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From complexity to food security decision-support: Novel methods of assessment and their role in enhancing the timeliness and relevance of food and nutrition security information

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ABSTRACT

Food and Nutrition Security Information (FNSI) is a critical tool for achieving food and nutrition security, yet FNSI efforts to date have not produced the intended impacts on policy and program decision making, largely due to shortcomings in available technologies and frameworks. The article reviews the evolution of FNSI efforts in the context of emerging technology and data collection techniques. A conceptual framework is provided to describe the evolution towards an FNSI characterized by integrating conventional and novel approaches to the collection, analysis and communication of information into a value stream that supports decision-making to achieve food security. Conclusions include the need to streamline and expand coverage of conventional information tools such as household surveys while facilitating the rapid uptake of analytical tools that leverage the novel, numerous, and rich data streams enabled by emergent information and communication technologies and dramatic increases in connectivity.

1. Introduction

Food security and nutrition problems affect people worldwide. The FAO recently estimated that 870 million people are undernourished while other authors suggest that as many as 2 billion people may suffer micronutrient deficiencies (FAO, 2012; Klotz et al., 2008; Bloem et al., 2009; Mason, 2001; Knight, 2011; UNSCN, 2010b; Horton, 2009). Considerable differences in the estimate of food and nutrition insecure people are largely due to the lack of comparable global level datasets containing consistent, regular, and synoptic measurement of key food security indicators. This issue is compounded by estimation methods that involve making broad assumptions (Barrett, 2010; FAO, 2012). The determinants of food and nutrition security have become increasingly globalized as reflected by recent food price volatility beginning in 2007 and 2008 (IFPRI, 2011; Webb, 2010). In a world that is both increasingly urban and increasingly interconnected, many families are relying on the market for a larger and larger share of their food (Ruel et al., 2009; Aslam et al., 2012). During the recent food price crisis, seemingly unrelated weather events, policy changes and market feedback sent prices spiraling upward and put basic food out of reach of millions of families, highlighting the complexity involved in achieving food and nutrition security (FNS) (Ghanem, 2008; Zezza, 2008; Headey and Fan, 2008; Sulaiman et al., 2009).

An important requirement for achieving food and nutrition security is timely, reliable and relevant information (FAO/WFP, 2011; Fan, 2012). Since the 1970s, substantial resources have been devoted to developing approaches and techniques which provide Food and Nutrition Security Information (FNSI) in support of improved decision-making related to food and nutrition security outcomes (Hawkes, 1974; UN, 1975; Buchanan-Smith et al., 1991). FNSI has been applied to specific decision-making problems such as early warning and emergency response planning, analyzing the need for market oriented interventions, and development policy formulation and evaluation. Indeed, organizations concerned with global food and nutrition security have invested in information systems that have aimed to develop on-going information collection, analysis and communication around both acute and chronic food and nutrition security problems. These include such efforts as the United States Government-sponsored Famine Early Warning Systems Network (FEWSNET), the UN Inter-agency Food Insecurity and Vulnerability Information and Mapping Systems Initiative (FIVIMS), the UN Food and Agricultural Organization's Global Information Early Warning System (GIEWS) among others. FNSI efforts traditionally have synthesized information from sources such as routine statistical data collection, synoptic monitoring from satellite remote sensing, and large cross-sectional surveys (Ecker and Breisinger, 2012; Brown, 2008; Devereux et al., 2004). Simple conceptual frameworks illustrating cause and effect relationships between

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health, nutrition, economic access and production have been used to organize data (FAO, 2011; Pinstrup-Andersen, 2009; Barrett, 1999; UNICEF, 1990). FNSI efforts aim to inform regular decision-making processes that prioritize food aid, market intervention and development-oriented policies.

Recent research, however, suggests that normative approaches to FNSI have been only partially successful in providing decision support (Barrett, 2010). These efforts have been hampered by a number of issues related to the lack of valid and reliable data, inadequate processing and analysis of data and the timeliness of information. Evaluations of FNSI efforts repeatedly find that they often do not deliver what decision makers need (Knight, 2011; WFP/FAO, 2009; EC/FAO, 2009; Benson et al., 2008; FAO, 2012). Furthermore, the functional and often physical separation of those that collect data from those that analyze the data and in turn from the intended users of FNSI tends to contribute to a disconnect between information and action as witnessed during the response to the famines in the Horn of Africa (Buchanan and Davies, 1995; Devereux, 2001; Funk, 2011; Hillier and Dempsey, 2012). Particularly at the national level, the communication of FNSI among different stakeholder groups and between individual knowledge producing activities and the broader collection of decision-makers and information-users is a traditional challenge resulting in poor linkages between information and decision-making (Devereux, 2001). Advances in Information/Communications Technologies (ICTs), however, have resulted in an explosion of new data streams and transformational tools for assessment of FNSI.

The article briefly reviews the evolution of FNSI initiatives from a complex systems perspective, analyzes the utility of recent technological advances and provides examples of how novel methods of assessment can strengthen FNSI efforts. For the purposes of this article, "assessment methods" refer to methods for information capture, curation, analysis and communication of FNSI.

1.1. Theories and frameworks useful to understanding modern decision support

Key to improving FNSI is to understand related initiatives as decision support for improved FNS. The recent Panel on Strategies and Methods for Climate-Related Decision Support studied the science of decision support and its evolution in modern times as it applies to the problem of climate change. They defined decision support broadly as "a set of processes intended to create conditions for production of decision relevant information and for its appropriate use" and argue that decision support systems are comprised "of the individuals, organizations, communications networks and supporting institutional structures that provide and use decision support products and services" (National Research Council, 2009). The panel concluded that the decision support enterprise has evolved considerably in recent years, in part facilitated by theoretical shifts in thinking about complex problems such as food security, climate change and sustainability, and in part because technological advances enable more sophisticated methods of data capture, management, analysis and connectivity to end-users.

While earlier efforts emphasized data and data systems designed by analysts, modern notions of decision support also emphasize information networks, close connectivity between providers and users of information and adaptive change (see text Box 1).

Box 1–A recent National Academy of Sciences study identified six Principals of Decision Support:

1. Begin with users' needs: these needs are not always known in advance, and they should be identified collaboratively and iteratively in ongoing two-way communication between knowledge producers and decision makers.
2. Give priority to processes over products: to identify, produce, and provide the appropriate kind of decision support, processes of interaction among and between decision support providers and users are essential.
3. Link information producers and users.
4. Build connections across disciplines and organizations: decision support services and products must account for the multidisciplinary character of the needed information.
5. Seek institutional stability: stable decision support systems are able to obtain greater visibility, stature, longevity, and effectiveness.
6. Design for learning: decision support systems should be structured for flexibility, adaptability, and learning from experience.

Source: National Research Council (2009).

1.2. Complex adaptive systems and the FNSI value stream

These modern conceptions of decision support are rooted in an interpretation of complex problems like food and nutrition security as complex systems problems (Jones, 2011) where many interrelated networks of individuals, households, communities, and organizations are connected in intricate ways. These intricate networks face risks and threats such as climate change, environmental degradation, war, energy policies and water use practices, among others. For example, drought affecting one major global cereal producer such as Russia or Australia combined with energy policies in the United States could have dramatic effects on global cereal prices, eroding dangerously the terms of trade for vulnerable households around the world (Abbott et al., 2008). Added to this increasing interdependence is the importance of understanding local context. Policies in some vulnerable countries regarding the acceptability of food derived from Genetically Modified Organisms (GMOs) have at times prevented food aid relief (Zerbe, 2004). The specific local causes of nutritional stunting vary widely according to local determinants of nutrition security. Complex systems thinking highlights the need for highly contextualized analysis that takes such local, interdependent determinants into account throughout the broader system. Such an analysis is contingent upon establishing FNSI of requisite complexity and adaptability.

Complex Adaptive Systems (CAS) represents a desired state where a system's complexity (and all its components) is modulated by timely and appropriate adaptation of the system based upon rapid learning (Holland, 1995). CAS depends upon rapid and efficient information feedback loops across the network of components. Information flow reflects multi-directional connectivity, in contrast to the one way flow of information that characterizes many conventional information systems. Benbya and McKelvey (2006) describe how information systems may achieve a high level of complexity through a process of "co-evolutionary development" within the context of a CAS. In such a competitive/adaptive environment, "official" systems designed from the top–down by institutional information specialists often interact with "emergent" initiatives which tend to be designed in response to information gaps, inefficiencies and other concerns as perceived by a much broader set of stakeholders, end-users and sometimes even the immediate beneficiaries of the system. Such emergent systems and tools are often—but not always—developed in a modular and distinctly bottom–up fashion. To the extent that a system for the provision of FNSI exists, it is useful to understand it as a set of co-evolving components, some of which are conventional and some of which are emergent.