessing the range of services provided by each sector, and performing a supply chain management assessment (Spring 2015). In this way, systems thinking initiates systemic change. It allows for the visualization of relationships between various actors and identifies areas for improvement

(Innovation Network n.d.). Figure 5 below illustrates the layered district solution for improved governance in Zimbabwe (Tinarwo et al, 2018). Governance mechanisms in the form of interventions not only establish organizational resilience, but also confidently pursue food systems resilience.

Figure 5. District layered approach



Source: Tinarwo, Babu, and Iyappan (2018).

Note: NGOs = non-governmental organizations; MSP = multistakeholder partnership

Through extensive literature review, we have concluded that policy, institutions, technology, capacity, and governance interventions all serve as the major entry points to build resilience within food systems. However, as observed in this paper, apt and sufficient research on these entry points'

relationship with resilience is still largely lacking. Given the novel nature of resilience as a sustainable development paradigm, stakeholders must broaden existing resilience literature by devoting more resources to food system resilience research. Therefore, we propose that in order to address this challenge, we must use case studies as a means to better understand specific elements of a food system and their role in enhancing resilience. In the next section, we will provide an introductory exploration into this case study approach and hope that it motivates stakeholders to take a more active role in using this approach to build knowledge on food system resilience.

VI. Case Study Approach and Success Stories

When closely examining the literature, there are three key gaps in resilience research that emerge. These are the lack of good decomposable resilience measures, the inability to properly forecast disasters, and the absence of effective multi sectoral convening areas. We propose that a case study approach to understanding food system resilience will address these knowledge gaps.

Aggregation of resilience characteristics would be helpful in developing a decomposable resilience measurement. In 1984, Foster, Greer, and Thorbecke's FGT poverty measures were revolutionary and well-received. The FGT poverty indices stressed the importance of the poorest individuals by creating a measure that combined poverty and income inequality (Foster et al. 1984). The FGT measure's decomposability was widely desired because it effectively links subgroup and overall poverty levels (Foster et al. 2010). Today, the FGT indices are a very important poverty measure in the developmental economics field. A similar decomposable measure should be developed to evaluate resilience. This overall indicator would summarize the micro units of developmental resilience of a subpopulation into an aggregate resilience index. This sort of resilience measure would to aid in targeting scarce resources and evaluating the impacts of policies (Cisse & Barrett 2016).

Next, the ability to forecast disasters is a key component to building resilience, but one that still requires intensive research and development. For example, an assessment of food security EWS for east and southern Africa reveals several challenges faced by EWS workers and organizations. There is a lack

of policies that outline the roles of EWS actors, thereby leading to the development of silos between sectors (Braimoh et al 2018). There is very limited coverage of weather observation which makes access to agro meteorology data difficult. Many countries in the studied regions lack qualified technical professionals who are well versed in agriculture, meteorology, and hydrology (Braimoh et al 2018). The absence of a robust framework for EWS information sharing makes it difficult for users to efficiently receive information at the regional and national levels. Additionally, EWS programs are treated as emergency response activities, thereby allowing funding for such programs to be ad hoc and EWS actors to compete for funding during an emergency response (Braimoh et al 2018). This sort of counter effectiveness illustrates the institutional, technical, sustainability, and financial challenges of developing strong EWS programs. Forecasting disasters must be facilitated by EWS that have high capacity and are able to provide risk informed policy advice.

Lastly, creating efficient multi sector convening areas is crucial to poverty reduction through resilience building. In essence, the primary building blocks within the context of poverty reduction are strategic poverty reduction work, a strong community base, robust organizational capacity, and technical and financial resource importation (Tamarack 2013). Expanding upon local efforts through strategic decision making and sufficient decision making are key to the success of organizations (Tamarack 2013). Multi sector convening areas aid in achieving this goal because of their innate collaborative nature. However, the effectiveness of such institutions remains relatively unexplored. There is a need to invest more research into how multi sector and multi stakeholder partnerships may thrive and help develop resilience within communities.

These three concerns-- decomposable resilience measures, forecasting disasters, and multi sectoral convening areas-- are multifarious. In other words, the research needs of each of these gaps consist of methodologies that are widely different from one another. For example, while the development of decomposable resilience measures requires strong statistical analysis, the creation of multi sectoral convening areas requires more institutional attention. A case study approach to studying resilience has the ability to address these concerns associated with the literature and research on resilience. Therefore, we

use case studies derived from several countries and regions to study resilience. Case study approaches to any global development topic allows for the coverage of a wide range of questions that ask, explore, and explain complex issues within specific contexts (Harrison et al 2017). They directly address the observation that one policy solution does not fit every community and strive to actively improve research (Woolcock 2015). Case studies also investigate the several sectors, stakeholders, and disciplines involved in a resilience building project. Their illustration of a diverse range of outcomes arise from context-specific efforts to enhance development (Woolcock 2015).

Over the past 40 years, the case studies approach to research has gained momentum. There are many instances, however, where case studies are presented in a weak manner and lack quality and sophistication (Harrison et al 2017). In these instances, case studies do not properly address policy concerns; they fail to raise coherent and practical policy solutions. Nonetheless, when implemented effectively, case studies illuminate many good practices and ways to enhance the implementation process of global development. Their ability to address how different communities face and deal with challenges within different contexts reinforces the multitude of resilience building approaches.

The Africa Climate Business Plan (ACBP) is an innovative measure that illustrates how African countries specifically manage risks from shocks and build resilience. The ACBP, launched by the World Bank in 2015, strives to accelerate climate resilient and low-carbon development through strengthening, powering, and enabling resilience (The World Bank 2017). In order to strengthen resilience, the ACBP participates in climate-smart agricultural practices, builds climate-resilient landscape, engages in integrated resource management, develops climate-smart ocean economies, helps to create climate-smart cities, develops social protections programs, and studies migration drivers (The World Bank 2017). The ACBP also uses solar, hydropower, and geothermal sources of energy and installs them in various areas to power resilience. Lastly the ACBP engages in the Africa Hydromet Program and the Africa Climate Resilient Investment Facility to enable resilience. Collectively, the ACBP's activities greatly contribute to building absorptive, adaptive, and transformative capacity. These activities primarily focus on enhancing a program's robustness, flexibility, and diversity. By doing so, the ACBP strongly highlights the

importance of co-benefits in promoting mitigation and adaptation through climate change efforts. The ACBP's focus on climate variability and change highlights the importance of co-beneficial practices that build resilience across several sectors (The World Bank 2017). This sort of programmatic approach to resilience has shown to be very successful in African countries.

The FAO's farmer field schools is another successful resilience building case study. Implemented to promote their Integrated Production and Pest Management Programme (IPPM), these schools focus on a learning-by-doing approach and primarily engage smallholder farmers in ten countries (FAO 2015). The school engages farmers in best practices and ways to solve technical programs relating to soil fertility, seed quality, toxic pesticides, farm management, and marketing skills. Additionally, the FAO also trains local farmers to become facilitators of the program. Farmer field schools focus on sustaining the cotton sector by building initiatives that target climate change adaptation, developing value chains, creating partnerships, supporting governments and stakeholders, and empowering women to gain access to the knowledge and assets required to increase agricultural productivity (FAO 2015). In this way, the FAO's farmer field schools have been successful in integrating a wide range of stakeholders and building their resilience through an effective education program. These farmer field schools use educational empowerment as an entry point for building resilience.

Ethiopia's Productive Safety Net Programme (PSNP), though primarily concerned with social protection, is another example of a successful resilience building program. PSNP was introduced more than a decade ago in light of Ethiopia's high levels of poverty and climate-related threats (Slater & Ulrichs n.d.). PSNP's phased approach to social protection allows for more enhanced analysis, especially of its impacts on resilience capacity and enhanced food security. The program's public works component participates in many activities that are directly related to promoting resilience and food security through climate change adaptation. For example, its Housing Asset Building Programme (HABP) provides beneficiaries with the agricultural credit necessary to build a household asset portfolio (Slater & Ulrichs n.d.). Ethiopia's PSNP also engages in a Risk Financing Mechanism (RFM) that pre-positions financial resources within the PSNP in case of a threat (Slater & Ulrichs n.d.). Therefore, in these ways, PSNP

serves as a *shock responsive* safety net that reacts to and highlights the importance of covariate shocks and stresses. More specifically, it contributes to adaptive, anticipatory, and absorptive capacities. Broadening the scope of such programs to promote resilience within the context of food systems, results in many positive spillover effects.

The integration of agriculture and farming into the 2015 Paris Climate Agreement showcases the importance of adaptation and mitigation within the agriculture sector in response to climate change (Meadu et al 2015). Though the Paris Agreement does not explicitly address agriculture, it makes specific references to food security within its preamble and throughout the Agreement. For instance, the Agreement outlines the need for the agricultural sector to take an active stance on reducing emissions (Meadu et al 2015). However, more specifically speaking, the Paris Agreement places a strong emphasis on the need for robust EWS to mitigate any climate change threats. Article 7c proposes that scientific knowledge regarding EWS must be strengthened, while article 8.4(a) denotes that EWS, among other things, is an area of cooperation (UN 2015). In response to the Paris Agreement negotiations and proposed action items in 2015, the Climate Risk and Early Warning Systems (CREWS) initiative was implemented (UNISDR 2017). After one year of implementation, this initiative conducted assessments of National Meteorological and Hydrological Services (NMHS), improved NMHS's service delivery, installed information and communications technology equipment, and created targeted education and public awareness programs (CREWS 2017). This sort of emphasis and work to improve EWS consequently has strong implications on building capacity of food system resilience.

Strong land property rights are crucial to promoting resilience of food systems. Farmers with insecure land rights are unable to purchase crop insurance and access public extension services. Additionally, they tend to be reluctant to make long-term, resilience-building investments on their land (Jochnick 2016). Land rights and tenure security in Mali pose a violent problem to smallholder farmers. Many borrowers become displaced from the land that they assumed to have rights over due to the deterioration of traditional transactions through loans and gifts. Customary tenure practices have not adapted to this context, resulting in the inability to resolve these land disputes. Additionally, linkages

between land management institutions and local governance have greatly undermined land administration (IIED 2014). In response to these conflicts, the government of Mali passed the Agricultural land law. This law, built on a vision to bring an end to land hoarding in Mali, identifies strong customary land rights through documentation of customary land certificates and certificates of land possession. Additionally, it improves governance by establishing village land commissions. Its emphasizes local institutions as the first level of intervention, thereby promoting decentralized management. It also attempts to protect women's rights by giving 15 percent of state land to women and vulnerable groups.

All of these cases of resilience, though categorized as successes, have shortcomings. In other words, each of these policies and programs has the ability to improve and better serve the relevant stakeholders interested in building resilience. However, in essence, these cases are all success stories detailing the types of programming and initiatives required to promote resilience within food systems. As mentioned previously, these programming and initiative types embody the key entry points for resilience; policy, institutions, technological innovation, capacity, and governance,

VII. Concluding Remarks

Societies have always faced shocks. The sources of these shocks are extremely diverse. They may be war conflicts, natural disasters, or food price volatility (Zselezky & Yosef 2014). Developing food systems that are robust and have the ability to strongly resist any damage a shock may create are key for attaining the sustainable development goals. Therefore, the survival and progress of today's societies is very closely linked to their ability to recover from these shocks, or their capacity for resilience.

This analytical literature review provided an introduction to the various themes of resilience within the context of different types of shocks. Through this literature review, we explained the importance of tailoring resilience studies to focus on food systems. In section 2, we analyzed why resilience building activities are important to achieving short term and long term sustainability. We introduced a conceptual framework that helps to assess specific efforts that may be taken at many levels to achieve resilience and build capital. We also recognized and addressed several knowledge gaps in the pursuit to building

resilience. We then delved into food system resilience through the context of climate change as a specific shock in section 3. We used the Paris Agreement as an outline to describe the relationship between food systems, resilience, and climate change. Then, we highlighted the problems that climate change poses on resilience through cases of demographic and geographic shifts. In section 4, before exploring the key entry points of food systems for resilience building, we addressed one of the primary challenges of resilience research: measurement issues and indicators. In section 5, we detailed the extensive literature review on the five key entry points for food system resilience: policy, institutions, technological innovations, capacity, and governance. Finally, in section 6, we proposed an effective approach to use in order to expand resilience literature and gain a better understanding of its ability to achieve the sustainable development: the case study approach. . Some progress has been made in studying various elements of a food system towards improving their resilience in different countries through this case study approach. For example, Lilian Nkengla and her collaborators (Nkengla et al, 2016) explore the role that gender plays in building resilient food systems in the face of climate change in Cameroon. Technological, institutional, organizational, and infrastructural challenges faced by the Sri Lankan food system in light of a brutal civil war are explored by Pathmanathan et al (2017). The impacts of establishing strong communication channels through multi-stakeholder partnerships within the context of Zimbabwe's food crisis induced by the 2015 El Nino is the focus of a study by Tinarwo et al (2018). Finally, Rana and Babu (2018) analyze the effect the private sector has in increasing resilience of Cambodian food systems. Each of these case studies hones in on one aspect of the food system, and studies its potential to enhance resilience. Each of these aspects, through better policies, institutions, technology, capacity building programs, governance, indicators, and research, has the ability to strengthen the food system and consequently promote resilience. More research is needed to develop context specific options for mainstreaming resilience building as part of the food system transformation in developing countries.

REFERENCES

- 100 Resilient Cities. (n.d.). *Surat's Resilience Challenge*. Retrieved from 100 Resilient Cities: <https://www.100resilientcities.org/cities/surat/>
- Alvarez, S., Jost, C. C., Scheutz, T., Forch, W., Schubert, C., & Kristjanson, P. (2014). *Lessons in Theory of Change from the Introductory Training on Theories of Change, Impact Pathways, and Monitoring and Evaluation*. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Anand, J., & Ramachandra, U. (2016). *Role of Various Sectors in Demonstrating Resilience during Chennai Floods 2015*. New Delhi: Taru Leading Edge Pvt Ltd (TARU) and Asian Cities Climate Change Resilience Network (ACCCRN).
- Babu, S. C., Comstock, A., Baulch, B., Gondwe, A., Kazembe, C., Kalagho, K., . . . Benson, T. (2018). *Assessment of the 2016/17 Food Insecurity Response Programme in Malawi*. Washington, DC: International Food Policy Research Institute (IFPRI).
- Babu, S. C., & Blom, S. (2014). Building capacity for resilient food systems. In R. Pandya-Lorch, & S. Yosef, *Resilience for Food and Nutrition Security* (pp. 119-126). Washington DC: International Food Policy Research Institute (IFPRI).
- Babu, S. C., & Dorosh, P. (2017). *From Famine to Food Security*. Washington D.C.: International Food Policy Research Institute (IFPRI).
- Barrett, C. B., & Headey, D. (2014). Measuring resilience in a risky world: Why, where, how, and who? In R. Pandya-Lorch, S. Yosef, & S. Fen, *Resilience for Food and Nutrition Security* (pp. 187-194). Washington, DC: International Food Policy Research Institute (IFPRI).
- Baser, H., & Morgan, P. (2008). *Capacity, Change and Performance Study Report*. Maastricht, Netherlands: European Centre for Development Policy Management (ECDPM).
- Bernier, Q., & Meinzen-Dick, R. S. (2014). Resilience and social capital. In R. Pandya-Lorch, S. Yosef, & S. Fan, *Resilience for Food and Nutrition Security* (p. 169). Addis Ababa, Ethiopia: International Food Policy Research Institute (IFPRI).
- Borquez, R., Adunce, P., & Adler, C. (2016). Resilience to climate change: From theory to practice through co-production of knowledge in Chile. *Sustainability Science*, 163-176.
- Braimoh, A., Manyena, B., Obuya, G., & Muraya, F. M. (2018). *Assessment of Food Security Early Warning Systems for East and Southern Africa*. Washington, DC: World Bank.
- Bugler, W. (n.d.). *Urban Resilience in a Land of Flood and Drought*. Retrieved from <https://acclimatise.atavist.com/urban-resilience-in-a-land-of-flood-and-drought>
- Bujones, A. K., Jaskiewicz, K., Linakis, L., & McGirr, M. (2013). *A Framework for Analyzing Resilience in Fragile and Conflict-Affected Situations*. New York: Columbia School of International and Public Affairs (SIPA).
- Calderone, J. (2016, May 14). The world's best coffee-growing regions are changing. *Business Insider*.
- CCAFS (CGIAR Research Program on Climate Change, Agriculture and Food Security). (n.d.). *Climate Analogues*. Retrieved from CCAFS Tools : https://ccafs.cgiar.org/tool-climate-analogue-tool#.W0UgB0m0WM_

- CDKN (Climate and Development Knowledge Network). (2011). *From Vulnerability to Resilience: Farmer Managed Natural Regeneration (FMNR) in Niger*. Cape Town, South Africa: CDKN.
- Chen, L.-C., & Wang, Y.-W. (2010). Building community capacity for disaster resilience in Taiwan. *Journal of Disaster Research*, 138-146.
- CIF (Climate Investment Funds). (n.d.). *Climate Resilience*. Retrieved from Climate Investment Funds : <https://www.climateinvestmentfunds.org/topics/climate-resilience>
- Cisse, J. D., & Barrett, C. B. (2016). *Estimating Development Resilience: A Conditional Moments-Based Approach*. Abidjan, Côte d'Ivoire: African Development Bank Group.
- Climate Communication. (n.d.). *Heat Waves: The Details*. Retrieved from Climate Communication: <https://www.climatecommunication.org/new/features/heat-waves-and-climate-change/heat-waves-the-details/>
- CREWS (Climate Risk and Early Warning Systems). (2017). *Annual Report 2017*. Geneva: CREWS.
- de Boer, M., & Aimiuwu, O. (2016). Implementing USAID's multi-sectoral nutritional strategy. *SPRING Agriculture-Nutrition Webinar Series*. Retrieved from SPRING Project: <https://www.spring-nutrition.org/events/implementing-usaids-multi-sectoral-nutrition-strategy>.
- Dikitanan, R., Grosjean, G., Nowak, A., & Leyte, J. (2017). *Climate-Resilient Agriculture in the Phillipines*. Cali, Colombia: International Center for Tropical Agriculture (CIAT).
- Doyle, C., Sullivan, J., Mahtta, R., & Pandey, B. (2017). *Assessing Biophysical and Social Vulnerability to Natural Hazards in Uttarakhand, India*. Washington, DC: World Bank.
- Dunnet, A., Shirshath, P. B., Aggarwal, P. K., Thornton, P., Joshi, P. K., Pal, B. D., . . . Ghosh, J. (2018). Multi-objective land use allocation modelling for prioritizing climate-smart agricultural interventions. *Ecological Modelling*, 23-35.
- Engle, N., de Bremond, A., Malone, E. L., & Moss, R. H. (2014). Towards a resilience indicator framework for making climate-change adaptation decisions. *Mitigation and Adaption Strategies for Global Change*, 1295-1312.
- Evans, A. (2011). *Governance for a Resilient Food System*. Oxford, UK: Oxfam.
- Fan, S., Pandya-Lorch, R., & Yosef, S. (2014). *Resilience for Food and Nutrition Security*. Washington, DC: International Food Policy Research Institute (IFPRI).
- FAO (Food and Agriculture Organization of the United Nations). (n.d.). *Climate-Smart Agriculture*. Retrieved from Food and Agriculture Organization of the United Nations : <http://www.fao.org/climate-smart-agriculture/en/>
- FAO (Food and Agriculture Organization of the United Nations). (n.d.). *Early Warning*. Retrieved from Resilience: <http://www.fao.org/resilience/background/early-warning/en/>
- FAO (Food and Agriculture Organization of the United Nations). (n.d.). *RIMA II: Moving Forward the Development of the Resilience Index Measurement and Analysis Model*. Rome: FAO.
- FAO (Food and Agriculture Organization of the United Nations). (2013). *Healthy People Depend on Healthy Food Systems: Sustainable Food Systems for Food Security and Nutrition*. Rome: FAO.
- FAO (Food and Agriculture Organization of the United Nations). (2014). *Strengthening the Links between Resilience and Nutrition in Food and Agriculture*. Rome; FAO.

- FAO (Food and Agriculture Organization of the United Nations). (2015). *Building Resilience Agricultural Systems through Farmer Field Schools*. Rome: FAO.
- FAO (Food and Agriculture Organization of the United Nations). (2017). *Migration, Agriculture, and Climate Change: Reducing Vulnerabilities and Enhancing Resilience*. Rome: FAO.
- Fenwick, T., Seville, E., & Brunson, D. (2009). *Reducing the Impact of Organizational Silos on Resilience*. Christchurch, New Zealand: Resilient Organizations.
- ForeignAssistance.gov. (2017). *Humanitarian Assistance*. Retrieved from ForeignAssistance.gov: <https://www.foreignassistance.gov/categories/Humanitarian-Assistance>
- Forum for the Future. (n.d.). *The Five Capitals*. Retrieved from Forum for the Future : <https://www.forumforthefuture.org/project/five-capitals/overview>
- Foster, J., Greer, J., & Thorbecke, E. (1984). A class of decomposable poverty measures. *Econometrica* 3, 761-766.
- Francis, R., Weston, P., & Birch, J. (2015). *The Social, Environmental and Economic Benefits of Farmer Managed Natural Regeneration (FMNR)*. Melbourne, Australia: World Vision Australia.
- Fuller, R., & Lain, J. (2017). *Building Resilience: A Meta-analysis of Oxfam's Resilience Effectiveness Reviews*. Oxford, UK: Oxfam GB.
- Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). *Case Study Research: Foundations and Methodological Orientations*. *Forum: Qualitative Social Research*, 18 (1).
- Hartmann, A., & Linn, J. F. (2008). Scaling Up: A Framework and Lessons for Development Effectiveness from Literature and Practice. *Brookings*, October 31.
- Health Policy Project. (2014). *Multisectoral Coordination*. Washington, DC: US Agency for International Development (USAID).
- HLPE (High Level Panel of Experts). (2017). *Nutrition and Food Systems*. Rome: Committee on World Food Security (CFS).
- Hovorka, D. S., & Auerbach, N. (2010). The generative potential of participatory geographic information systems. *Positive Design and Appreciative Construction: From Sustainable Development to Sustainable Value. Advances in Appreciative Inquiry, Volume 3*, 157-173. Bingley, UK: Emerald Publishing.
- Humanitarian Policy Group. (2018). Resilience Scan presentation. London: Overseas Development Institute.
- IFPRI (International Food Policy Research Institute). (2011). Food Security Portal. Retrieved January 30, 2011 from <http://www.foodsecurityportal.org>.
- International Institute for Environment and Development (IIED). (2014). *Securing Land Rights in Mali: Local Solutions to Thorny National Problems*. London: IIED.
- Innovation Network. (n.d.). *System Mapping: A Case Example*. Washington DC: Innovation Network.
- Jamsin, E. (2015). Balancing efficiency and resilience: A recipe for systems that last. *Circulate News*, June.

- Jassogne, L., Laderach, P., & van Asten, P. (2013). *The Impact of Climate Change on Coffee in Uganda: Lessons from a Case Study in the Rwenzori Mountains*. Oxford, UK: Oxfam GB.
- Jochnick, C. (2016). Secure land rights and climate change resilience go hand in hand: Here's why. *Landesa Rural Development Institute*. June 3
- Knight, C. (2010). 10 adaptation technologies. *Climate Action*, December 22.
- Labbe, J. (2014). Humanitarian Aid vs Resilience Debate Should Put Priorities in Context. *IPI Global Observatory*, March 28.
- Lee, Y. (2017). A synthesized biophysical and social vulnerability assessment. *IOP Conf. Series: Earth and Environmental Science* 94.
- Malawi Government. (2015). *National Disaster Risk Management Policy*. Lilongwe, Malawi: Malawi Government.
- Malawi, Office of the Vice President. (n.d.). Disaster Management Affairs. Retrieved from Office of the Vice President: Republic of Malawi: <http://www.ovp.gov.mw/index.php/features/disaster-management-affairs>.
- Malawi, Ministry of Economic Planning and Development. (2017). *The Malawi Growth and Development Strategy (MGDS) III*. Blantyre, Malawi: Centre for Environmental Policy and Advocacy (CEPA).
- Mali, Department of Disaster Management Affairs (DoDMA). (2016). *2016/2017 Food Insecurity Response Plan*. Lilongwe, Malawi: DoDMA.
- Mali, Department of Disaster Management Affairs (DoDMA). (2016). *The National Resilience Plan: Breaking the Cycle of Food Insecurity in Malawi*. Lilongwe, Malawi: DoDMA.
- Meadu, V., Coche, I., Vermeulen, S., & Friis, A. E. (2015). *The Paris Climate Agreement: What It Means for Food and Farming*. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Michel, R. (2016). Here's why foreign assistance is important. *USGLC Forum*. Nashville, TN, US US Global Leadership Coalition.
- Moussa, A. S., Radeny, M., & Bonilla-Findji, O. (2013). *Farms of the Future: An Innovative Approach to Strengthening Adaptive Capacity*. Accra, Ghana: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
- Mwamakamba, S. (2017). *Paper on Policies for Building Resilience for Food and Nutrition Security*. Pretoria, South Africa: Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN).
- National Research Council (NRC). (2011). *Building Community Disaster Resilience through Private-Public Collaboration*. Washington DC: The National Academies Press.
- Nkengla-Asi, L.; Babu, S. C.; Kirscht, H.; Apfelbacher, S.; Hanna, R.; and Tegbaru, A. 2017. *Gender, Climate Change, and Resilient Food Systems: Lessons from Strategic Adaptation by Smallholder Farmers in Cameroon*. IFPRI Discussion Paper 1658. Washington, DC: International Food Policy Research Institute (IFPRI).

- Nyasimi, M., Kimeli, P., Sayula, G., Radeny, M., Kinyangi, J., & Mungai, C. (2017). Adoption and Dissemination Pathways for Climate Smart Agriculture Technologies and Practices for Climate Resilient Livelihoods in Lushoto, Northeast Tanzania. *Climate*, 63-85.
- Oehman, J., & Seering, W. (2011). Risk-driven design processes: Balancing efficiency with resilience in product design. In H. Birkhofer, *The Future of Design Methodology*. London: Springer.
- Orr, A. (2008). Why were so many social scientists wrong about the Green Revolution? Learning from Bangladesh. *The Journal of Development Studies*, 1565-1586.
- Oteros-Rozas, E., Martin-Lopez, B., Daw, T. M., Bohensky, E., Butler, J. R., Hill, R., . . . Vilardey, S. P. (2015). Participatory scenario planning in place-based social-ecological research: Insights and experiences from 23 case studies. *Ecology and Society* 20 (4):32.
- Oxfam. (2017). *The Future is a Choice: Absorb, Adapt, Transform Resilience Capacities*. Oxford, UK: Oxfam GB.
- Pachico, D. H., & Fujisaka, S. (2004). Scaling Up and Out: Achieving Widespread Impact through Agricultural Research. *Economics and Impact series 3*.
- Pathmanathan, H.; Babu, S. C.; and Pal, C. 2017. *Building Resilience for Food Systems in Postwar Communities: Case Study and Lessons from Northern Sri Lanka*. IFPRI Discussion Paper 1644. Washington, DC: International Food Policy Research Institute (IFPRI).
- PEP-CBMS (Partnership Economic Policy-Community-Based Monitoring System) Network Coordinating Team. (2011). Definition and types of shocks and coping strategies to be monitored. In *Monitoring Household Coping Strategies during Complex Crises*. Manila, Philippines: PEP.
- Pinstrup-Andersen, P. (2011). *The Food System and Its Interaction with Human Health and Nutrition*. 2020 Conference Brief. Washington, DC: International Food Policy Research Institute (IFPRI).
- Rana, A.; and Babu, S. C.. 2018. *The Role of the Private Sector in Food System Resilience: Lessons from Cambodia*. IFPRI Discussion Paper 1721. Washington, DC: International Food Policy Research Institute (IFPRI).
- Ravi, S. (2015.). Chennai floods: A smart city must also be a resilient city. *Brookings*, December 4.
- Reij, C., Tappan, G., & Smale, M. (2009). *Agroenvironmental transformation in the Sahel*. International Food Policy Research Institute (IFPRI).
- Resilient America. (n.d.). *ResilientAmerica*. Retrieved from The National Academies of Sciences, Engineering, Medicine: http://sites.nationalacademies.org/PGA/ResilientAmerica/PGA_153014
- Romano, D., & Traverso, S. (2017). *Disentangling the Effect of International Migration on Household Food and Nutrition Security*. Florence, Italy: Dipartimento di Scienze per l'Economia e l'Impresa.
- Ruibal, M. (2017). Preparing for an Uncertain Future: Doing “Scenario Planning” in Boulder. *100 Resilient Cities*, November 14.
- Savitsky, R. (2017). Climate Variability vs. Climate Change—What’s the Difference? *AIR*, June 15.
- Slater, R., & Ulrichs, M. (n.d.). *How is Social Protection Building Resilience in Ethiopia? Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED)*, London.

- Sobal, J., Khan, L. K., & Bisogni, C. (1998). A conceptual model of the food and nutrition system. *Social Science and Medicine*, 853-863.
- Spring. (2015). *Systems Thinking and Action for Nutrition*. Washington, DC: US Agency for International Development (USAID).
- Tamarack. (2013). *Convening a Comprehensive, Multi-sector Effort to Reduce Poverty: A Primer*. Waterloo, ON, Canada: Tamarack.
- The Economics of Ecosystems and Biodiversity (TEEB). (2018). *TEEB for Agriculture & Food: Scientific and Economic Foundations*. Geneva: UN Environment.
- Tinarwo, J., Babu, S. C., & Iyappan, K. (2018). *Improving Food System Resilience through Better Governance: Lessons from Multi Stakeholder Partnerships in Zimbabwe*. Washington DC: International Food Policy Research Institute (IFPRI).
- Tyler, S., Keller, M., Swanson, D., Bizikova, L., Hammill, A., Zamudio, N. A., . . . Bushey, S. (2013). *Climate Resilience and Food Security: A Framework for Planning and Monitoring*. Winnipeg, MB, Canada: International Institute for Sustainable Development (IISD).
- UN (United Nations). (2015). *Paris Agreement*. Paris: UN.
- UN (United Nations). (2015). *Sustainable Development Goals*. Retrieved from Sustainable Development Goals Knowledge Platform: <https://sustainabledevelopment.un.org/sdgs>
- UNDP (United Nations Development Programme). (2016). *Multidimensional Progress: Human Resilience beyond Income: Caribbean Human Development Report*. New York: UNDP.
- UNISDR (United Nations International Strategy for Disaster Reduction). (2017). *COP23 Focus on Early Warning Systems*. Geneva: UNISDR.
- USAID (US Agency for International Development). (2012). *Building Resilience to Recurrent Crisis: USAID Policy and Program Guidance*. Washington, DC: USAID.
- USAID (US Agency for International Development). (2013). *The Resilience Agenda: Measuring Resilience in USAID*. Washington, DC: USAID.
- USAID (US Agency for International Development). (2014). *Multisectoral Nutrition Strategy 2014-2025*. Washington, DC: USAID .
- USAID (US Agency for International Development). (2017). *Nigeria LSMS Resilience Analysis: Phase 1*. Washington, DC: USAID.
- USAID (US Agency for International Development). (2018). *Resilience and Sustainable Poverty Escapes in Rural Kenya*. Washington, DC: USAID.
- White House. (2015). *Statement by the President on the Trans-Pacific Partnership*. Washington, DC: White House.
- Willis, H. H., & Loa, K. (2015). *Measuring the Resilience of Energy Distribution Systems*. Santa Monica, CA, US: RAND Corporation.
- Wodon, Q., & Liverani, A. (2014). *Climate Change and Migration in the MENA Region*. Washington, DC: World Bank.

- Woolcock, M. (2015). Making the case for case studies in development practice. *The World Bank*, February 23.
- World Bank. (2017). *Accelerating Climate-Resilience and Low-Carbon Development: Second Progress Report on the Implementation of the Africa Climate Business Plan*. Washington, DC: World Bank.
- World Bank PPCR (Pilot Program for Climate Resilience) Team. (2015). *Shaping Climate Resilience for Transformational Change: Key Lessons from the Pilot Program for Climate Resilience*. Washington, DC: World Bank.
- Zamudio, A. N., Bizikova, L., & Keller, M. (2014). *Measuring Local Food Systems' Resilience: Lessons Learned from Honduras and Nicaragua*. Winnipeg, MB, Canada: International Institute for Sustainable Development.
- Zseleszczy, L., & Yosef, S. (2014). Are shocks becoming more frequent or intense? In R. Pandya-Lorch, S. Fan, & S. Yosef, *Resilience for Food and Nutrition Security* (pp. 9-17). Washington, DC: International Food Policy Research Institute (IFPRI).

ALL IFPRI DISCUSSION PAPERS

All discussion papers are available [here](#)

They can be downloaded free of charge

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

www.ifpri.org

IFPRI HEADQUARTERS

1201 Eye Street, NW
Washington, DC 20005 USA
Tel.: +1-202-862-5600
Fax: +1-202-862-5606
Email: ifpri@cgiar.org