

Molly D. Anderson (2015)

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The role of knowledge in building food security resilience across food system domains

Abstract

Food systems are social-ecological systems essential for human life. Many food systems are in parallel operation globally, differing in their practices, impacts, use of knowledge and resilience. Those that are adapted to local constraints and assets and intentionally use and preserve ecosystem services result in lower environmental impacts and are less prone to lead to catastrophic environmental thresholds.

Actors within food systems are constantly changing their practices to adapt to pressure and perturbations. Changing activities are correlated with changes in knowledge systems as well. Contributions to the resilience of social-ecological systems have been identified and evaluated, primarily based in ecosystem studies. Many of these attributes (e.g., memory, learning, self-organization) have to do with forms of knowledge. This paper suggests characteristics of “resilient knowledge” and links it with enabling power to make needed changes. How can this enabling power allow social organizations from the community to the international scale to build resilience to all kinds of perturbations into their food systems, and create the knowledge systems that resilience requires?

This paper compares knowledge generation, transmission, access and use in four food system domains (Global Industrial, Independent Commercial, Local & Sustainable, and Fair Trade) discriminated on dimensions of globalization and multifunctionality. The objective of these comparisons is to understand connections among the resilience of food systems, food security and knowledge systems. The paper concludes with a case study of the Committee on World Food Security (CFS), hosted by the United Nations Food & Agriculture Organization. The CFS embodies and facilitates many of the attributes of resilient knowledge generation and access; some of the tensions within the CFS reflect whether knowledge used by the Committee will have attributes of resilient knowledge. I argue that forms of knowledge generation, transmission and access must be participatory, multi-actor, iterative and transparent in order to build food security resilience. I also argue that knowledge at multiple scales must be resilient and interlocking, in order to protect social organizations from food shortages and impaired food security.

Key Words: food systems, resilience, knowledge systems, transitions, Committee on World Food Security

Introduction

In 2009, partly in response to the food price crisis of 2007 and recognition that the Food and Agriculture Organization (FAO) of the United Nations had not adequately foreseen nor forestalled the crisis, the United Nations Committee on World Food Security (CFS) based at the FAO went through a major structural reform. One of the most significant aspects of this reform is a new Civil Society Mechanism (CSM) that creates policy space for participation by civil society (social movements and non-governmental organizations) in all functions of the Committee up to final votes and decisions. In addition to civil society, representatives of the private sector, philanthropic organizations, international research organizations and related UN agencies may participate in all activities. The CSM is unique among United Nations forums and agencies: this is the only UN Committee in which actors beyond government delegates and selected UN representatives are able to participate fully in debates and discussion (Food and Agriculture Organization 2014). The idea behind the 2009 reform was to bring all of the actors involved in food security to the same table for discussion, resolution of contentious issues, and sharing of best practices. The CFS is a space for information sharing by people who experience hunger and malnutrition with those implementing programs at State and regional levels to address hunger and malnutrition and with the most powerful people at the global level who control funds and decisions. But "sharing information" is much more than simply describing experiences and facts; it can be impeded by different worldviews about how change happens, which problems are most significant, the most effective solutions and pathways to solving those problems, and who should benefit from those solutions. Questions of power and voice are inevitably intermixed with information sharing, even in a forum like the CFS that is designed to be multi-actor and transparent. The solutions and enabling mechanisms for moving from food insecurity to food security, informed by food-insecure people sharing their perspectives, are thus intimately connected with the power that these people hold.

Food systems have become increasingly vulnerable over the last several decades, along with significant changes in their structure toward greater concentration of actors and power in almost every food system activity from input production through retailing (Reardon and Timmer 2012). Food systems consist of all activities and actors involved in food, from the production of inputs for cropping, livestock or aquaculture to management of food waste, and the institutions that govern these activities. Food system vulnerability burst into public awareness with the sharp rises in food and input prices in 2007; but it had been apparent for several decades earlier as environmental degradation, emergent threats and social costs of food systems escalated, despite concomitant increases in production and productivity of major crops (McIntyre et al. 2009). "Vulnerability" is a notoriously difficult concept to define; but it is related to exposure to harm from environmental or social stresses, sensitivity to that harm, and the ability to manage risk or adapt so that harm can be prevented or minimized (Adger 2006). Its assessment and mitigation require attention to institutional forces that determine who will be harmed in which ways from any particular perturbation (Eakin and Luers 2006). The 2014 United Nations Development Programme's Human Development Report makes the abstract concept of vulnerability more manageable by breaking it down into those who experience vulnerability and the causes (Figure 1):

Fig. 1. Human vulnerability (Source: Malik 2014).

Who is vulnerable, to what, and why?



Source: Human Development Report Office.

Resilience is often conceptualized in contrast to vulnerability: resilience decreases vulnerability (Gallopín 2006). Therefore, food system resilience has received increasing attention as public awareness of vulnerability has grown (Godfray et al. 2010). For this paper, vulnerability and resilience are considered with respect to the sustained ability of food systems to fulfill their fundamental goal of providing sufficient nutritious food for all people, or (from the perspective of individuals who receive their food from that food system) the risk that people participating in a food system will be food insecure or chronically hungry. Vulnerability to food insecurity is most acute for small-scale farmers and other food producers (fisherfolk, pastoralists, gatherers of forest products) who make up 60% of the hungry people in the world at present (WFP 2014). Of the extremely poor people in the world (living on less than \$1.25/day), approximately 70 percent live in rural areas and most of them depend on agriculture for food and livelihoods (HLPE 2013). These vulnerable people are the ones that the Civil Society Mechanism (CSM) is engaging, and who now have voice in the Committee on World Food Security (CFS). While food security and vulnerability to food insecurity and hunger are characteristics of individuals as well as social systems at various scales, this paper is concerned primarily with systemic attributes that encourage or allow food systems to ensure food security for all, and the knowledge informing these attributes. Food security is defined by the Food and Agriculture Organization on its CFS home-page as follows: "Food security exists when all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." The central importance of the right to food in food security is emphasized by the decision of the CFS to ensure that all of its decisions and recommendations are congruent with the right to food, defined as follows: "The right to adequate food is realized when every man, woman and child, alone or in community with others, has the physical and economic access at all times to adequate food or means for its procurement" (CESCR 1999). While these definitions may sound very similar, the right to food is much more than a condition that people experience: it has been elaborated through multiple documents of the United Nations that specify the process by which it is realized and obligations of duty-bearers who must respect, protect and fulfill it.

Many aspects of resilience are related to knowledge: in particular, how and by whom it is generated, owned, transmitted, accessed and used; and who benefits from its use. This paper begins with the conceptual underpinnings of resilience in social-ecological systems. It suggests attributes of resilient knowledge and introduces a typology of food system domains, the pressures that affect each domain, their uses of knowledge, and their respective resilience. It concludes with a case study of the reformed CFS, which illustrates in its design and functioning many of the key attributes of resilient knowledge. The case study demonstrates recognition at the global level that resilient knowledge is necessary for food security.

Resilience and sustainability in social-ecological systems

The field of resilience studies has expanded rapidly since 1973, when C.S. Holling launched a wave of research and analysis on ecological resilience, which moved into social-ecological systems in the ensuing decades. Resilience is most fully developed conceptually in ecological systems, and the transfer of concepts from ecological to linked social-ecological systems (which include economic and cultural attributes) is not altogether satisfactory. The idea of a "domain" or "state" is critical to the original definition of ecological resilience (Holling 1973, p. 17) as "the ability of ... systems to absorb changes of state variables, driving variables, and parameters, and still persist" [within a given domain]. The concept of alternate domains of attraction or stability replaced an earlier fascination in ecology with stability or climax conditions for ecosystems (Worster 1994). Alternate domains are different forms of structure and function, separated by thresholds marked by levels of controlling variables. The variables in turn are controlled by feedback mechanisms; when these change, the system may change states (Holling 1973), sometimes irreversibly.

Alternate domains of attraction have been well documented in natural system transitions, such as the conversion of a lake from a healthy state to one overgrown with algae or the conversion of grazeable rangeland to impenetrable brush (Carpenter 2000). They are much less used in work on social-ecological systems, although changes in a socioeconomic system also may be sudden, dramatic and irreversible (e.g., the fall of the Berlin Wall, or the shift in the United States away from tolerance of public smoking). Recently, scientific teams have identified thresholds or "planetary boundaries" beyond which social-ecological systems are likely to cross into alternate (and less desirable) states (Rockstrom et al. 2009, Steffen et al. 2015). By combining these planetary boundaries with "lower bounds" imposed by human rights, a safe space for trajectories of social-ecological systems can be conceptualized (Raworth 2012, Leach et al. 2013).

The essential structures or functions that a socioeconomic system must maintain, in order to stay within a particular domain, may not be apparent even in retrospect after it has clearly deteriorated. The choice of what constitutes "deterioration" is value-laden, although it may be assessed through less-subjective factors such as decreased complexity of interrelationships within the system. Controlling variables that can flip both social and ecological systems into new states are often changes in social, political and economic institutions—enabling policies, regulating policies, the existence of specific forms of organization or infrastructure—and values or "mindsets".

The concept of socioeconomic domains is useful if it helps to explain changes over time, or to illuminate how undesirable changes can be resisted. Since food security resilience is the main attribute of interest in this paper, learning how to resist changes that lead to greater food

insecurity is the ultimate objective of understanding food system domains. This paper describes four food system domains with the full recognition that their boundaries are permeable. The relative size and strength of the domains change over time, and tensions exist within each domain that can attract or repel actors to or from other domains.

Ecological resilience is clearly associated with food security, in that a degraded ecosystem that is on track for further deterioration is unlikely to provide conditions for sustainable food production. An example from Central America shows how agricultural practices can contribute to resilience. Farms that used agroecological practices suffered less damage from Hurricane Mitch in 1998 than farms using industrialized agriculture, in an area where deforestation had led to tremendous ecological damage and loss of life from landslides after hurricanes during the last few decades (Holt-Giménez 2001). But are there further clues from study of the resilience of social-ecological systems that might show pathways to food security resilience?

Berkes and Ross (2013) attempted to synthesize resilience concepts coming from ecology, the psychology of personal development and mental health, and community development to show where overlaps occur and which concepts are stressed in the social literature. They found that a community's resilience seems to rely on its existing strengths and assets, augmented by social learning, formal and informal networks, the integration of knowledge from different sources, economic diversification, infrastructure, values and beliefs. Their findings point to the strong roles of social cohesion, personal relationships and agency in community resilience. People can diversify their assets, relationships and sources of livelihoods; change their lifestyles; and self-organize around intentional goals in ways that other organisms cannot. That is, resilience is not an inherent systemic trait of communities that is either there or not; it can be built when individuals and communities hold sufficient power over their actions and interactions.

The term "adaptability" is often used in studies of social-ecological systems to indicate the capacity of a system to manage resilience in relation to alternate regimes or domains of attraction. When system structure or function is undermined, the ability to adapt and regenerate after catastrophic changes is weakened and the system becomes less resilient. In terms of food security resilience, adaptability then is the capacity to withstand and recover from perturbations that affect stable access to healthy food. Given the larger number of tools that humans have for building resilience, one would expect food security resilience to be more complex and malleable than the resilience of, say, a pasture or a pond.

In studies of the resilience of social-ecological systems, several actions or attributes have been suggested that seem to enhance resilience: increasing the system's buffering capacity; allowing frequent small-scale disturbances to alleviate build-up of pressure that could lead to a massive disturbance; avoiding chronic stress that weakens the system's responses; managing and monitoring responses at multiple scales; protecting diversity, memory and legacy; and focusing on sources of renewal and restoration (Walker and Salt 2006). Berkes and Seixas (2005) identified clusters of factors from the ecological literature that lead to resilience in social-ecological lagoon systems (Table 1). The factors within their clusters are quite similar to those highlighted as critical to success by Walker and Salt in numerous case studies of social-ecological systems (2012).

Table 1. Factors that seem to build resilience in social-ecological systems (Source: Berkes and Seixas 2005)

- Learning to live with change and uncertainty
 - learning from crises
 - building rapid feedback capacity to respond to environmental change
 - managing disturbance
 - building a portfolio of livelihood activities
 - developing coping strategies
 - Nurturing diversity for reorganization and renewal
 - nurturing ecological memory
 - nurturing a diversity of institutions to respond to change
 - creating political space for experimentation
 - building trust among users
 - using social memory as a source of innovation and novelty
 - Combining different kinds of knowledge
 - building capacity to monitor the environment
 - building capacity for participatory management
 - building institutions that frame learning, memory and creativity
 - combining local and scientific knowledge
 - Creating opportunity for self-organization
 - building capacity for user self-organization
 - building conflict management mechanisms
 - self-organizing for equity in resource access and allocation
 - self-organizing in response to external drivers
 - matching scales of ecosystem and governance
 - creating multi-level governance
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How relevant are these attributes to food security resilience? Studies of food security and how to enhance it over time suggest considerable overlap in general concepts. Brooks and Loevinsohn (2011) reviewed agricultural innovation systems and found that responsiveness to food insecurity and climate change was associated with recognition of multifunctionality (opportunities to realize multiple benefits from agriculture); access to diversity; concern for enhancing the capacity of decision makers at different scales; and continuity of effort to ensure the well-being of people who depend on agriculture. Others studying resilience of communities to climate change have identified similar features (IFAD 2014, Oxfam International 2014). The International Fund for Agricultural Development (IFAD), which focuses on needs of smallholders, emphasized building the capacity of farmers and community organizations to shift into agricultural practices that can build greater resilience, such as agroforestry, terracing, minimum tillage and integrated pest management. IFAD also underlined the role of policies and institutions that guarantee social protection, a buffer against perturbations of all kinds. Crop insurance and public food stocks are examples of social protection mechanisms that can help protect small-scale farmers (Oxfam International 2014). In summary, food security resilience is strongly affected by household and community dynamics, and political dynamics at larger scales of sociopolitical organization (e.g., city, state, nation, global), as well as by environmental changes and perturbation. It is important to understand that attempts to build resilience at the local level may be undermined by initiatives at the global level, such as free trade agreements or structural adjustment terms that prohibit food reserves.

Resilience and food systems knowledge

Food system transitions, such as movement toward ensuring greater food security, depend on knowledge systems as well as changing practices (Röling and Jiggins 1998). Many of the factors

that have been identified as increasing resilience in social-ecological systems rely on generation, transfer and appropriate use of knowledge. Modes of production, control and access to food system knowledge contribute to both the social and ecological resilience of food systems and their adaptability. If critical knowledge transfers are restricted, the system is likely to become more brittle because it cannot adapt to a changing environment. Brittleness is manifest in inflexibility and lack of responsiveness, which can lead to a catastrophic break-down. Diamond (2005) explored factors that lead to the brittleness and eventual collapse of entire societies and concluded that the failure to adapt (or sometimes even recognize) environmental problems and dysfunctional cultural and political systems are two of five common problems. The dysfunctions that he examined include leadership that is isolated from the rest of society and unresponsive to its concerns. This sounds a warning about the need to respond to food insecurity, which is surely the most pressing and urgent concern of poor people today, whose numbers are rising due to increasing global wealth inequity (Shorrocks et al. 2014, UNDESA 2013).

Each activity and actor within a food system and each type of production system has distinct knowledge needs, depending on the use of goods and services produced; needs for new knowledge appear within food systems as their scale and other factors change. For example, a subsistence farmer is not bound by international regulations affecting trade nor must she know the cost of wage labor as long as extended family do all of the work. However, the cost of wage labor may be the key factor determining whether a highly mechanized broiler producer can stay in business. A farmer raising crops for a regional market must pay attention to competitors' practices and food safety regulations for anything produced for sale, but not for similar goods produced for household use. If these farmers' access to knowledge (e.g., production practices, early warning of weather disasters, market prices, the going rate for wage labor, availability of labor) is restricted, then they may not be able to continue farming successfully. Similar examples can be drawn from businesses engaged in every food system activity from production of inputs to each activity through waste management.

Many impediments exist to the generation of appropriate knowledge, its exchange, access to it, and effective use. Regarding knowledge generation, the people who most need agricultural knowledge and technology for avoiding hunger and food insecurity (smallholders, farmworkers and women) have relatively little control over scientific research, precisely because of the political and economic marginalization that leads them to be food-insecure in the first place. Another barrier to knowledge generation is imposed by the lack of funding for public-interest research. The amounts of money invested from public coffers (governments and intergovernmental agencies) have risen minimally since 1980, while private funding has grown rapidly, especially in food processing (Fuglie and Toole 2014). The need to increase public investment in agriculture and food systems has been stressed repeatedly; this was one of the main messages of the International Assessment of Knowledge, Science and Technology for Development (McIntyre et al. 2009). Private investors have little incentive to invest in research that will generate low profits. While most businesses are interested in increasing or stabilizing their markets, food-insecure people may not seem to be as lucrative a market as people with discretionary income. Yet flows of money into subsidized programs that support food access in the United States (US), such as the Supplemental Nutrition Assistance Program (SNAP), are vast: for example, in 2013, nearly \$80 billion went into SNAP to help families access food, and federal expenditures for the National School Lunch Program (which includes 62% free lunches to children whose families earn less than 185% of the federal poverty threshold) were over \$11 billion (Food and Nutrition Service 2014). These funds significantly boost the food buying capacity of low-income people.

Closely related to the lack of public funding for research is public divestment in education needed to prepare young people for research and other agricultural careers. This divestment has been mandated for several decades as a condition of receiving loans from international financial institutions, under the name of structural adjustment; it is becoming common in industrialized countries too as part of austerity programs imposed to avoid raising taxes to pay for social services (AFP 2014). There is a serious lack of training for young professionals in all countries on how to respond to changing demands on agricultural research and technology due to changing agricultural structure and pressures, and insufficient interaction among farmers, scientists, policymakers, and people working in different sectors of the food system. Researchers seldom receive training in cooperation, teamwork and interaction with food producers and community partners.

Additional barriers to the generation of knowledge exist in the structure of universities and training programs worldwide. Most global problems that affect vulnerability in the food system (e.g., poverty, climate change, weak tenure and water rights) are not amenable to solutions from single disciplines, yet scientists often encounter difficulties communicating across disciplinary boundaries and institutional cultures. A final barrier particularly affecting poor developing countries, but also relevant to farmers in industrialized countries who are seeking agroecological practices, is insufficient capacity to generate locally-specific science and technology. Crops, breeds and technology can seldom be transplanted from one region to another without adaptation to local conditions. Adaptation must be done in cooperation with the people who will be using the technology, but there is still too much knowledge generation *for* rather than *with* users and responding directly to users' needs. This leads to low adoption rates and inability to adapt imported technology to local needs.

The applicability of knowledge is a function of the knowledge itself, but also the manner and medium through which it is conveyed, received and applied. Issues in access and use of food system knowledge particularly relevant to vulnerability to food insecurity include whether the knowledge is applicable in the face of climate change. Climate change is likely to cause abrupt decreases in availability of resources and infrastructure needed for food production and distribution as storms become more severe, freshwater becomes less available, and droughts become more frequent and intense (Fischer and Knutti 2015). While this information is publicly disseminated, receiving it in a timely way may require technology that is not accessible to very poor or isolated people, such as cell-phones or radios. And these people may have few options open to them, even if they know that disaster is on the way.

The cultural appropriateness of outreach or training also affects access to knowledge, especially as many of the people vulnerable to food insecurity are politically marginalized because they belong to ethnic minorities or are female (UNDESA 2013). Globally, twice as many women as men are malnourished, and girls are twice as likely to die of malnutrition as boys (Food and Agriculture Organization nd). Language barriers are obvious, but cultural differences also may prevent contact or the development of trust between the people or agency that holds important knowledge and the people who most need the knowledge. For example, in some traditional sub-Saharan African societies, women are 60-80 percent of farmers; yet the percentage of Extension agents who are female is less than 10%. Women in some of these societies are not permitted to speak or meet with men outside their families, so they lose access to agricultural knowledge conveyed through Extension. Worldwide, women receive only 5 percent of agricultural Extension

services although almost 70 percent of women work in agriculture in low-income food-deficit countries (Food and Agriculture Organization 2007). Clearly the form of extension in these countries needs to be changed to be more accessible by women, especially in societies where women have limited freedom.

Privatization and increasing competition for natural resources may prohibit access to knowledge that would be relevant for preventing food insecurity. A widespread example of this is land-grabs where producers are forced off their land by government deals with corporations or foreign investors without full prior informed consent of producers who had been using the land. Privatization of food system knowledge is a growing trend. Only the wealthiest farmers and others in the food system can afford the best information and technical assistance now in the US, as well as in developing countries. In the US, Cooperative Extension has predominantly catered to the needs of the largest-scale farmers and abandoned small-scale or limited-resource farmers until quite recently (Evans 1992, Hiller 2005). But the largest farmers no longer turn to Extension because they can buy better and more tailored services from private providers. Meanwhile Cooperative Extension lost much of its public support and funding over the last few decades and has not successfully re-oriented in many states to serve different users (Sun 2014).

Several fields of research provide insights into how and why knowledge is adopted and how to encourage its use: theory on learning and the diffusion of innovations, farmer and consumer attitude surveys regarding trusted sources of information, risk perception, risk communication and stages of behavioral change. Factors affecting the application of information received include perceived need or advantage in use; convenience and ease of use; whether a new practice can be visualized or imagined (i.e., whether a demonstration model exists); the extent of change in behavior required; initial cost of application; cost of continued application; perceived credibility, salience and legitimacy of the source of information; perceived risk of using new information or practices; success in first application; whether there is ongoing assistance with problems; and finally, peer support and opinions, i.e., whether information is received in a social or individual context (see Cash et al. 2002, Kirchhoff et al. 2013, Oreszczy et al. 2010, Wejnert 2002).

The most useful knowledge for resilient food systems is resilient itself, so that it can be tested and adapted for local circumstances and changing needs. Information gained through scientific methods is inherently resilient because it is subject to testing, but loses its resilience if applied where the capacity to test and adapt it is lacking. Therefore, assuring the capacity for a region or country to produce its own contextual science—science at the service of problems arising from the attributes and people of a certain place—is of more value than providing products of science outside that context. The importance of stressing local capacity-building for knowledge testing and use is included in the principles and practice for resilience, food security and nutrition championed by the Rome-based United Nations agencies that deal with food because this ensures better ownership, uptake and relevance to local needs (Cousin et al. 2013).

Table 2 lists factors that may affect the resilience of information and how it is conveyed. The characteristics of resilient knowledge are largely the practices, facilitation and learning methods of the “ecological knowledge system” proposed by Röling and Jiggins (1998), although their knowledge system also includes policies, epistemology and institutions. While local and contextual knowledge is important for its applicability, knowledge appropriate to food security and nutrition at the local level must reach the global level as well to inform strategies and investment at the national and international scale. This is the significance of resilient knowledge

being coordinated with knowledge produced across sites and scales, and collected in ways that make it comparable, as the reformed Committee on World Food Security is intended to do. Note that many of the characteristics of resilient knowledge in this table are similar to the attributes that Berkes and Seixas (2005) summarized which build resilience in social-ecological systems (see Table 1). For example, they included "creating political space for experimentation" and "combining local and scientific knowledge", which are comparable to the attributes in Table 2 of "testable, adaptable" and "based in evidence from multiple sources".

Table 2. Factors affecting brittleness/resilience of knowledge.

<i>Brittle</i>	<i>Resilient</i>
produced off-site	locally produced
non-embedded, non-contextual	embedded in local context
produced by a single actor	shared, collaboratively produced
top-down or delivered to users	produced by users or in flat hierarchy of producers & users
"one size fits all"	testable, adaptable
produced for only one place, with only that site's needs in mind	coordinated with knowledge being produced and used in other sites; comparable with other sites
no support services	mentored, with follow-up support for use and adaptation
secret or proprietary	transparent, open-source
lacking accountability to users	producers and disseminators accountable to users
based in ideology or assumptions	based on evidence from multiple sources
neglecting feedback loops and systemic impacts	tightening or increasing the number of feedback loops; considering the full scope of impacts

Food security is fundamentally related to power at the individual, household and community level: power to hold others accountable for violations and abuses of the right to food, purchasing power, power to access resources for production, power to choose the food system that people want. This is illustrated by the demands of food sovereignty advocates (primarily small-scale producers) for greater control and democracy in their food systems. Resilient knowledge for food security is knowledge that effectively empowers people to act on their own behalf, to ensure their own food security by producing or buying the food they want. Food systems and institutions that contain checks and balances to help distribute power more equitably and give feedbacks about inequity are more resilient because food-insecure people can act more easily on their own behalf instead of relying on emergency funds or aid. Transparency in business and political negotiations, such as trade agreements, seems to be a critical balancing tool, providing knowledge as the cost of holding power. The case study of the Committee on World Food Security (CFS) in this paper shows how checks and balances have been instituted in its 2009 reform, to increase the resilience of knowledge and accountability of CFS actions and recommendations.

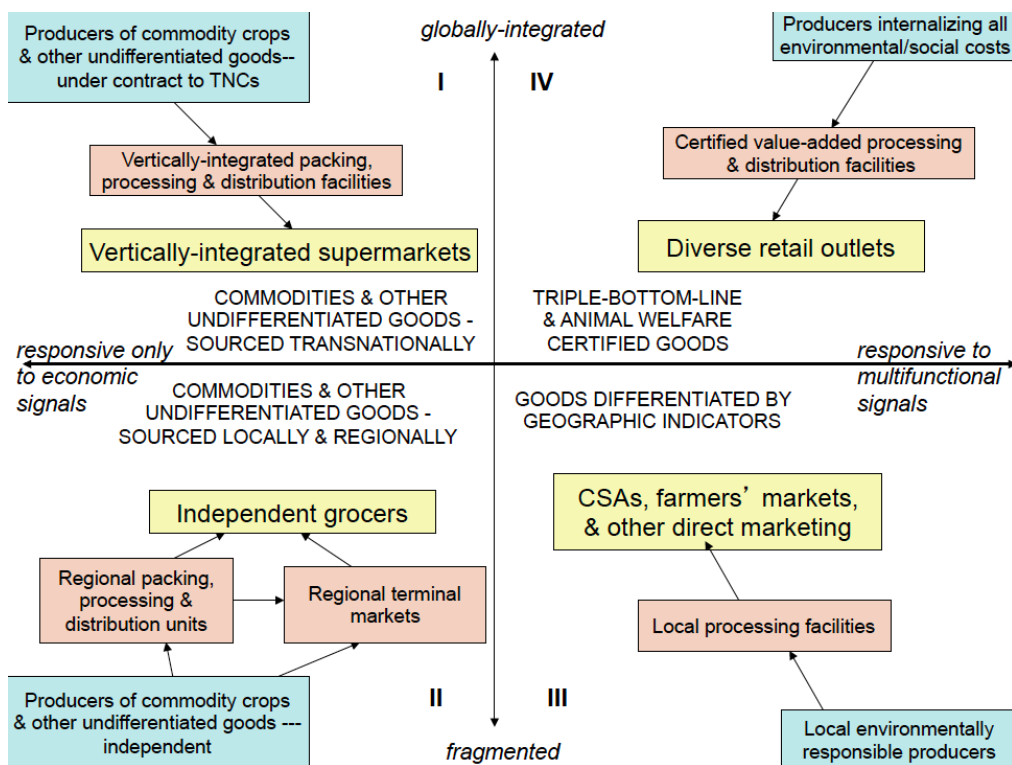
Parallel food system domains and their dynamics

Different food environments may be viewed as alternate “domains” with thresholds separating them. Given the issues mentioned earlier of delineating distinct social “domains”, a typology that shows where social-ecological systems are located on gradients fits food systems better than domains with rigid boundaries. However, for convenience this paper refers to quadrants of the typology as domains, with the understanding that they are permeable, co-existing and in flux as food systems respond to various pressures by moving up or down the gradients. Historical social and ecological conditions (hysteresis) and institutional factors determine the resilience of each domain. Resilience is not always a good thing (e.g., institutions such as slavery have been remarkably resilient) and a particular food system may be quite resilient, yet fail to provide access to healthy food for all. The right to food is one of many public goods that food systems can provide, along with ecosystem services and other cultural, environmental, social and health benefits.

Figure 2 depicts a typology for food systems, with axes designating the degree of integration with the global economy and responsiveness to multifunctional market signals, i.e., demands to provide multiple goods and services, including the means of assuring the right to food. These axes were used to develop global scenarios for the Millennium Ecosystem Assessment (2005) and considered for scenario development during the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), which took place through a series of global and regional meetings between 2004 and 2008. Although the IAASTD authors and Secretariat decided not to develop global scenarios, contrasts between globalized and fragmented food systems and the concept of multifunctionality infused the reports.¹

Multifunctionality refers to the provision of multiple goods and services by food systems. Food systems use natural resources and other forms of capital, but they provide in return a range of goods and services in addition to food. Some of these goods have been exchanged in formal and informal markets since the beginnings of agriculture: food; fiber; fuel from dung, wood or other bio-products; and animal feed. Some of the goods and services have been recognized more recently and are not easily valued in economic terms, although their loss may be irremediable and result in tremendous costs to society. These more recently acknowledged goods and services include nutrient cycling, pollination, purification of water supply, conservation of local biodiversity and cultural values. Many traditional and agroecological production practices rely on local knowledge and local sources of nutrients and other inputs, rather than synthetic pesticides or fertilizer. These systems tend to have much lower environmental impacts than industrialized practices because they intentionally preserve ecosystem goods and services. Food systems also provide social goods and services such as the means of achieving the right to food; energy security through agricultural by-products; and community, spiritual and cultural values associated with meals and specific foods. While the multifunctionality of agriculture may seem obvious, social and environmental values that food systems can provide have been truncated by food systems that value primarily the economic benefits of selling food, fuel, feed and fiber.

Fig. 2. Food system domains (Anderson and Firbank 2007. Unpublished).



In Figure 2, typical products of each quadrant of the typology of food systems are at the center of the diagram; and typical producers, intermediaries and retailers are shown linked together with arrows. These are the most important or distinctive sources for each sector, not entire supply chains. A given food system might occur anywhere on the diagram, depending on its attributes with respect to globalization and prioritization of profit over multifunctional goals. The labels of each axis show the end-points of that axis; for example, food systems that lie to the left of the vertical axis do not value only economic outputs, but they place increasingly greater value on profits the closer they are situated to the left side of the typology. The Roman numerals are used for convenience, but we named each quadrant according to the most typical supply links within it. Roman numeral I is the Global Industrial food system; II is the Independent Commercial system; III is the Local & Sustainable food system; and IV is the Fair Trade food system. Each sector is described in more detail below in this section.

The four quadrants that we depicted bear similarities to the regimes that have been elegantly theorized and explained by Harriet Friedmann, Philip McMichael and others (Friedmann 1987, McMichael 2009, Rosin and Campbell 2009). They also can be mapped onto the “economies of worth” of convention theory (Boltanski and Thevenot 1989, Biggart and Beamish 2003). Our Global Industrial domain follows the norms and values of the Industrial domain in convention theory because of its emphasis on efficiency; Local & Sustainable comes close to the Domestic domain in its emphasis on direct relationships between producer and consumer, although it also bears similarities to the alternative future regimes proposed by Friedmann and the “Food from Somewhere” regime proposed by Rosin and Campbell (Friedmann 1993; Rosin and Campbell 2009). The Independent Commercial domain corresponds to the Market domain of Boltanski and Thevenot through its emphasis on market relationships and performance. The Fair Trade domain is closer to the civic or green economies of worth through its emphasis on public goods and

environmental value, although it also has attributes of Friedmann's corporate environmental regime.

While we followed in the steps of many others who have tried to categorize food systems and their transitions, our typology adds new elements to this rich theoretical work. First, in our original conceptualization, Les Firbank and I understood that different food system domains co-exist in parallel, sometimes in the same geographic location. They are not sequential, and actors may participate in more than one food system domain. Second, we saw food systems as competing and dynamic, constantly responding to pressures and perturbations. Perturbation is the norm, not an unusual event. Climate change is a perturbation of a new scale of magnitude for food systems, but it is experienced by food system actors through the same types of weather events (albeit more severe and frequent) that they have experienced previously. Third, in this paper I develop the role of knowledge and resilience in food systems within different food system domains. And fourth, by mapping food systems along consistent dimensions, critical institutional shifts (such as creating policy incentives that provide payment for ecosystem services, increasing generation of or access to particular kinds of knowledge, or linking low-income rural producers with low-income urban consumers) to "push" a particular food system into a qualitatively different domain become apparent. Since food security is the primary concern here, movement of food systems to the right in this typology is desirable. However, note that the overall resilience of that food system may be either enhanced or diminished by that shift, depending on the kinds of perturbation that the food system encounters.

The Global Industrial domain (I) includes food systems managed by the largest transnational companies. These companies have achieved high profitability and often rank among the list of Fortune 500 companies; other values (such as creating well-paying jobs for employees, protecting the environment, or preserving cultural values) are important to them primarily insofar as they contribute to profitability, which is often demanded by their shareholders. The Independent Commercial domain (II) contains more fragmented and independent companies, including mid-size and large-scale farmers who are not participating in vertically integrated supply chains. The Fair Trade domain (IV) includes a multiplicity of value-bundled products and supply chains in addition to Fair Trade certified products. The key aspect of this domain is that it serves consumer interest in supporting values that go beyond company profits. The Local & Sustainable domain (III) consists of independent producers, intermediaries and sales venues that offer value bundles, just like the Fair Trade domain. "Local" and "sustainable" only refer explicitly to the bottom right corner of the typology; that is, a food system within this quadrant may place high value on economic returns and its performance with respect to environmental impacts and decent work may not be optimal. There is no implication that being "local" is necessarily associated with being "sustainable"; these are different qualities associated with the two dimensions. However, in contrast to food systems located to the left, this domain has stronger performance on the multifunctional scale.

Whereas the Fair Trade (IV) domain operates internationally, the Local & Sustainable (III) domain capitalizes on being local and building relationships between producers (usually farmers or fishermen) and their customers through direct markets. Many producers in the bottom right of the typology eschew certification altogether, even though they use certifiable practices, because the cost of certification is not warranted. Their customers buy from them because of the trust they have established, not because they are certified. The appeal of "local" food has grown considerably in industrialized countries and local or regional food feeds most people in the world.

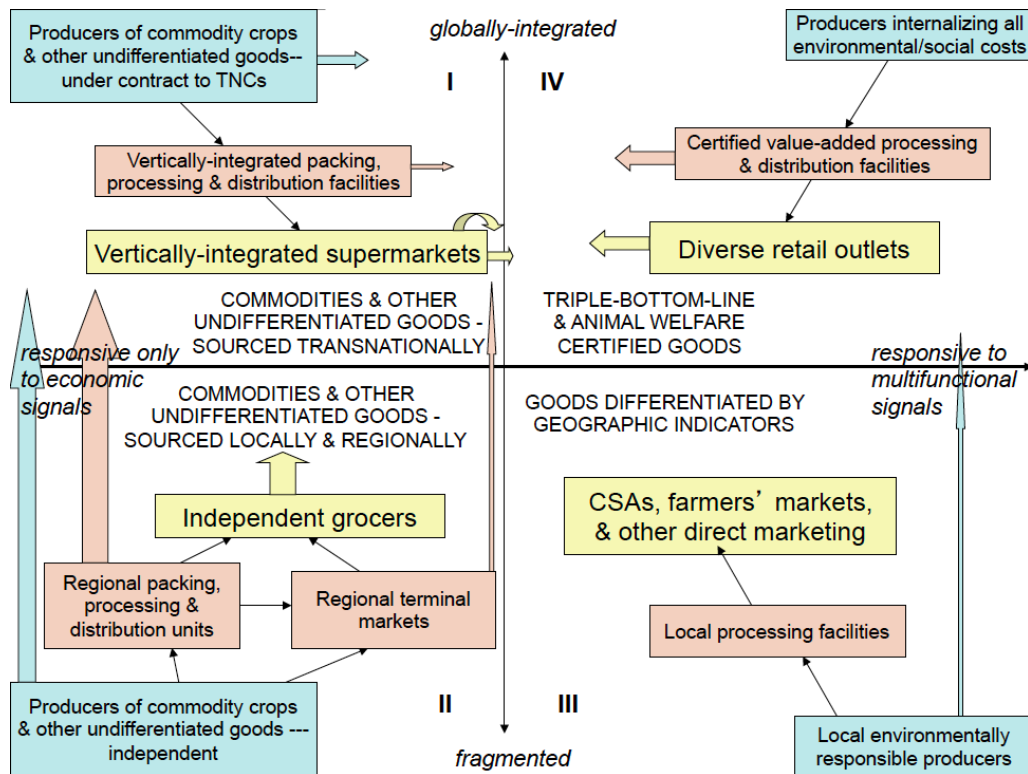
However, customers in industrialized countries often value local food because of its novelty and because they make assumptions that are not necessarily borne out in fact (e.g., assuming that all foods marked as “local” are organic, or that all local farmers use environmentally sustainable practices or pay fair wages to their workers; Anderson 2008).

Vulnerability and resilience of each domain

Different kinds of perturbations may favor resilience in different domains; that is, a single domain may not always be most resilient all of the time. An earlier example in this paper of agroecology in Central America illustrated that food systems using such practices were more resilient to hurricanes. However, powerful storms can wipe out local food supply chains and leave people reliant on Global Industrial supply chains, which can source from outside the storm's area. Later in this section, I explain how the Global Industrial domain is particularly vulnerable to financial perturbations because of its complexity. Not only resilience affects a food system's ability to provide access to healthy food for all people; also critical are the capacities to produce or source enough healthy food and get it to customers who need it, at prices they can afford and with reliable quality and safety. A food system may be resilient but not provide access to healthy food for all people at all times (as in food systems on the left side of the typology).

Figure 3 shows responses to pressures within and between food system quadrants, and some of the important trends that affect their resilience. The size of the arrow indicates the relative strength of a trend or response. Overall, food systems within the Independent Commercial domain are least resilient, as indicated by wider arrows: independent farmers are going under contract to vertically-integrated processors (especially in livestock), and regional infrastructure such as packing and processing plants that serve them has disappeared in many parts of the US (Western SARE 2013). In many aspects, the Global Industrial domain is consuming the Independent Commercial domain. With considerable attention from private foundations in the US to “scaling up” local food systems, some local and regional infrastructure is being replaced. But the new services have not been in place long enough, nor evaluated well enough, to know whether they are contributing to reducing food insecurity.

Fig. 3. Dynamics of food system domains (Anderson and Firbank 2007, Unpublished).



There is a lot of interplay between the Global Industrial (I) and Independent Commercial (II) domains; for example, independent supermarkets in the latter domain buy products from vertically integrated as well as independent and regional processors and distributors. There has been considerable distress in the US at the “disappearing middle”, or the demise of mid-sized independent commercial farmers. However, as the Global Industrial domain continues to concentrate buyers, processors, input producers and retailers, the producers and intermediaries in the Independent Commercial domain find fewer companies from which they can buy inputs appropriate for their location and fewer companies to which they can sell their products. Use of genetically engineered (GE) crops is an example relevant to this phenomenon: access to large quantities of locally-adapted seed that is not genetically modified is no longer easy in some parts of the US as independent seed companies have been bought up by large companies that supply GE seed (Binemelis et al. 2013). So although consumers consistently ask for GE labels in the US, farmers in this domain would be at a disadvantage if consumers rejected labeled products because of their limited access to non-GE seed. In contrast, large companies in the Global Industrialized sector are diversifying their product lines already, in anticipation of mandatory labeling (Lindholm 2014). Many of these companies maintain separate GE and non-GE product lines now for markets in the European Union and some other countries.

Figure 3 shows that companies in the Global Industrial domain are responding to consumer interest in supporting environmental and social values, often by imposing standards on their producers and stocking labeled value-certified goods (e.g., Fair Trade, humanely raised, local, organic) in their retail outlets. They seek certified goods wherever they can be obtained as cheaply and reliably as possible; hence, US supermarkets see an influx of organic produce from Mexico and other developing countries where labor is cheaper than on US organic farms. As competition rises within the Fair Trade domain and between Fair Trade and Global Industrial

supply chains, companies that are not able to remain profitable can no longer stay in business: simply “doing good” is not a winning sales pitch, if price significantly exceeds the prices offered in the Global Industrial domain or product quality is not consistent. This is the rationale behind trend arrows pointing intermediaries and retailers in Quadrant IV toward Quadrant I. Because the Fair Trade domain operates in a global market, consumers do not have direct relationships with producers, thus little sense of loyalty to a specific source other than whatever has been created through branding.

As local production saturates local markets, producers in the Local & Sustainable quadrant may start exploring marketing options beyond direct marketing, such as Internet sales through online farmers' markets or individual websites. This option risks sacrificing customer loyalty, however, because producers cannot maintain direct relationships as well at a distance. Local producers also may try to differentiate themselves from large-scale globalized organic food manufacturers by adopting certification schemes that cover social issues (e.g., labor) or animal welfare, thus moving farther to the right on the multifunctional axis.

The application of knowledge and technology within a food system can counteract inherent vulnerability of supply chains dependent on weather. The privatization of knowledge, global reach and economies of scale give substantial advantages to the Global Industrial domain that can increase its resilience. In addition, enabling policy environments that do not require the internalization of social and environmental costs and lack of regulations give this domain a competitive advantage. However, the long supply chains of a global food system are vulnerable to breakdown, intentional sabotage and human error. The Global Industrial system also is prone to overcomplexity through interconnectedness of key actors, which leads to cascading problems when a key node in the system malfunctions. This occurred in the financial crisis starting in 2008; the concentration of power in the financial sector caused problems that originated in part of the financial industry to cascade through the entire sector, exacerbated by deregulation and poor loan practices that many banks had adopted (Harmon et al. 2010).

The ability of food systems in the Global Industrial domain to source products internationally may help to protect them from breakdowns; i.e., if a flood or drought affects production in one region, a processor or wholesaler can simply source from another region. The vulnerability of long supply chains remains, however, unless sourcing moves much closer to retailing. And with this choice, a food system moves toward the bottom of the food system typology where it may start competing with local producers who have the advantages of direct relationships. While Local & Sustainable food systems (domain IV) have shorter supply chains, sometimes selling food directly to customers from the farm or dock, their advantages can be overcome to some extent by the sourcing power and superior international knowledge of the Global Industrial system. Very few people buy their food only from local farmers. However, when floods or droughts or other catastrophes knock down Local & Sustainable food systems, community support engendered through direct relationships between producers and customers and state funds help them to re-establish as soon as environmental conditions are more favorable.

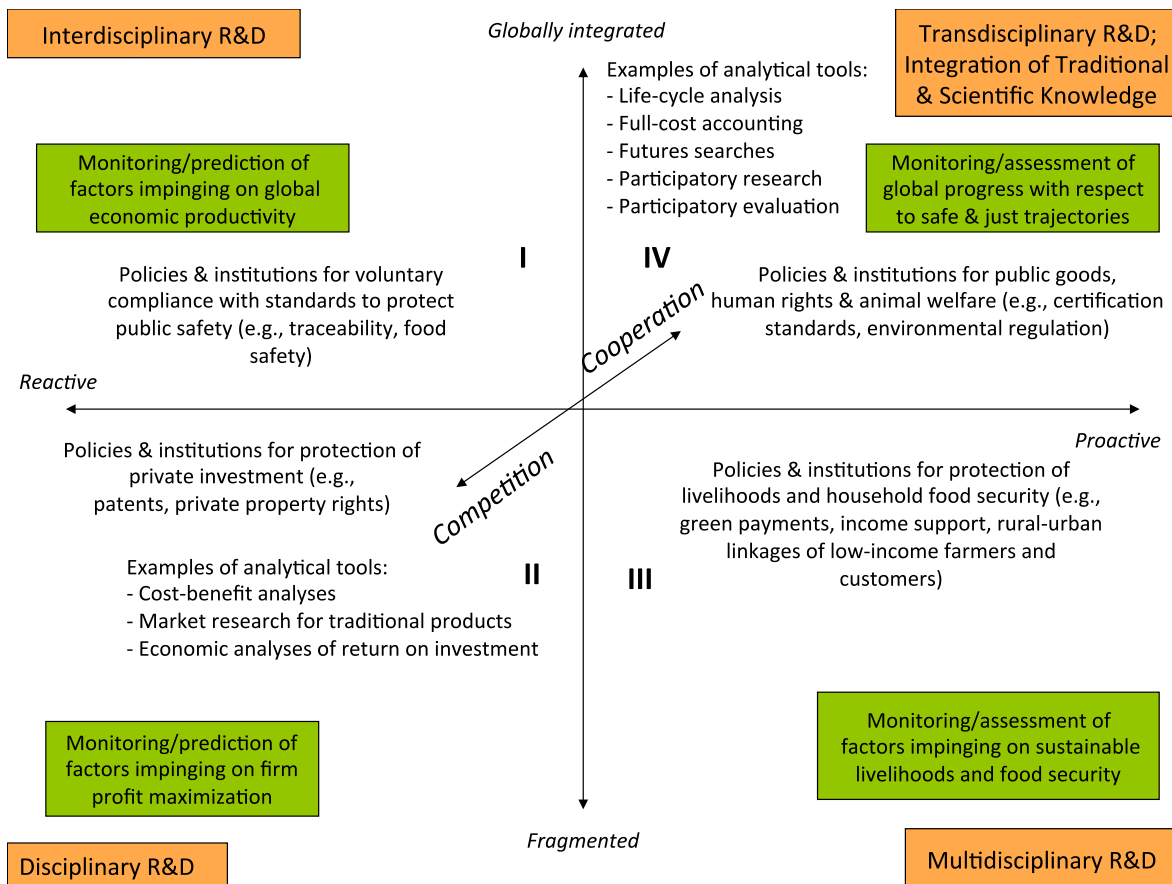
Fair Trade has the advantages of globalized sourcing, yet also values food security and decent work and livelihoods for producers (at least in most variants of triple-bottom-line certification). The need to work with certified producers may restrict availability of some crops (e.g., bananas); but large companies such as Unilever and Whole Foods have been working around this by developing their own social and environmental standards and certifying large numbers of

producers in different regions. It remains to be seen whether the social standards that large publicly owned companies have adopted will encompass living wages for workers in each food system activity. There is an inherent tension between making profits for shareholders and distributing profits more equitably across the food system. Transparency and full-cost accounting are meaningful steps toward greater equity: if customers can see how profits are being distributed, then those who value equity will have the choice of buying from companies that push profits down the line. Companies such as Walmart with a strategy of pushing costs down the line to workers would lose out with greater transparency. Although Walmart demonstrates progressive environmental values and has documented much lower environmental impacts of its practices over the last few years, its track record with regards to respecting and protecting economic and social human rights has been criticized consistently (Epstein 2008).

Use of knowledge relevant to food security within each domain

Knowledge is among the critical factors that trigger movement between domains or allow a given food system to remain within a given domain (see Table 1). Figure 4 depicts different kinds of knowledge and analyses that are most relevant within the four quadrants. The top of the diagram shows integrated knowledge systems, and the top right quadrant shows analytical tools that are comprehensive and draw from multiple sources. The bottom of the diagram shows more fragmented knowledge systems and examples of analytical tools (in the bottom left) that are appropriate to assessing economic performance. Institutional dynamics within each domain encourage certain types of knowledge generation and transmission. The tendency toward increasing cooperation and lessened competition from lower left to upper right applies to both knowledge and the interactions among actors in food systems located in those quadrants. For example, disciplinary knowledge competes for legitimacy against other disciplines unless there are explicit efforts and incentives to blend or merge disciplines.

Fig. 4. Knowledge corresponding to food system domains.



The knowledge of trade networks and global supply, demand and prices allows transnational firms to dominate the Global Industrial domain. This knowledge is often proprietary because accumulating information and monitoring trends in prices, supply and demand that companies can use to adjust their own responses is expensive, and a company needs to gain back its investment. Companies operating in this domain are constantly adjusting their strategies to meet current trends, whether those are environmental issues that relate to long-term supply or social issues that relate to demand for food and other products (see Oosterveer 2012). They need to be versatile and innovative to maintain their positions vis-a-vis other companies. Yet the closed nature of knowledge within this domain operates against resilience; the number of people who can contribute to and edit that knowledge is limited.

Very localized knowledge of supply, demand and customer expectations allows producers to operate successfully within the Local & Sustainable domain; and knowledge of global demand for value-added products is essential for successful operation within the Fair Trade domain. Food systems anywhere on the typology need good information about their customers' needs and must be responsive to those needs: lack of adequate response to changing customer interests, such as resistance to adopting non-GE labels, may be one of the reasons why the Independent Commercial sector is slipping. Companies operating in this part of the typology space are producing undifferentiated commodity crops (corn, soybeans, beef, etc.) rather than products such as organic corn or grass-fed, hormone-free and antibiotic-free beef. Customers are willing to pay more for these "specialty" products (Curtis et al. 2012), but not willing to pay for undifferentiated commodities just because a farmer is operating outside the transnational

corporate system. These farmers are growing too much of the wrong things to participate in direct markets, but they are closed out of vertically integrated markets. Yet the costs to producers and intermediaries in the Independent Commercial domain are higher, because they do not have the same economies of scale as integrators within Global Industrial food systems.

Selling to large-scale public institutions (such as the school system for a city) is one of the few markets that seems to be growing for Independent Commercial growers, and providing healthy food through this venue is a promising strategy for enhancing food security internationally (Ashe and Sonnino 2012). In the US, the non-governmental organization School Food FOCUS has led the way in connecting such growers with school systems. The missing link that School Food FOCUS provides is often knowledge about what products and quality specifications farmers must provide to meet schools' needs; that is, it functions in the supply chain as a nonprofit knowledge broker. Another organization, Red Tomato, plays a similar role for medium-scale independent fruit growers in the Northeastern states. Red Tomato specializes in brokering contracts between the growers and small- to medium scale retailers. This service and the education needed to maintain it requires additional funding beyond the profits that can be realized within the supply chain itself. Red Tomato is not organized as a cooperative, but it encourages growers to work together cooperatively. Its Eco-labeled products position it to the right of School Food FOCUS, although practitioners in the latter organization are increasingly interested in public health benefits, according to its staff. Both organizations provide excellent examples of social learning: as their participants became more comfortable working together and realized the power that they wield over markets and impacts through their choices, they moved further toward realizing greater multifunctional benefits.

Cooperatives are another form of marketing and retailing, now common in the Fair Trade domain, which could help growers within the Independent Commercial domain to survive. Practitioners in these food systems would need to learn skills of greater cooperation to realize the benefits of cooperative marketing and retailing, however. Food hubs bear some similarities to cooperatives, although they are not necessarily incorporated in this way. They usually integrate products across several farms, sometimes also sharing access to equipment or services such as packing and marketing. Food hubs are a fairly new innovation in supply chains, and their impacts on food insecurity remain to be seen. They will not result in greater access to healthy food for disadvantaged customers unless this is an explicit goal; if the goal is simply improved marketing options for producers, there is no incentive to implement innovations that will help reach disadvantaged customers.

There are many connections between the knowledge attributes of food system domains on the right side of Figure 4 and the attributes of resilient knowledge in Table 2: toward the bottom right, knowledge is locally produced and embedded in the local context. Where knowledge is generated on-farm and disseminated through farm demonstrations or field days, it is testable, adaptable, shared, and often coordinated with knowledge being produced and used on other farms. Knowledge produced in the upper right domain is likewise often coordinated with knowledge being produced and used in other sites. It is based on evidence from multiple sources, and it tends to be more transparent and more likely to be open-source. Food systems that are concerned with multifunctionality will pay more attention to the full scope of their impacts and seek to strengthen feedback loops that provide this information.

The reformed Committee on World Food Security: resilient knowledge in action

The CFS is an intriguing model of a new governance framework for promoting food security resilience. The Civil Society Mechanism (CSM) has focal points in 17 sub-regions of the world and 11 constituencies: farmers, fisherfolk, herders/pastoralists, landless people, consumers, urban poor, agricultural workers, women, youth, indigenous people and non-governmental organizations (NGOs). The Coordinating Committee of the CSM has 4 focal points from smallholder family farmer organizations to reflect their importance, 2 from each of the other constituencies, and 1 from each sub-region (CSM 2014). La Via Campesina plays an important role as a transnational network of farmers' organizations that has pushed for food sovereignty as the counterweight to globalization. The right to food is recognized as the first principle of food sovereignty. La Via Campesina helped to establish the International Planning Committee (IPC) for Food Sovereignty, consisting of nearly 50 peoples' networks and NGOs linked to at least 800 organizations. The IPC supported the CFS reform, and brought its structured and well-organized constituency to the CSM (De Schutter 2013). Social learning from the established IPC network to the CFS facilitated creation of the effective CSM structure.

The 2009 reform was designed to create "the foremost inclusive international and intergovernmental platform for a broad range of committed stakeholders to work together in a coordinated manner and in support of country-led processes towards the elimination of hunger and ensuring food security and nutrition for all human beings" (Food and Agriculture Organization 2009, paragraph 4). It was an effort by some actors to overcome international policy fragmentation and the lack of coherence between human rights and various international policy regimes, such as labor, trade and health. The CFS has not been able to completely integrate these policy regimes, although the World Trade Organization, the World Health Organization, and the United Nations Environment Programme all hold seats in the CFS. Yet they are in no way accountable to the CFS, even when their work affects or closely intersects with food security; and some governments (particularly the US) have blocked discussion within the CFS of trade-related or nutrition-related issues.

Civil society participation is especially important to the CFS, because civil society historically plays the "watch-dog" role of monitoring governmental decisions and incorporates those who are on the "front line" of coping with social and environmental problems. CSM participation in the CFS creates both a check on the power of intergovernmental decision-making, and a bottom-up perspective from people who suffer from food insecurity and violations or abuses of their right to food. This significantly enhances the credibility of the CFS as an open platform for collaborative action. In addition, this multi-scale aspect of the CFS (from local to global and ensuring that food insecure people can speak directly to those responsible for food system governance) tightens feedback loops, as resilient knowledge requires.

Collective learning about best practices from local experience including indigenous and traditional knowledge and national and regional levels, in addition to expert advice and opinions, is one of the goals of the CFS (Gitz and Meybeck 2013). To make sure that decisions are based on solid evidence, the CFS established a High Level Panel of Experts (HLPE). The HLPE was designed so that its composition, functions and the sources of knowledge used in reports ensure that politically charged views of causes of food insecurity, and how to achieve food security and nutrition, have a solid evidence base and integrate different kinds of knowledge from local to global scales (Gitz and Meybeck 2013). Thus, the HLPE's structure and mandate matches the

following characteristics of resilient knowledge in Table 2: it is shared and collaboratively produced, it is transparent, and it is based on evidence from multiple sources rather than ideology or assumptions.

The CFS is supposed to develop strategies and action plans that allocate responsibilities across actors, and develop indicators of accountability. Having civil society participation in all Working Groups and workstreams of the CFS ensures that local voices and people who experience food insecurity are part of these action plans. The outcomes of policy roundtables and negotiations of the CFS are recorded in updated versions of the Global Strategic Framework for Food Security and Nutrition, which provides a transparent reference which may help ensure that subsequent decisions do not undermine earlier decisions.

Another explicit goal of the CFS is an innovative monitoring mechanism to assess whether its decisions and recommendations are being followed, and the consequent impacts on food security and nutrition. Monitoring will allow feedback loops between trends in food insecurity and programs or policies at local, regional and global scales. The CSM has proposed that monitoring be implemented in the same multi-actor mode that characterizes the CFS itself, which would allow direct input from social movements representing people suffering from food insecurity through the CSM, thus allowing greater accountability as well as better feedback.

In addition to meeting the characteristics of resilient knowledge, the CFS is aligned with many of the factors that have been suggested to increase resilience in social-ecological systems (Table 1). Its focus on learning, through the HLPE and sharing best practices, helps people to learn to live with change and uncertainty. Its multi-actor structure nurtures diversity for reorganization and renewal. It combines different kinds of knowledge, both in the decision in setting up the HLPE to include traditional and indigenous knowledge as well as "expert" scientific knowledge and through interventions to discussions and side-events made by members of the CSM. And it creates opportunities for self-organization, by allowing the CSM and the Private Sector Mechanism (PSM) to decide on their appropriate internal structures and functioning. Conflict management mechanisms are built in, to some extent, by allowing voice to different kinds of participants (i.e., member governments, international financial institutions, UN agencies dealing with issues related to food and nutrition, the CSM and PSM). Although conflicts still occur, no voice is silenced.

The reformed CFS uses and generates resilient knowledge, in the sense that it is defined in this paper. Members of the CSM, in particular, are generating new kinds of knowledge through new forms, such as the "peasant universities" that La Via Campesina has set up in several locations to teach agroecology and food sovereignty. Localized knowledge and knowledge from multiple sources is brought to bear on food system issues in the CFS, with the aim of cooperation and collaboration in developing strategies and action plans. The HLPE assembles the best possible evidence on selected issues; and, once the innovative monitoring mechanism is established, recommendations of the CFS will be monitored to ensure that they are achieving their aims. The idea is that recommendations will be revisited, if there is a discrepancy between aims and results.

The CFS has raised hopes among many observers of decades of unfulfilled commitments to end world hunger. While it is all too easy to become cynical and jaded about these promises, the CFS has checks and balances written into its structure, composition and functions that are intended to prevent it being co-opted by private interests or agencies that are not protecting public goods.

Many of the corporations in the PSM and participants in "public-private partnerships" between governments and the private sector are squarely in the Global Industrial domain of the food system typology presented in this paper. But the producers who feed most people in most of the member countries of the CFS are in the Local & Sustainable domain. Although actors in the Global Industrial domain dominate the US media and much of the rhetoric from the US government about "how to feed the world", at least 70% of global food production is by small-scale producers and only 15% is traded through transnational supply chains (etcGroup 2009). The CFS structure allows the small-scale producers who are in fact feeding the world to speak for themselves and argue for actions that will enhance their quality of life and ability to achieve the right to food.

Food systems in the other two domains, the Independent Commercial and Fair Trade, are less visible in the CFS. The absence of the Independent Commercial producers is understandable, as they are much less likely than Global Industrial food systems to operate at the global level. Fair Trade food systems might realize advantages by participating in the CFS, but they are not doing so yet. The primary tension in the CFS is between the Global Industrial food systems, which are defending their use of resources to create global supply chains, and the Local & Sustainable food systems, which are defending their rights (to land, seeds, food, etc.) against encroachment by the Global Industrial domain. These two domains have staked out special claims with respect to food security, with Global Industrial representatives asserting that they are essential to provide food for all, and Local & Sustainable representatives asserting that they want freedom to provide their own food.

The private sector is not responsible for, nor best equipped to be, the main actors accountable for food security. Its actions can either impede or enhance food security; so governments have the responsibility to regulate them so that they consistently further access to healthy food for more people. The obligations of government are clarified in the 2011 Maastricht Principles on The Extraterritorial Obligations of States in the area of Economic, Social and Cultural Rights. Public-private partnerships are one of the most common operational mechanisms for international interventions aimed at improving food security and resilience, supported by powerful States and philanthropic organizations. While the private sector has access to far greater funds than the public sector, its role in partnerships for the public good must be carefully limited so that the partnership does not become an avenue primarily to enhance markets and profitability for the minority of food supply actors who are in the Global Industrial domain (Kraak et al. 2011).

States have responsibilities through international human rights agreements and conventions to set up safeguards for investment practices to protect relatively powerless people, protect ecosystem goods and services necessary for food production, and provide social protection "safety nets". They are also responsible for setting up transparent and well-functioning markets that overcome various market failures, and ensuring fair and transparent transactions related to the assets and entitlements of poor people. All of these responsibilities affect food security and are thus in the purview of the CFS. Yet the extent to which member countries allow them to be debated depends to a large extent on the political power of corporations operating in the Global Industrial domain within that country. Notably, the US has attempted to shut down debates on many of these issues within the CFS; the growing influence of transnational corporations on the US government may well be the reason that US delegates are uncomfortable discussing issues that might lead to recommendations restricting their actions. This also may be the reason that no mechanism comparable to the CFS, with full participation by social movements and NGOs, exists

in the US. Yet the efforts to promote resilience and to end hunger in the US, largely spearheaded by civil society, would benefit tremendously from the open debate and decision-making that the CFS embodies. Solutions to food insecurity will not be resilient if they privilege input from the wealthiest and most powerful sectors of society.

Despite considerable optimism, the CFS is still struggling for full recognition as the foremost international and intergovernmental platform for negotiation of food security and nutrition issues. New alliances and organizations that compete for parts of this space are springing up constantly or continuing from an earlier era without rolling under CFS oversight (e.g., the Global Alliance for the Future of Food, the New Alliance for Food Security and Nutrition, Scaling Up Nutrition, the Global Agriculture & Food Security Program). The G20 (the 20 most powerful global economies) exerts a chilling effect on discussion of policy alternatives within the CFS (Clapp and Murphy 2013). The findings in the reports of the HLPE are not always given the attention they deserve, such as in debates about the role of biofuels in competing with food crops that occurred at the CFS meeting in October, 2013. An innovative monitoring mechanism that incorporates human rights monitoring has not yet been set up, although it was agreed to in 2009. The behind-the-scenes power brokering between corporate interests and wealthy (as well as poor but strategic) countries continues, despite commitments to shared discussion and negotiation. While billions of dollars have been mobilized to fight hunger since 2009, one West African farmer leader noted in 2011 that “more than half of the peasant families in the majority of our countries do not have access to money to buy a plough, a couple of oxen, a cart, or a donkey” (Coulibaly, quoted in Duncan and Barling 2012, pg. 157). The CSM has internal tensions between social movements representing food-insecure people and large international NGOs, although there is widespread recognition that voices of those who are most affected by food insecurity must be heard in the CFS.

The CFS reform is still a “work in progress”. But even in its incomplete state, the CSM is a significant model for engaging social movements in international action, linking local to global concerns, and challenging the logic of neoliberalism that holds sway over global efforts to address food insecurity (Duncan and Barling 2012). According to Olivier De Schutter, the United Nations Special Rapporteur on the Right to Food between 2008 and 2014, the CFS reform is “perhaps the single most significant development in the area of global food security in recent years” (De Schutter 2013, pg. 219). Much of the hope behind the CFS is due to its potential, as currently structured, to bring resilient knowledge to food security debates.

Conclusion

Open political and economic institutions foster peace and prosperity, and they are important means of acquiring global power (Acemoglu and Robinson 2012). The CFS is the foremost institution for global food system governance, and it is characterized in its current structure and function by openness, diversity, a focus on learning, and multi-level interaction and communication. For food systems knowledge to more effectively contribute to food security resilience, greater public investment in public goods and public institutions that provide them is needed, including funding for the generation and dissemination of resilient food systems knowledge. That is, public investment should be skewed toward the right-hand side of the food system typology presented in this paper (Figure 1), to ensure multifunctional outcomes from food systems, including food security for all.

A shift from brittle to more resilient food system knowledge is needed to ensure food security resilience. This will entail shifting how knowledge is generated in institutions of higher education, laboratory research and field trials to be more responsive to the needs of food-insecure people. It will entail greater transparency of knowledge and open access, such as by eliminating patents on staple foods needed for food security and allowing open-source platforms for dissemination of food system knowledge. Proprietary knowledge is a prerogative of the private sector, but information about trends and issues relevant to ensuring food security must remain accessible to the public.

Shifting toward more resilient knowledge will mean seeking how to use knowledge in all of its stages, from generation through adaptation and use, in ways that empower food-insecure people. The aims of food sovereignty are consistent with local and community empowerment and capacity building to encourage adoption of more resilient agricultural and fishing knowledge and practices. Actors within the CSM who advocate for food sovereignty, such as La Via Campesina and the IPC, are therefore especially important in encouraging this shift.

The transition toward more resilient and food secure food systems is vital. The interests of many actors in the Global Industrial domain are served quite well by current political and economic institutions; for them, profits are accruing steadily. However, continued high rates of food insecurity and malnutrition, degradation of resources needed for food production, and the failure of nations to end hunger and malnutrition, despite years of commitments and investment, show that multifunctional goals are not being met well enough. Meeting these goals will serve all of humanity, including people who are benefiting from current food systems and the power they hold in them, since continued inequity in access to healthy food elicits moral outrage, political instability, rising national and international conflict, and higher costs in the long term from combatting disasters than would be incurred by preventing food insecurity.

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¹ Diagrams depicted in Figures 2 and 3 were developed in 2007 by the author, who served as a Coordinating Lead Author on the IAASTD's North America/Europe IAASTD Report, in collaboration with Les Firbank, the other Coordinating Lead Author of Chapter One. While they guided our thinking in the IAASTD and our contributions (Anderson et al. 2009), they did not become part of the final reports.