A holistic vision for food security research

Arika Ligmann-Zielinska¹ · Louie Rivers III²

Published online: 5 March 2018

© Springer Science+Business Media, LLC, part of Springer Nature 2018

Despite recent gains in global agricultural productivity, lack of food security persists in many regions of the world. Furthermore, global change, toxic contaminants, loss of agricultural land, and reduced access to sufficient water sources threaten to exacerbate existing food security issues and to challenge the food security of currently stable regions. Given these considerations, addressing the four interconnected aspects of food security—food availability, food access, food utilization, and food stability—present unique challenges to decision makers at many levels of aggregation, including continental, regional, household, group, and individual.

A significant decline in the world's food production during mid-1970s and late 1970s initiated a food security discourse that was largely dominated by an examination of food production and supply as central factors. Food supply at a national or regional level was erroneously considered as a primary indicator of household food security. However, Staatz et al. (1990) argues that national measures of sufficient food supply do not adequately guarantee food security at the household level. Moreover, traditional measures of household income do not necessarily provide accurate information about household food security. For example, many low-income households appear to be food secure, while non-poor households may periodically face food scarcity (Bickel et al. 2000). The complexity of addressing food security is reflected in the Reutlinger (1986) definition of food security as access to enough food to supply the energy needed for all family members to live healthy, active and productive lives. This conceptualization of the phenomenon shifted the focus of food security studies to the individual level. It was widely realized that intra-household food distribution and consumption were not uniform. Many

consumption and anthropometric indicators were developed to analyze calorie sufficiency at the individual level. This focus on individual factors and food security has greatly improved our understanding of what is needed for someone to be food secure; however, many of these indicators are not reliable or misleading. For instance, malnutrition can be caused by diseases, not necessarily due to inadequate food consumption. Additionally, anthropometric indicators can be more indicative of nutritional security than food security (Pinstrup-Andersen 2009). As the quantitative indicators for food security analysis are unreliable, there is a recent shift in deepening food security understanding—toward more subjective measures.

More recently, system approaches for analyzing food security have received greater attention and various models (Gregory et al. 2005; Bharwani et al. 2005) are being developed to analyze food security at different spatial and temporal scales. These models are often driven by ancillary issues such as climate change, irrigation water quality, and the sustainability of agricultural systems. This special issue of *Environment Systems and Decisions* is a contribution to the growing body of food security literature that focuses on the use of models and insights into systems science. Articles in this issue examine the complexity of food security from a wide array of perspectives using an array of both quantitative and qualitative modeling techniques (mental models, structural equation modeling, participatory (causal loop diagrams) models, and probit regression models).

In their study, Denny et al. (2018) use statistical analysis to identify drivers of food security at multiple spatial scales (continental, regional, and national). The authors build a model of food security that utilizes national data and therefore reflect the regional scale of food security. Variables across the whole spectrum of food security system are evaluated including, social, economic, and political as well as biophysical issues. The study uses longitudinal data covering over half a century and therefore provides a comprehensive picture of food security dynamics in African countries. They identify multiple paths leading to undernutrition as the latent variable (Denny et al. figure 1, in this issue). All four

✉ Louie Rivers III
lrivers@ncsu.edu

¹ Department of Geography, 673 Auditorium Rd., 121
Geography Building, East Lansing, MI 48824-1117, USA

² Department of Forestry and Environmental Resources, North
Carolina State University, 22219 Jordan Hall Addition,
Raleigh, NC 27695, USA

dimensions of food security are covered using a variety of predictor variables: (1) stability: social rights, refugees, and natural disasters; (2) accessibility: poverty index; (3) utilization: disease prevention and treatment (with water sanitation and infrastructure as indirect variables); and (4) availability: food production and aid, food imports, and diet adequacy. The result of their analysis illustrates the complexity of the food security system. Different drivers of undernutrition are identified depending on the examined path model. The authors also stress the importance of heterogeneity, and it is likely that the food security of countries and regions demonstrates different paths toward population undernutrition.

The aspects of health risks associated with food production are further examined by Woldetsadik et al. (2018). The foundation for their study is the fact that the use of contaminated water to irrigate food crops/vegetables is ubiquitous in Ethiopia. The use of polluted water can lead to food insecurity via the increase in risk due to water borne diseases. Unwashed vegetables further heighten this risk. Their work examines how farmers perceive the risks associated with the use of contaminated water. The authors use multivariate probit regression analysis to examine data about farmers' individual perceptions collected using interviews and focus group discussions. While understanding the negative aspects of the use of contaminated water in food production, farmers perceive the quality of their water used for irrigation as good. Interestingly, health risks identified are more external in nature (i.e., eyes, skin) than abdominal. Woldetsadik et al. (2018) report a complex narrative of farmers' perceptions and subsequent decisions. The farmers know and understand the potential risks; however, they do not really think that their water poses these risks. Yet they support health promotion programs and the cessation of irrigation before harvesting. Additionally, there is significant heterogeneity between farmers from different sites in terms of risk perception and the adoption of health promoting management practices.

Both Denny et al. and Woldetsadik use quantitative models to study food security issues. Schmitt Olabisi et al. (2018) and Rivers et al. (2018) employ qualitative modeling approaches to evaluate the drivers of food insecurity and the different pathways toward nutritious and safe food.

Schmitt Olabisi et al. (2018) focus their study on climatic risks as one of the underlying causes of food insecurity in Nigeria, Ghana, and Mali. The researchers organized three workshops where they worked with stakeholders to build casual loop diagrams (Nigeria) and generate future scenarios (Ghana and Mali) to evaluate the resilience of agricultural systems and identify potential trajectories of food production given the long-term changes in precipitation and temperature. Other factors were also identified, namely migration due to political instability, conflicts over natural resources between farmers and pastoralists, poor land management leading to desertification, and poor access to agricultural

resources necessary to produce food (i.e., access to land and water). Interestingly, climate change was not identified as the most pressing issue in the stability of food production. However, participants did voice their concerns related to longer droughts and volatile rainfall, both of which are closely linked to climate change. Similar to other studies on these issues, the results of this work suggest the heterogeneity and complexity of food security systems. Results from the workshops differed by location and by the method used (casual loop diagrams vs. scenario planning).

Rivers et al. (2018) make use of mental modeling methodology to examine food security challenges and adaptive behaviors to these challenges at the household level in rural, southern Mali. This work has a distinct focus on inter- and intra-family behavioral dynamics. Similar to Schmitt Olabisi et al. (2018), this work found that the development of unpredictable rainfall patterns, associated with climate change, has proven to be a significant challenge to traditional farming practices that were essential to providing a food secure household. Additionally, farmers are finding it difficult to adapt to other external challenges, such as the loss of labor due to the migration of young men to urban areas in search of work to support their families. This work also highlights the unique vulnerabilities faced by young women in this part of Mali. Young women are key to providing the labor for a food secure household; however, unlike other family members (especially elder men), they have little control over relevant food security decision-making processes.

The collected insights into the research presented in this special issue paint a picture of food security as a dynamic system with complex feedbacks, heterogeneity, and inherent uncertainty. Simple composite indicators are not enough to capture the complexity of the problem. Unfortunately, the prevalence of such indicators and their considerable influence in policy-making processes at multiple scales have not allowed us to identify long-term, sustainable solutions to make communities, households, and individuals food secure. Rather than single variables, we should focus our attention on pathways (interrelated dynamic variables) to shape future policies of sustainable agriculture.

There is a need for more holistic research on food security from traditionally neglected scales; specifically, the individual, household, and local community perspective that study the dynamics of food security given the climatic changes, economic, and political instability in many African countries. Furthermore, it is important that this research seriously examines the impact of changing social dynamics and generational changes on food security systems. The work in this special issue is a small, but critical step in this direction.

References

- Bharwani S, Bithell M, Downing TE, New M, Washington R, Zier-vogel G (2005) Multi-agent modelling of climate outlooks and food security on a community garden scheme in Limpopo, South Africa. *Philos Trans R Soc Lond B Biol Sci* 360(1463):2183–2194. <https://doi.org/10.1098/rstb.2005.1742>
- Bickel G, Nord M, Price C, Hamilton WL, Cook JT (2000) Guide to measuring household food security, Revised 2000. USDA, Food and Nutrition Service. <http://www.fns.usda.gov/fsec/files/fsguide.pdf/>
- Denny RCH, Marquart-Pyatt ST, Ligmann-Zielinska A et al (2018) Food security in Africa: a cross-scale, empirical investigation using structural equation modeling. *Environ Syst Decis*. <https://doi.org/10.1007/s10669-017-9652-7>
- Gregory PJ, Ingram JS, Brklacich M (2005) Climate change and food security. *Philos Trans R Soc Lond B Biol Sci* 360(1463):2139–2148. <https://doi.org/10.1098/rstb.2005.1745>
- Pinstrup-Andersen P (2009) Food security: definition and measurement. *Food Secur* 1(1):5–7
- Reutlinger S (1986) Poverty and hunger: issues and options for food security in developing countries. A World Bank Policy Study. The World Bank, Washington, DC
- Rivers L III, Sanga U, Sidibe A et al (2018) Mental models of food security in rural Mali. *Environ Syst Decis*. <https://doi.org/10.1007/s10669-017-9669-y>
- Schmitt Olabisi L, Liverpool-Tasie S, Rivers L et al (2018) Using participatory modeling processes to identify sources of climate risk in West Africa. *Environ Syst Decis*. <https://doi.org/10.1007/s10669-017-9653-6>
- Staatz JM, D’agostino VC, Sundberg S (1990) Measuring food security in Africa: conceptual, empirical, and policy issues. *Am J Agr Econ* 72(5):1311–1317
- Woldetsadik D, Drechsel P, Keraita B et al (2018) Farmers’ perceptions on irrigation water contamination, health risks and risk management measures in prominent wastewater-irrigated vegetable farming sites of Addis Ababa, Ethiopia. *Environ Syst Decis*. <https://doi.org/10.1007/s10669-017-9665-2>