Chapter 17
Food Security Policy Analysis Using System Dynamics:
The Case of Uganda

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ABSTRACT

Food security (FS) challenges exist in both the developed and the developing countries, the difference being the severity and the proportion of the population affected. Previous studies maintain that chronic food insecurity at subsistence farming level has persisted due to a number of factors including unsustainable subsistence agriculture and livelihood policies, lack of inputs, poor conservation methods, weak extension services, unregulated markets, limited land among others. This article investigates FS challenges at subsistence farming level using system dynamics tools. The emerging system dynamics model is conceptualised into four sectors; food production, sales, income and food consumption, representing a real-life food security system. The model is used to evaluate policies for better livelihoods as well as explore strategies for profitable subsistence farming and food security.

INTRODUCTION

The concept of food security has been used extensively at the household level as a measure of welfare of household needs (Pinstrup-Andersen, 2009; Production, 2011; UBOS-GoU-WFP, 2013). Several attempts have been made to conceptualize operational usefulness in the design, implementation, and evaluation of policies of the food system. At household level, food security is defined as the availability of food

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in one's home for which one has access to so that members of the family do not live in hunger or fear of starvation (Production, 2011). Hence, there is a distinction between transitory and permanent food insecurity. The former describes periodic food insecurity such as seasonal food insecurity, while the latter describes long term lack of access to sufficient food (UBOS-GoU-WFP, 2013; Pinstrup-Andersen, 2009).

In particular, in developing countries, food security is considered a critical national problem (Rosen et al., 2016). In this research, the specific case of Uganda country is studied. In the context of Uganda country, the smallholders' SD models are available for seed banking (Oyo, 2013) and farmers' livelihood (Guma et al., 2016). At the same time, food insecurity has been volatile in Uganda with percentages in the range of 35%-59% (UBOS-GoU-WFP, 2013). The largest food insecure area is northern Uganda with about 50% prevalence arising from two decades of armed conflict (1986-2006) that significantly affected food production (Tusiime et al., 2013). Therefore, it is considered necessary and worthy to investigate and model other strategies towards self-provisioning at subsistence farmers' level.

To this end, this paper develops a system dynamics model for exploring strategies and policies for household food security. System dynamics (SD) is a powerful methodology and computer simulation modeling technique for structuring, understanding and discussing complex issues and problems (Azar, 2012; Georgantzas & Katsamakas, 2008; Luna-Reyes & Andersen, 2003). It is extensively used to analyse a range of systems in business, ecology, medical and social systems as well as engineering. Dynamics refers to change over time. System dynamics is, therefore, a methodology used to understand how systems change over time. It presents a means to describe and simulate dynamically complex issues through the structural identification of feedback, and in many cases, delay processes that drive system behavior.

The importance of SD in studying food security is underscored by the fact that FS requirements are complex, the interactions in the food systems are dynamic and involve feedbacks and delays. Complexity arises from these interconnected and interdependent variables of the food system (Oyo & Kalema, 2016; Tsolakis et al., 2014; Tittonell, 2014; Steenwerth et al., 2014) and dynamic feedback processes (Ayenew, 2015; Oyo & Kalema, 2016; Georgantzas & Katsamakas, 2012); dynamic changes are reflected by change in food demand and supply (Guma et al., 2016; Oyo & Kalema, 2016; Oyo, 2013) and feedbacks arise because increasing agricultural (food) production increases food supplies, which does not necessarily translate into food security since those who need food may not have access to the food either on account of income or geographical location (Barrett; 2010; Carletto, Zezza & Barnejee, 2013).

A number of SD models have been built over the last decade on different aspects of food security including prediction of global food security (Sandvik & Moxnes, 2009), competition for food and bio-fuels (Pruyt & De Sitter, 2008), food systems at different levels (Giraldo, Betancur & Arango, 2008), subsistence farming (Oyo & Kalema, 2016; Guma et al., 2016; Ayenew, 2015; Tittonell, 2014; Oyo, 2013), and climate change effect (Demeke, Pangrazio &Maetz, 2008; Harvey et al., 2014).

However, the conventional agricultural science and policy do not explain complexity, diversity, uncertainty, and non-equilibrium states, yet subsistence agriculture is a complex enterprise. For instance, the competition for food and bio-energy or bio-fuels places pressure on the supply (availability) and price (accessibility) on the market for these goods (Pruyt & De Sitter, 2008).

The interconnectivity between energy and food markets creates pressure between land uses and competition for crops representing moral and national food dilemma, as food riots continue to demonstrate interconnectedness (Hu, 2012). In contrast, increase in food allocation puts higher demand for such food, creating a problem endogenously and is highly counterintuitive. The counterintuitive behaviour is an example of policy resistance. Such policies fail due to unanticipated feedback from the environment (Forrester, 1971; Ghaffarzadegan et al., 2009; Sterman, 2000). There is need for better understanding

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