Principles of Resilience Measurement for Food Insecurity:

Metrics, Mechanisms, and Implementation Issues

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The move towards resilience thinking and programming marks a collective recognition of the need for an urgent and fundamental change in all our work … [The concept of resilience] recognises that current approaches to managing risks in development planning, peace-building and humanitarian response are disjointed and that better cross-sectorial collaboration is required on analysis, planning, and implementing support for resilience-building (Interagency Resilience Working Group, 2012, p. 2)

It is now broadly accepted that the array of shocks that threaten the well-being of vulnerable populations has become more frequent and more pronounced as the stability of systems (e.g., climate, political, economic) that define vital features of everyday life have become less stable. Although shocks and stressors can be observed in both developed and in developing countries, those who reside in less developed settings are subject to more severe and more frequent set-backs emanating from both idiosyncratic shocks, such as protracted illnesses, loss of a family members, community unrest) and from covariate such as catastrophic weather events, crop failures, and price declines in commodity export markets (see Collier & Goderis, 2009; Kozul-Wright, 2010). The effort to identify the most effective strategies to minimize both short and long term impact of shocks and stressors is important because such strategies can dampen and/or reverse the effects of shocks and help affected parties recover from degraded conditions. In far too many cases, however, the improved status of affected populations after they have received aid often fragile and there exists a strong a likelihood that all or large fraction of affected populations will return to conditions that existed prior to aid.

Although resilience has long been a topic of interest in the field of (e.g., Folke, 2006; Gunderson and Hollings, 2002; Hollings, 1973, 1996) inclusion of the term *resilience* in international development policy discussions has only recently become popular. Resilience is a compelling concept for development because it implies a capacity to reduce, transfer, cope with and/or adapt to an array of recurrent environmental hazards, economic shocks, health risks, and political instabilities that regularly undermine efforts to generate durable solutions to chronic poverty. Resilience offers the promise of helping individuals, households, and other units such as communities, regions, bounce back from the negative effects of adverse shocks and stressors. Resilience thus represents a positive capacity, one which that does not just protect people from adverse effects

The rapid and widespread embrace of the resilience concept, both by the development assistance community and by the humanitarian aid community, suggests that many now see resilience as one of the key solutions to poverty and food insecurity. There a large and growing number of funded projects, working groups, position papers focused on resilience. While there is some skepticism about the use of resilience to address problems of food insecurity problems (see Bene et al., 2012), enthusiasm for using resilience as organizing concept continues. Whenever one witnesses the proliferation of programs, policies, and promises made in connection with a new concept, questions about the wisdom of re-directing attention and resources should be raised. Is the broad application of the concept justified? Does the use of the new concept indicate a substantive change in how a given problem is framed or is it simply a change in vocabulary? Is the redirecting of attention and resources in the direction of the new concept productive? Is resilience merely a rhetorical device that, at least for now, serves as an effective tool for attracting attention to longstanding, seemingly intractable problems of development? At the moment, there may not be a high degree of consensus about how to answer these questions. If, however, we take seriously the views expressed by Interagency Working Group on Resilience noted above, a good deal of work needs to done to move discussions of resilience onto firm ground.

If resilience is to emerge as a coherent and durable policy objective upon which programs may be based and against which progress may be measured, we must develop a clear a set of metrics to determine the extent to which a given intervention has succeeded. Focusing attention on building measures to identify empirical properties of ex ante and ex post properties of resilience will sharpen our focus and us allow to track progress. Without a foundation of empirical evidence the concept of resilience cannot be tested and will likely be replaced by another concept at some point in the future. The main benefit of focusing on measurement of resilience for food insecurity is that it creates an opportunity to accumulate data over time, across programs and settings.

Although a large number of white papers and policy statements have been published and initiatives funded, there is a very limited amount of work that offers guidance and/or provides empirical examples on how to measure resilience for poverty and food security. To wit, Vaitla et al (2012, p. 5) recently observed that “academics and practitioners have yet to achieve a consensus on how to measure resilience.” The most detailed conceptual and empirical work on resilience measurement for poverty and food security has been carried out by Alinovi et al. (2010), Frankenberger, et al. (2012), Pingali et al. (2005), Vaitla et al., (2010) There is also a small body of work in child development and nutrition (Engle, et al., 1996). To contribute to the effort to develop measures of resilience for food security, the present paper describes principles that might be used as a framework to guide the development of indicators and the specification of analytical approaches. The paper is organized into four sections. Recognizing that all measures are based on a set of theoretical assumptions about the dynamics of what is being assessed, we begin by outlining a theory of resilience for poverty and food insecurity. Second, we highlight key elements of that theory and explore how they might influence the ways in which we collect and analyze data on resilience related to food insecurity. In the third section of the paper, we also describe how the use of focused case studies can be used to uncover some of the causal mechanisms that can explain variations in resilience. In the final section of the paper, we offer some suggestions about how a program of work for building resilience measures, with both common indicators and context-specific indicators, focused and implemented structured.

**Theoretical Foundation: Resilience Related to Poverty and Food Insecurity**

Our conception resilience related to poverty and food security is as follows:

*Resilience represents the likelihood over time of a person, household or other unit being non-poor and food secure in the face of various stressors and in the wake of myriad shocks. If and only if that likelihood is and remains high, then the unit is resilient.*

This conceptualization focuses tightly on human standards of living, most simplistically broken into discrete categories: poor or non-poor and food secure or food insecure. Furthermore, it recognizes the central role of background risk (‘stressors’) of all sorts and that sometimes risk turns into adverse events (‘shocks’) that can catastrophically change the course of lives. Finally, it emphasizes the time path of standards of living. The normative implication of this conceptualization is that one wants to prioritize avoidance of and escape from chronic poverty and food insecurity and to minimize within the population and over time any experience of low standards of living. Thus conceptualized, resilience emphasizes the qualitative difference between temporary setbacks from which people recover and those that cast people permanently into penury. Uninsured risk exposure is a central cause of chronic poverty (Hulme and Shepherd 2003, Dercon 2005, Carter and Barrett 2006, Krishna 2010) and therefore a condition that undermines resilience thus defined.

**Figure 1: Nonlinear expected well-being dynamics with multiple stable states** Employing that common apparatus of dynamical systems, one potentially useful way to conceptualize resilience for poverty and food security is depicted in the heuristic in Figure 1. In this sort of abstract representation of system dynamics, today’s state – in this case, capabilities - appears on the horizontal axis and tomorrow’s expected capabilities on the vertical axis. The dashed diagonal line represents points where the standard of living is expected not to change over time (so-called dynamic equilibria or stable states). As drawn, the system exhibits three stable states: one is death, the second is a poor standard of living and food insecurity, the third is a non-poor standard of living and food security.

random dynamic

ideal dynamic

variation

threshold point

**T2**

**T1**

**E[future] capabilities**

**Death**

**Non-poor food secure zone**

**Chronic poverty food insecure zone**

**Humanitarian emergency zone**

**Current capabilities**

Using the dynamics illustrated in Figure 1, we highlight five features of resilience that may inform the development of resilience measures for food security.

*Critical thresholds*

The foundational ecology literature (e.g., Folke, 2006; Gunderson and Holling, 2002; Holling 1973, 1996) highlights the importance of thresholds and explains how crossing thresholds can produce cascade effects (Kinzig et al., 2012) where a the value of a single variable (e.g., health) moving below a critical thresholds can cause broad collapse among other sets of variables (e.g., livelihoods, asset stocks, food security) . Figure one illustrates critical thresholds (black boxes ) that separate the basins of attraction for three distinct zones: (i) a humanitarian emergency zone within which populations are collapsing toward death, (ii) a chronic poverty/food insecure zone within which people recover from shocks – of both the adverse and favorable sorts – to a stable but low quality standard of living manifest in meager capabilities, and (iii) a non-poor/food secure zone within which people likewise are expected to recover from non-catastrophic shocks. We can readily order these zones: people prefer (iii) relative to the other two, and in (ii) rather than (i). Anyone in either zones (i) or (ii) is dynamically poor (Carter and Barrett 2006).

*Initial conditions and state dependence*

Well-being dynamics, including how units respond to stressors or shocks, depends on their initial conditions, consistent with a vast literature on poverty dynamics (Barrett and Carter 2012). So one must allow for state-dependence use non-static measures. The likelihood of being or becoming poor must be estimated or inferred with reference to the initial condition of the individual(s). This brings a three-way dynamic interaction into focus: among some set of measured initial conditions that describe the household or other unit, the shocks/stressors experienced by that unit, and observed responses. Any one element of the interaction and the combined effect may be important for predicting resilience. Given the theory’s focus on the likelihood of being or becoming poor, measures of development resilience require a temporal dimension. In particular, they must be forward-, rather than backward-looking, and should encompass direction(s) and rate(s) of change in measures so as to distinguish among upward, downward, or oscillatory movements (Carter and Barrett 2006, Carter and Ikegami 2007).

*Stability and productive disruption*

In their work on resilience, Alinovi et al (2010, p. 4) pointed out “..that focus of the analysis of complex adaptive systems should b be less on the study of steady-state or near equilibrium states, and more on the conditions that ensure maintenance of system functions in the face of stress and shock…”The framing of resilience we offer underscores that stability is not equivalent to resilience, although much current discourse would seem to suggest such equivalence.[[1]](#footnote-1) Indeed, stability is neither necessary nor sufficient for resilience. The possibility of a stable but miserable existence within the chronic poverty-food insecure zone illustrates that stability is not sufficient; the possibility of *productive disruption* that necessarily entails instability to shift states demonstrates that stability is not even necessary. For the current poor, those who presently occupy the humanitarian emergency or chronic poverty zones, the objective is not maintenance of the present state but rather *productive disruption*. This relates loosely to the ‘transformability’ property of ecological resilience thinking (Walker et al. 2004). The point is that disruptions can serve a constructive goal. It is not desirable to extinguish risk from systems for the fundamental reason that all change requires disruption that is inherently risky. Rather, we want to encourage sustainable accumulation – and discourage divestiture of – productive human, natural, physical and social capital – what Arrow et al. (2012) term ‘comprehensive wealth’ – as well as efficiency-enhancing innovation.

*Multi-system-multi-level interactions*

As the ecologists have demonstrated, the concept of resilience makes most sense when nested within a systems framework that highlights the reciprocal causality among different variables and the underlying complexity of dynamics. The poor operate within complex socio-ecological systems with multi-scalar feedback (Barrett and Swallow 2006, Folke 2006). For example, when poor farmers find it optimal to harvest soil nutrients without investing in replenishing them through inorganic or organic fertilizer application, the resulting decline of the soil state reinforces farmer behaviors, thereby exacerbating within-village inequality by differentiating poorer farmers eschewing ‘modern’ inputs from their better-off neighbors who find it feasible and profitable to invest in maintaining their soils (Marenya and Barrett 2009, Stephens et al. 2012).

*Stochastic functions*

The concept of ecological resilience is one of the main foundations upon which efforts to leverage the concept of resilience for development have been based. It is worth noting that ecological resilience bears striking resemblance to that of stochastic poverty traps on which we build (Azariadis and Stachurski 2005, Carter and Barrett 2006, Barrett and Carter 2012). As Barrett, Travis and Dasgupta. (2011) explain, both ecological theorists working on resilience and economists studying poverty traps use similar frameworks that draw on basic concepts from the mathematics of dynamical systems. The evolution of one or more key state variables – e.g., some poverty indicator(s) – follows some stochastic and potentially highly nonlinear law of motion that results in multiple attractors – stable states – and tipping points that lead to discernible shifts in behavior and performance.

**Resilience Measurement Related to Food Insecurity**

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (WFP, 1996)

One of the challenges in developing measures of resilience for food security is that the measurement of food security itself is not a settled issue. In a recent IFPRI discussion paper, Headey and Ecker (2012, p.1 ), for example, noted that “ . .the bewildering proliferation of food security indicators in recent years has provided greater variety but little consensus and insufficient coordination among different agencies.” On a more technical level, they also asserted that “..much of the existing research on food security indicators that we review often falls far short …in terms of providing any rigorous assessment of the statistical properties of the indicators” (Headey and Ecker, 2012, p. 2). The prospects of developing a clear, agreed upon measure of resilience for food security seem dim when one considers further that little consensus exists around notion of resilience. While two negatives produce a positive in algebra, it is unlikely that two ambiguities will produce a clarification.

To move forward, we simply accept FAO’s four components of food security (availability, access, utilization, and stability) as a point of substantive departure (FAO. 2009). Using these four components as a starting point, our strategy for offering resilience measurement principles for food security principles is presented in three sections. First, drawing on the discussion of resilience theory offered above, we use the five core features of resilience to articulate broadly applicable measurement principles. We then ask how each of four components of food security measurement might be adapted to meet the needs of a resilience measurement for food security. Second, we then describe what we see as standard measures of resilience and offer a modest proposal to guide attempts to develop resilience measures that are sensitive to contextual variation found as one from one country to another and, in some cases, from one region within a country to another region. Third, we describe how focused qualitative case studies may be used to take a closer look at the causal mechanisms account for various outcomes.

*Resilience Measurement Principles Related to Food Insecurity*

For the purpose of specifying measurement principles for resilience related to food security, we identify five theoretically based claims based on longstanding ecological literature on resilience (see Folke, 2006; Gunderson and Hollings, 2002; Hollings, 1973, 1996) and on the more center development economics literature on poverty traps (Azariadis and Stachurski 2005; Barrett, Travis and Dasgupta, 2011). The five principles of resilience that we believe should inform the development of resilience measures for food insecurity are:

**1. Initial condition and intertemporal variation** - initial conditions of poverty and food security for a given unit (individual, household, community) should be measured as dynamic conditions rather than as a static conditions. Measurements of poverty and food security should be sensitive to intertemporal variation and should administered at high frequencies and reflect the speed at which key variables are expected to change.

**2. Critical thresholds and tipping points** – The boundaries that separate food secure from food insecure should be identified. Measurement efforts should focus on and attempt to explain both negative instances (downward paths) and positive instances (upward progressions that illustrate mobility across boundary points.

**3. Instability and disruption** – Instability should be viewed and measured as an objective condition, one which may produce positive or negative outcomes for food security

**4. Multisystem, multi-level -** Interdependencies between levels at which system function should be identified and measured

**5. Stochastic functions** - The factors that predict resilience may, at various times, be governed by and or contain stochastic elements characterized by high degrees of inherent randomness. The analytical tools used to analyze data from resilience measures should

**Building and Inventory of Resilience Metrics: Standard and Context-Specific Metrics**

Two set of metrics need to specified for a measure of resilience related to food insecurity. A standard set will be specified at a level of generality that they will permit their use across varied interventions delivered across national setting. A context-specific set will be tailored to meet the needs of the different setting and reflect specific features of a programs that is being evaluated. The development of standard metrics will allow us to develop a common core data set so that data be aggregated and analyzed across sites over time. Context specific measures will facilitate the local interpretation of

*Standard metrics and application of resilience measurement principles. (incomplete)*

Using a simple logic of resilience, standard measures are organized into three main categories. *Basic condition measures* include a broad set of indicators that represent and affect household food insecurity. *Disturbance measures* include indicators related to both covariate and idiosyncratic shocks and stressors. *Response measures* include the typical set of mitigation strategies, coping strategies, and adaption strategies. A fourth measurement category related to programmatic examines the selection of programs in place, for a given setting, at a given point in time. *Programmatic content* measures, which do no need to be considered in terms of resilience focus on the programmatic focus, the programmatic convergence/divergence

Table 1.

|  |
| --- |
| **Standard Measures for Estimating Food Security Resilience** |
| **Sample of Proposed****Standard Metrics** | **Application of Resilience** **Measurement Principles** |
| **Basic Condition Measures** |
| Food security index | High frequency; intertemporal; dynamic; sensitive to threshold ; conditions measured at multiple levels –from households, to communities, to villages, to districts…. |
| Assets index |
| Social capital index |
| Access to services index |
| Ecological |
| Health  |
| **Disturbance Measures** |
| Covariate shocks and stressors | High frequency, intertemporal, dynamic, existence and effects of shocks measured at multiple levels –from households, to communities, to villages, to districts…. |
| Idiosyncratic shocks and stressors |
| **Response Measures** |
| Mitigation (ex ante, but included) | Responses measured at multiple levels, across the systems that affect food security, return time, as an indicator |
| Coping |
| Adaptation |

*Context-specific metrics (incomplete)*

* Localized socio-cultural practices and effects
* Localized ecological challenges and effects
* Localized meteorological history and effects
* Current political conditions and effects
* Political legacy and effects

**Focused Case Studies for Causal Mechanism (incomplete)**

Given some configuration of services, one can imagine a range of resilience impacts for food security (RIFS). For simplicity, let us assume that the distribution of RIsFS at a given point could be separated into those that are resilient and those that not resilient. If RIsFS for given set of intervention were placed on a distribution, resilient the Let us also assume that for any given set of observed RIsFS the conditions to achieve resilience were either in place or not. The simplistic rendering is useful because it allows to identify three types of case studies, each of which answers a particular question about response heterogeneity: 1. Positive deviance case studies - Why do some households exhibit food security resilience when most do not? 2. Negative deviance studies – Why are some households unable to achieve resilience most do? 3. Differential effects case studies – How do specific program elements and conditions produce varied outcomes? Table 2 provides and simplified illustration of where these three types of case studies are locaed in a two by two framework.

Table 2. 2 X 2 matrix to guide case study selection



Response heterogeneity presents both a puzzle and opportunity in impact studies. Even in instances when an intervention may be regarded as a success, a large –but statistically insignificant - number of households may not fare well. Conversely, it is possible for a large number of households to fare well when an intervention may be regarded as not having produced the hoped for impacts. This variation around dominant response patterns is useful because it allows one to pose causal questions that may be investigated through detailed case studies. As a quantitative analysis task, this can be pursued through a special kind of sub-group analysis –one where groups are constituted according to relative degrees of success experienced under some set of conditions and re-modeled using a different set of variables. When the quantitative analysis is supplemented by detailed qualitative studies, one may gain a more complete understanding of how local conditions either facilitate or interfere with a planned set of interventions.

**Implementation Plans: Building the Capacity to Measure Resilience for Food Security**

The decision to advance a coherent, well-coordinated plan of work that will produce measures of resilience related to food security must be supported by a comprehensive effort. Building on some of strategies discussed in earlier parts of our paper, we identify and briefly describe six initiatives:

**1. Common metrics initiative –** Determine what indicators, for what types of food security outcomes, across national settings should be included in a common core data set that measures resilience related to food security.

**2. Contextualized metrics initiative –** Develop a protocol to support efforts to identify metrics related to resilience for food security that take national conditions and local conditions into account

**3. Data mining initiative -** review existing measures for resilience-oriented data and build/test scales for multi-level/system measures to produce cross-agency data capability. A small sample of extant measures to review includes:

* + Food Insecurity and vulnerability mapping system (FIVIM)
	+ State of Food Insecurity in the World (SOFI)
	+ Global Information and Early Warning System (GIEWS)
	+ Integrated Food Supply Assessment Missions (IPC)
	+ Country statistical information (CountrySTAT)
	+ Household Budget Survey (HBS)
	+ Comprehensive and Food Sec Measures (CFSVA)
	+ Emergency Food Sec Analyis (EFSA)
	+ FAO/WFP Crop and Food Sec Assessment (CFSA)
	+ Famine Early Warning System (FEWSNET)

Consistent with the aims of development, resilience demand a cross disciplinary, multi-agency approach. In addition to the above food-security-focused measures, data sources such as those produced by WMO and UNEP, for example, will also need to be part of a data mining initiative.

**4. New indicators initiative-** identify opportunities to add new indicators focused on resilience within existing scales and/or establish new data collection tools focused on resilience.

**5. Case Studies Initiative** - Explore idea of launching case studies to identify the specific conditions that account for varying degrees of resilience observed in connection with certain conditions ---defined in terms of programmatic features and local conditions.

**6. Resilience Data Base Initiative** – Explore idea of building a cross-national data base to compile, consolidate, and track data elements important for resilience. This initiative would support data aggregation and more advanced analysis (e.g., meta-analysis), particularly if combined an effort to influence the design of impact evaluations.

**Conclusion**

Growing interest in resilience provides the development community with a wonderful opportunity to cross boundaries and integrate programs of work in the interest of the poor and the food insecure. While a number of strategies may be used to help refine the resilience agenda for food security, measurement directs attention to the empirical qualities of the resilience concept. One could argue that the immediate value and the long term utility of resilience for food security can only be determined if we have reliable and valid measures that will allow us to generate empirical evidence need to judge the effectiveness of resilience interventions. In an effort to help advance the measurement of resilience for food security, the present paper offered theoretically-based set of measurement principles and outlined a set of broader measurement-related initiatives.

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1. The canonical ecology literature built on Holling (1973) likewise expressly differentiates resilience from stability. The concept of stability is closely aligned with maintenance of equilibrium. Holling and those who have built on his insights emphasize the ubiquity of disequilibrium and the inevitability of change. The point of resilience in ecological systems, they argue is adaptability to change so as to maintain the core relationships among system components, often summarized as maintaining ‘identity’ (Walker et al. 2004, 2006; Cumming et al. 2005). [↑](#footnote-ref-1)