Food Security and Social Networks: Impacts for Smallholder Farmers in the Mount Elgon Region of Kenya and Uganda

Jennifer Lamb

Thesis submitted to the faculty of Virginia Polytechnic and State University in partial fulfillment of the requirements for the degree of

Masters of Science
in
Agricultural and Applied Economics

Bradford F. Mills, Committee Chair
Keith M. Moore, Committee Co-Chair
Jeffrey Alwang

October 26, 2011
Blacksburg, Virginia

Food Security and Social Networks: Impacts for Smallholder Farmers in the Mount Elgon Region of Kenya and Uganda

Jennifer Lamb

Abstract

This thesis investigates the relationship between smallholder farm household networks for food acquisition and agricultural production, food security and dietary quality in the Mount Elgon region of western Kenya and eastern Uganda. Food security and dietary quality were measured through calorie consumption of the female household head in a 24 hour dietary recall, the calculation the World Food Program Food Consumption Score (WFP FCS), and the calculation of the percentage of energy sourced from staples in the diet. Correlations between these indicators support that the WFP FCS is capturing elements of both sufficiency and quality of diet. Subsequent application of Ordinary Least Squares regression determines that both food acquisition networks and technology networks for agricultural production have a statistically significant positive impact upon calorie procurement across the sites included in the study. However, networks for agricultural production appear to operate differently in different locations with regard to dietary quality. Interpretation of qualitative data gathered through interviews with agricultural service sector providers and focus groups regarding these local networks for agricultural production suggests that this might be due to differences in the types of crops promoted and attitudes held regarding food security and dietary quality prevalent in these different localities. Overall, the results suggest that both food acquisition networks and agricultural production networks are important avenues through which gains in food security may be realized. However, development efforts need to be mindful of the crops and attitudes promoted by these networks to secure gains in both caloric sufficiency and dietary quality.

Dedication

This thesis is dedicated to the smallholder farmers of Kenya and Uganda, and especially to the mothers who so kindly welcomed me into their homes and communities with kindness, patience, and hospitality. I identified personally with so many of these women, for it was from my own mother, Dorothy Lamb, that I learned a reverence for cultivating the earth and first came to believe in the celebration of an ecological landscape suited to the human condition.

While working in the mountains of Uganda, one of these mothers gave me the highest honor of naming a daughter after me who was born on the evening of our focus group in Kween District. It is my sincerest wish that this honor is by some small fraction repaid through the contribution of this thesis toward achieving our common goal of nutritional security through sustainable agricultural production, so that baby Jennifer, and indeed all of the world's children can have the same equality of opportunity to pursue their dreams.

Acknowledgements

This thesis would not have been possible without the generous support of the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program Managing Entity Technology Networks Cross Cutting Research Activity and the Long Term Research Activity 10 (LTRA 10) Team headed by the University of Wyoming in partnership with Makerere University, SACRED Africa Training Institute and Manor House Agricultural Training Institute, and Appropriate Technology (AT) Uganda.

I would like to begin by thanking Principal Investigator for LTRA 10, Dr. Jay Norton for opening up his contacts and connecting me to Dr. Eusebias Mukwhana and Dr. Emmanuel Omondi, the founders of SACRED Africa and Manor House, and Dr. Rita Laker-Ojok, the Executive Director of AT Uganda and a truly outstanding in-country research team.

At Virginia Tech, my committee co-chairs Dr. Bradford Mills and Dr. Keith Moore have served as a constant source of support throughout this process, including reviewing weekly reports while I was working in the field and in serving as a sounding board toward creating a valuable experience in interdisciplinary research. Thank you also to Dr. Jeffrey Alwang who has served as a member of my committee and provided thoughtful advice during committee meetings and throughout the research process.

The in-country team of researchers also played an instrumental role in the success of this thesis. Thank you to Dr. Dominic Sikuku, Johnstone Odera, Nicodemus Nyongesa, Dennis Shibonje, Julian Nyachwo and Ketty Nambozo for introducing me to each of the research sites and providing critical connections and comments to work successfully in the field. Dr. Rita Laker-Ojok, Executive Director of AT Uganda offered both her expertise and hospitality during my visits to Kampala and has remained an important contact upon my return to the U.S. Thank you also to Dr. Bernard Bashaasha at Makerere University for both providing comments on the work in the field and for arranging the opportunity to share my preliminary findings with students and faculty at the University.

I would also like to thank the individuals I worked with locally as guides and enumerators. Moses Aisu Okurut, David Chemusto, William Weswa, and Enoch Mayo all facilitated my work in the field through helping to locate and introduce me to households and key agricultural service sector providers. Elizabeth Baraza, Nuru Juma, Wilikister Wabuyabo, Akisa Betty, Rose Ndegere, Maliam Chelimo, Stella Chepategei, Betsy Chepkus, Lizzie Letting, Dinah Yano, and Rachel Otuyo all worked with me as wonderful enumerators and assisted in the facilitation of local focus groups.

Finally, I wish to thank my parents, Pete and Nancy Lamb for their love and support throughout my education at Virginia Tech. To my boyfriend, Chris Rogers, I am not sure that I would have made it through this long process without your love and support from our daily conversations while I was working in the field to your understanding and assistance as I began the process of analyzing and writing up the data collected. To my Dad, Nancy, and Chris, thank you and I love you.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Problem Statement

Worldwide approximately one billion people suffer from hunger and malnutrition (FAO, 2010). Given the fact that there is sufficient quality and quantity to meet basic nutritional needs of the global population, the persistence of hunger has come to be identified as a leading political failure with an inherent moral obligation to correct. As evidence of this global prioritization, halving hunger and malnutrition by 2015 was identified as the first of the eight Millennium Development Goals (MDGs) in 2000. Two thirds of the way to this deadline, it has become clear that global efforts will fall far short of reaching this critical goal (FAO, 2010). This is especially true in Sub-Saharan Africa where extreme hunger is experienced by one-third of the population.

Policies and programs which seek to eradicate extreme hunger are usually defined in terms of food security. Food security is obtained when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2002). Conversely, food insecurity occurs "whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is uncertain" (USDA, 2000). As these definitions present, food security—and insecurity— is a variable, individually experienced state embedded within dynamic social processes.

Agricultural smallholders are identified as one of the groups most vulnerable to food insecurity due to a number of structural conditions (Barrett 2002, Alinovi 2009). Typically, smallholder households in rain-fed agricultural systems rely upon the receipts from agricultural production to store enough food for the family and to purchase household necessities over the non-cultivable season. When these smallholders are net consumers of agricultural products, they are even more sensitive to price shocks and variation. Subsequently, many smallholder farmers suffer from periodic food insecurity near the time of planting and shortly after crops are in the ground, as these are the points in time when food stocks are lowest from

the previous season's harvest. Smallholder agricultural households must carefully balance productive and reproductive decisions to maintain a minimum level of consumption throughout the course of the year (Barrett, 2002).

Smallholders are also a critical sub-unit of global food systems. As the predominant landholders in much of Sub-Saharan Africa, the decisions that smallholder farmers make are simultaneously dependent upon and dictate the condition of the natural resource base for agricultural production. Therefore, sustainable management of smallholder production systems is a key food security and a key environmental concern. This crucial intersection is the entry point for the investigation of smallholder food security proposed by this thesis.

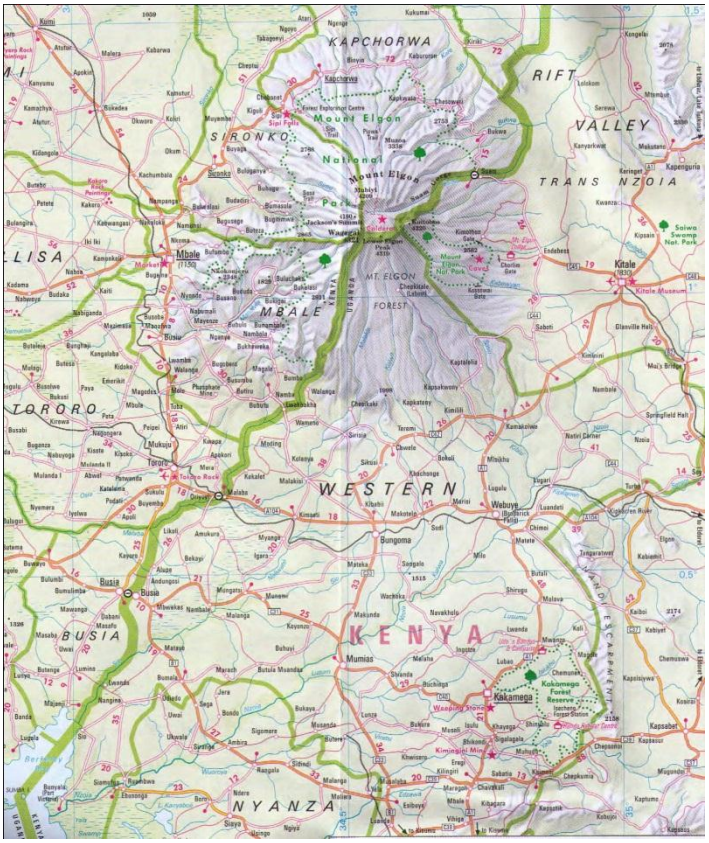
The introduction of Conservation Agriculture Production Systems (CAPS) has been proposed as a potential method to improve soil fertility, reduce soil erosion, and increase smallholder food security. Through strict adherence to three principles: 1) minimizing tillage, 2) maintaining a permanent ground cover, and 3) rotating crops; conservation agriculture seeks to improve soil quality and yields over the long term without the need for extended fallowing. Conservation agriculture systems have also been demonstrated to be more resilient to climatic variability and reduce the need for artificial fertilizers over time (Niggli et al 2009, Uri 2000, García-Torres et al 2003).

The research theme of the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP) is "increasing smallholder food security through the introduction of conservation agriculture production systems" (SANREM CRSP, 2009). Managed by Virginia Tech, the SANREM CRSP has a five year contract from the United States Agency for International Development (USAID) to research CAPS in developing countries from September 2009-October 2014. Currently, the project has seven United States university partners, who head up projects in 13 countries around the world. Four cross-cutting research activities in technology networks, economic impact and analysis, gender perspectives, and soil quality and carbon sequestration intend to find

commonalities across the various countries in order to provide a more global perspective on how to facilitate the introduction of CAPS. This thesis is funded by the Technology Networks Cross Cutting Research Activity and focuses on the SANREM Long Term Research Activity 10 (hereafter LTRA 10) headed by the University of Wyoming to introduce and scale up CAPS in East Africa.

In economics and sociology, social networks have already been demonstrated to play a key role in facilitating processes of technological change (Bandiera and Rasul 2006; Kiptot 2006) Specifically, structures of communication and advice between social actors have a greater impact upon technology adoption than individual attributes such as age, gender, education or ideology (Knoke and Yang, 2008). Moreover, social networks are crucial to maintaining the support structure for producers to experiment and adopt practices to improve the sustainability of cropping systems through facilitating exchange in labor, technology, and food resources (Mazzucato, 2000). This thesis extends the application of social networks to the study of food security, and aims to determine whether the strength of smallholder social networks for food acquisition and accessing agricultural resources and information have an impact on household food security status.

Figure 1: Mt. Elgon Region of Kenya and Uganda



(Nelles Map, 2011)

The LTRA 10 Project, titled "CAPS for smallholder farms in eastern Uganda and western Kenya", selected a cross-section of ethnically and agriculturally diverse production systems in which to study

conditions for the experimental development and scaling up of CAPS (Odhiamba et al 2011; Wyoming SANREM project 2011; LTRA 10: CAPS for smallholder farms in eastern Uganda and western Kenya 2011). The research works in four locations: Bungoma and Kitale in western Kenya and Tororo and Kapchorwa in eastern Uganda. As can be viewed in figure 1, these research sites are clustered around Mt. Elgon, an extinct volcano which spans the Kenya and Uganda border. The northern sites, Kitale and Kapchorwa are considered higher potential regions because of more fertile volcanic soils in being directly positioned on the slopes of Mount Elgon and higher overall rainfall. Conversely, Bungoma and Tororo are thought to be the lower potential areas due to poorer, sandier soils and more variable rainfall (Norton and Laker-Ojok, pers. comm December 2010).[1] In terms of industrialization and agricultural potential, the sites make up a continuum, as visualized below:

Figure 2: Continuum of Commercialization of Agriculture and Nutrition Networks

Beyond the geographical variation between the sites, there are also important cultural and infrastructural notes to be made about the research areas. Between the "high" and "low" potential areas there are also similarities in ethnicity. Tororo and in Bungoma are considered Bukusu regions. In fact, the legend in Tororo is that the Bukusu tribe split when some of the people stopped venturing eastward toward Kenya because they wished to settle at the base of Mount Tororo in order to place themselves closer to God. The rest of the tribe continued east and began to populate the area which is now Bungoma, Kenya. In general, the Bukusu people are agriculturalists who farmed and hunted wild game for food. By contrast, the Sabiny people of Kapchorwa and Kitale are native pastoralists who have more recently widely adopted agriculture in the twentieth century, in many cases due to colonial influence. In particular, Kitale's gently

[1] This said, it is important to realize that Bungoma remains a key maize producing region in Kenya.

sloping plains and fertile soils were recognized as ideal for coffee and maize production and large colonial landholdings were established throughout the first half of the twentieth century (Anderson and Throup, 1985).

The locations are also connected from an infrastructural perspective. Specifically, many of the inputs for commercial agricultural production in Kapchorwa are imported from Kitale, Kenya. While Kapchorwa is only 50 kilometers from Kitale, there are no good roads running directly between them through the mountains, nor is there an effective inland port for the trading of goods between the two sites. As a result, hybrid maize seed produced in Kitale must pass through Bungoma, then the Malaba port, Tororo and up to Kapchorwa. Interestingly enough, however, the adoption of technologies for commercialized agricultural production is not widespread across the geographic sites. These geographic and cultural factors present considerable variation for the study of food security and the social network conditions which may affect both food security and agricultural production practices. For this reason, significant qualitative and quantitative work was undertaken in each study region in an attempt to understand both the location specific and cross cutting factors affecting agricultural production technology choices and food security.

Objective

The objective of this thesis is to estimate the impact of social networks on food security. This will involve the execution of several primary tasks:

1) Describe basic demographic characteristics, food security status and features of social networks in two sites in western Kenya and two sites in eastern Uganda.
2) Compare multiple methods for the measurement of food security based on the caloric consumption as reported by a 24-hour dietary recall with female heads of household and the calculation of the WFP Food Consumption Score (FCS).
3) Estimate and discuss the impact of social networks on food security status at the household level
4) Explore opportunities for applying research findings to improve the measurement of food security

5) Discuss potential applications of social network analysis methods to ensure that agricultural development and food assistance programs enhance existing social structures.

Data Collection and Methods

Primary data collection and field work comprised a major component of this thesis research. Data collection was based on a two phase process, the first a 790 household baseline survey developed and conducted by the LTRA 10 research team from June through September 2010 for baseline household data on production practices, and social networks for agricultural production in two sites in western Kenya and two sites in eastern Uganda (Odhiamba et al 2011; Wyoming SANREM project 2011; LTRA 10: CAPS for smallholder farms in eastern Uganda and western Kenya 2011, Lamb et al 2010). In the second phase of data collection, I traveled to Kenya and Uganda and spent five months working between the sites to collect data on food security and household social networks for food acquisition from January through May 2011. This included conducting focus groups in each site to develop locally adapted survey instruments, completion of a 357 person survey of female household heads, and 69 technology network interviews. The main statistical operations of this thesis include the use of Pearson Correlation and Compare Means Testing to explore significant differences and compare different measures of food security and social networks between sites. Subsequently, Ordinary Least Squares regression is applied to estimate the impact of social networks for agricultural production and for food acquisition on food security.

Organization of the Thesis

This thesis sets forward a framework to measure the impact of social networks on food security at the household level. Chapter 2 begins with a review of evolving conceptions and measurement frameworks of food security in economics, highlighting a transition from macro to microeconomic approaches in the latter half of the twentieth century. Chapter 3 reviews current microeconomic perspectives on the modeling of food insecurity at the household level. Chapter 4 builds upon these frameworks to outline a model for estimating the impact of social networks on food security in agricultural households from cross

sectional data and describes how and why particular variables were collected. Chapter 5 explores some of the background conditions and qualitative findings in focus groups and interviews with agricultural service sector providers which motivate hypotheses in the later quantitative sections. Chapter 6 provides summary statistics and an analysis of the relationships between the indicators for food security. Chapter 7 focuses on exploratory statistical analysis of the social network measurements collected and the potential impact of enumerator effects on the data collected. Chapter 8 presents the final model specification and analyzes the results for regressions for calorie procurement and dietary quality. Chapter 9 concludes and offers recommendations for further research.

Chapter 2: Food Security in Evolving Economic Frameworks

Economic approaches to food insecurity have evolved greatly over the latter half of the twentieth century. Macroeconomic conceptions of food security date back to Robert Malthus, who predicted that limited land availability and agricultural productivity would contribute to widespread famine under rapid population growth. Even up to the 1974 World Food Summit, food security was largely conceived as a problem of limited national agricultural supplies (Barrett 2002; Webb et al 2006) . Under this macroeconomic framework, economists measured food security by national stock levels and then calculated per capita food availability based on population. Meanwhile, health perspectives focused on the micro level manifestations of food insecurity, such as wasting, kwashiorkor, and marasmus. Within this framework, food security was thought to be best addressed through creating more favorable terms of trade for food poor countries and through large scale efforts to increase agricultural supply through seed and production technologies (Webb et al, 2006). Faced with rapid population growth in India and Southeast Asia, this logic was a major driver of the introduction and dissemination of Green Revolution technologies in the late sixties and early seventies.

The work of Amartya Sen substantially reformed conceptions of food security. In his 1981 *Essay on Poverty and Famines*, Sen describes starvation as "the characteristic of some people not *having* enough food to eat, not the characteristic of there not *being* enough food to eat". Sen argues that individual *exchange entitlement*, (ability to labor and earn an income) dictates the ability to obtain food. Sen uses the concept of exchange entitlement to demonstrate the empirical reality of the persistence of food insecurity despite the fact that food is available in a given locality. Basically, when prices of food rise to the extent that individuals can no longer afford to purchase food, the erosion of exchange entitlement, not the absence of food, is responsible for the food insecurity experienced by the individual (Sen, 1981). By casting hunger and famine as an individually experienced phenomenon, Sen shifted economic approaches to address food insecurity from the domain of macroeconomics to microeconomics. Sen's contribution

also ushered in a reformed set of measurement tools based on food access at the household level (Barrett 2002; Webb 2006).

More recently, economics has come to view food security through a framework of uncertainty, risk and vulnerability. Introducing concepts of risk and uncertainty more accurately portrays food security as a time variant probability of falling below a certain threshold of consumption to satisfy the physical and social requirements of food intake. As such, risk and uncertainty help to account for the fact that food security status is likely to vary over the course of the lifetime of the individual and is subject to random shocks to health and the immediate environment (Barrett, 2002).

In economics, vulnerability can be defined as a combination of exposure to risk and access to coping mechanisms to manage that risk. Attempts to develop theoretical frameworks for vulnerability to food security have expanded recognition for sociological views of food security (and insecurity) as a "managed experience" (Radimer, et al 1990; Frankenberger et al, 1992). People are not victims of catastrophic events, rather are "active participants in responding to risk in their everyday lives" (Coates et al, 2006). Support for this notion of food insecurity as a managed process comes from cross-cultural evidence of an orderliness to the food insecurity experience in which households allocate and reallocate resources under conditions of scarcity. First, households express worry and uncertainty over the sources of their food, then begin substituting foods of insufficient quantity or inadequate quality, and then resort to eating foods which are not socially acceptable or acquiring foods through socially unacceptable methods or begin going without meals (Coates et al, 2006).

Measuring Household Food Security

Shifting phases in economic thought correspond to changing approaches in the measurement of food insecurity. These are generally grouped into three generations or classes. Below, I present a table summarizing these different classes. Interestingly, all three classes of food security continue to be utilized today as each may be more appropriate to different assessment, program, or research contexts.

Table 1: Classes of Food Security Measurement in the Twentieth Century

Class	Description	Research and Measurement Methods
1	Problem of agricultural supply Green Revolution	-Food availability per capita -Anthropometric data collection
2	*Essay on Poverty and Famines* (Sen,1981) Access and exchange entitlement	-Household expenditure (and less frequently consumption) surveys (Smith and Subandoro, 2008)
3	Individual microeconomic problem under risk and uncertainty "Managed Experience"– (Coates et al, 2006)	-Construction of qualitative scales -Ethnographic studies

As suggested by the complexity of understanding and measuring food insecurity, a single perfect measure of food security does not exist. Nevertheless, it is commonly agreed that attempts should be made to measure food security as a multidimensional experience. Dimensions of food insecurity include:

1. Worry and uncertainty
2. Insufficient quantity
3. Inadequate quality
4. Social acceptability of foods consumed and methods for obtaining foods

Consequences of food insecurity, such as hunger, the adoption of potentially harmful strategies to augment the food supply, and reductions in quality of health are also important.

Anthropometric measures, such as stunting, upper arm circumference, and weight to height ratios are some of the oldest and most commonly utilized measures which have been used for the documentation of food insecurity. However, there are several issues with these measures as indicators of food insecurity, especially in modeling applications. For one, food insecurity is an inherently *ex ante* condition of limited access, whereas anthropometric measures document the *ex post* consequences in the human body (Barrett, 2002). While inadequate quality or insufficient quantities of food are usually necessary conditions for anthropometric indicators of food insecurity to be present, they are not sufficient conditions for anthropometric measures to be severe or alarming. Specifically, anthropometric measures pick up a

number of additional variables such as individual health status, access to clean water supplies, sanitation, and adequate shelter which must be accounted for in their ability to measure food security.

Class 2 measures provide quantitative analyses of whether minimal nutritional needs are being met against different thresholds for food security and dietary quality. These include measures such as calories available at the household level and dietary diversity. Additional indicators of dietary quality can also be calculated from these measures, such as percentage of dietary energy derived from staples. Some Class 2 measures attempt to combine measures of sufficiency and quality, such as the World Food Program Consumption Score. Criticisms of Class 2 measures are that thresholds for food security and dietary quality are arbitrarily determined because of the diverse nutritional requirements of individuals depending upon activity level and health status. Moreover, Class 2 measures are usually based upon household expenditure data, which may or may not closely track actual consumption, especially under conditions where food is unevenly distributed in the household. In an effort to improve the accuracy of Class 2 measures, some recently recommended adaptations encourage utilizing methods which more nearly approximate or actually gather consumption instead of expenditure data for more direct estimation of food access (Smith and Subandoro, 2008).

Both Class 1 and Class 2 measures are criticized on the grounds that they fail to represent the multidimensionality of the food insecurity experience by disregarding conditions of worry and uncertainty and the socially acceptability of foods consumed and/or the methods by which such foods are consumed (Coates et al, 2006). Class 3 measures attempt to offer a more comprehensive picture of food security by incorporating measures of social acceptability and uncertainty and worry, but they must be closely adapted to the particular cultural context. The United States currently uses a Class 3 indicator of food insecurity, the Household Food Security Module (HFSM), which is an 18 question scale that covers uncertainty and worry over food, insufficient quantity, and inadequate quality, and consequences such as hunger. Other examples of third generation measures include the Coping Strategies Index (CSI), which outlines a process for facilitating the development of localized scale for assessing food security

(Maxwell,1999) and the more recently developed Household Food Insecurity Access Scale (Coates et al 2007).

Critics of Class 3 measures argue that such individually determined levels of sufficiency and reporting make it much easier to manipulate these scales. In the event that the respondent feels they could stand to benefit from their choice of response, these scales have the potential to over-report food insecurity. Moreover, Class 3 measures need to be adapted to ensure that they are asking questions which are culturally appropriate, both for the sake of eliciting accurate responses and to avoid causing shame or embarrassment to the respondent. Adding to the complexity of the debate, different classes of measures of food security conducted on the same populations often disagree over the classification of which individuals are food insecure (Maxwell, 1999, 2008; Wiesmann et al 2009).

Despite remaining controversy over which methods should be applied to the measurement of food security, the apparent disconnect between the suffering of the hungry and the macroeconomic availability of food have fostered consensus among the research community that food security must be addressed at the individual and household level. The following two chapters draw on this review of food security measures towards developing a theoretical framework for measuring the impact of social networks on food security and for the selection of appropriate indicators for modeling this relationship econometrically.

Chapter 3: Microeconomic Models of Household Food Security

Contrasting Household and Individual Approaches

Food security is now commonly identified as a microeconomic problem subject to conditions of risk and uncertainty. In seeking to develop microeconomic frameworks for the analysis of food security, the two most common levels of analysis are the individual and household. Attempting to lay out a framework for analyzing vulnerability to food security, Løvendal et al (2004) describes food security as a jointly determined product of household food access, individual food access and biological utilization based upon individual health activities. The focus of this literature review will be on household level frameworks, but it is important to recognize that representing food security through individual microeconomic models has distinct advantages which should be kept in mind for the exploration of household level approaches.

Individual approaches allow for direct measurement of nutritional status as a product of individual activity levels, health, and consumption (Chavas, 2000). Second, individual level models capture the common pattern of inequitable distribution of food within the household. As demonstrated by a number of researchers, women and children are often more vulnerable to food insecurity than men within the household. For women, this is often a consequence of mother to child buffering, or the mother reducing her portion size to ensure that children have enough (Lemke et al, 2003). Even so, evidence suggests that food insecure children living in otherwise food secure households are the most likely to be missed by household level analyses (Guha-Khasnobis and Hazarika, 2006).

As pointed out by Barrett (2002), the development of useful microeconomic frameworks should carefully weigh the tradeoff between modeling food security as a function of individualized human need while providing a level of aggregation that is useful to program designers and policy makers. To address food insecurity among smallholders, households are the more common unit of analysis. This is a function of both practical and intuitive reasons. For one, executing programs at the household level is more manageable with smallholders located in rural settings. Secondly, rural agricultural households often

share a common set of characteristics which are particularly appropriate for the development of microeconomic models and also have significance for food security.

Smallholder households are typically characterized as small producers who retain at least some of their agricultural production for consumption within the household. From a food security perspective, the consumption of agricultural products is thus likely to be more similar amongst members of smallholder households. This is due to the fact that decisions regarding what and how much to plant, how much to sell, how much to keep, and how much to work off the farm are typically decided at the household level.[2] Therefore, members of the smallholder household can be assumed to have a common basic diet (De Janvry and Sadoulet, 1995).

Based upon these assumptions, household models have been utilized as a tool to gain insight into the behavioral patterns and decision making of smallholder households for more than half a century. The original household model developed by Becker in 1965 sets forth the smallholder household problem as one of maximizing utility subject to a household profit function, preferences for consumption of agricultural and non-agricultural goods, and preferences for work or leisure[3].

Depending upon socio-economic context, household models can either be specified as separable or non-separable models. In a separable household model, most of the markets[4] important to the production, consumption and labor decisions of the household work well and are capable of absorbing both supply and demand functions of the household. This allows for the household to commoditize the value of its production of agricultural goods or labor, even in the case that the household faces a considerable band between the prices at which it could sell or purchase a good. Thus, in separable models, decisions regarding labor, production and consumption can be solved independently of one another and vary

[2] This holds even in the likely case that the distribution of production responsibilities, consumption, and labor are not uniformly distributed among household rather than individual level members.
[3] Leisure includes activities such as time spent cooking, cleaning, sleeping and maintaining the household so that one has the ability to labor, either for him/herself or for others.
[4] In the event that a single market is missing, the model can be resolved recursively. In effect, the functioning markets will make up for the market that is missing. An exception to this is the availability of credit.

according to different targeted levels of farm income. Variation in household responses to different policies and programs is a function of whether a household is a net producer or net consumer (De Janvry and Sadoulet, 1995).

However, smallholder households who live with food insecurity or suffer from the threat of food insecurity in the near future do not often live in settings where markets are fully developed. This is especially true with regard to access to credit. In settings where credit is constrained for seasonal production to the point that a household cannot access as much as it would like and begins to substitute toward investment in other goods, then prices are no longer exogenous because they carry an additional opportunity cost of credit (De Janvry and Sadoulet, 1995). When credit markets or more than one market is not adequately developed, a nonseperable household model is specified. Within these models, consideration of risk and uncertainty is now a crucial aspect of modeling food security. Introducing concepts of risk and uncertainty more accurately models food security as a time variant probability of falling below a certain threshold of consumption to satisfy the physical and social requirements of food intake. Risk and uncertainty most often appear in models as stochastic shocks which do not strike uniformly and will likely have systemic effects on smallholder behavior.

A Household Approach

Developing a household model for food security offers the opportunity to develop a comprehensive picture of the complexity of factors which households balance in seeking to minimize risk of food insecurity. On the following page, I present a non-separable model of food security under risk and uncertainty developed by Barrett (2002).

$$\underset{x_t, l_t, s_t}{\text{Max}} E_0 \sum_{t=0}^{\infty} B^t U(w_t, \chi_t) \qquad \text{(1) Utility (consumption, physical well - being)}$$

s.t.

$W_{t+1} = \Theta(W_t, n_t, l_t, x_t^{nf}, z_t, \Phi_t^h)$ (2) Physical well - being

$W_{t+1} \geq 0$

$n_t = \gamma(x_t^f, N, \Phi_t^h, I_t),$ (3) Nutrition

$a_{t+1} = \delta a_t + s_t + \Phi_t^h,$ (4) Assets

$p_t^{x^t}(x_t + s_t) = p_t^{q'}(q_t) + b_t + g_t, \quad \forall x, s, \in T,$ (5) Budget constraint for tradeable goods

$x_t + s_t = q_t + k_l, \quad \forall x, s, \in NT,$ (6) Non - tradeables

$\wedge(q_t, l_t, a_t, w_t \mid \Phi_t^h) = 0,$ (7) Production technology

$b_t \leq \Omega(a_t),$ (8) Credit constraint

$e' l_t \leq l_0,$ (9) Time constraint (of labor and activities)

$a_t, l_t, x_t \geq 0$ (10) Non - negativity

This model attempts to capture the multi-dimensional nature of food security at the household level. Equation 1 represents a utility function which maximizes household physical well-being (W_t) and consumption over time (χ_t), while the constraints specify the parameters within which utility can be maximized. Equation 2 recognizes physical well-being over time as a product of previous well-being (W_t), nutritional status (n_t), activity levels (l_t), consumption (x_t^f), and shocks to health (Φ_t^h). Equation 3 relates nutrition as the product of consumption (x_t^f), the nutritional value of foods (N), shocks to health (Φ_t^h), and consumer knowledge (I_t) of how to utilize food products. Asset levels (Equation 4) are a function of depreciation (δa_t), ability to save (s_t), and shocks to property rights (Φ_t^h). The budget constraints for tradable (Equation 5) and non-tradable goods (Equation 6) simply reflect that outflows spent on consumption (plus quantities borrowed (b_t) or given to the household (g_t,) must balance the value of the households income earned from productive activities and its savings ($p_t^{x^t}(x_t + s_t)$). Meanwhile, output is subject to a production function (Equation 7) dependent upon inputs (q_t), activity levels (l_t), asset levels (a_t), well-being of the producers (w_t) and health shocks. Equation 8 restricts the

ability to borrow to the amount of assets held and Equation 9 places a time constraint on household ability to pursue a given level of activities. Equation 10 simply refers to the fact that savings, activity levels, and consumption must be greater than or equal to 0.

Food security is argued to fall out of the model as the probability of maintaining a minimal threshold of consumption (set as greater than 0 so as to enable to survival but to possibly impair health, *m* in order to ensure a non-impairment level of consumption, and w* a healthy or optimum level of consumption):

$$\textit{Survival}:$$
$$F_t^1(n) = \text{Prob}(w_{t+s} > 0)$$
$$\textit{Nonimpairment}:$$
$$F_t^2(n) = \text{Prob}(w_{t+s} > m)$$
$$\textit{Healthy}:$$
$$F_t^3(n) = \text{Prob}(w_{t+s} \approx w^*)$$

Key contributions of the Barrett (2002) household model is that while retaining the household as the unit of analysis, it allows for consideration of the relationship between health status, consumption, nutrition, and physical well-being; even if less precisely than would be possible at the individual level. Moreover, in creating three levels of food security, it also accounts for some of the irreversible welfare effects of falling below a given food security threshold (Barrett, 2002; Chavas, 2000). Most significantly, in developing separate constraints for nutrition, physical well-being, and productive activities, the model establishes a framework with different entry points through which projects and programs may operate to improve food security status. The interrelation of constraints allows for the derivation of potential effects of food assistance programs on household food security status. In the next section, I will briefly walk through how two common food security programs would operate through the Barrett model.

Predicting Food Security Intervention Impacts

In the first example, a nutritional feeding program to improve food security would most likely predominantly operate through Equation 2 and Equation 3.

$$W_{t+1} = \Theta(W_t, n_{t,} l_t, x_t^{nf}, z_t, \Phi_t^h) \quad \text{(2) Physical well - being}$$
$$W_{t+1} \geq 0$$
$$n_t = \gamma(x_t^f, N, \Phi_t^h, I_t), \quad \text{(3) Nutrition}$$

In Equation 3, the nutritional feeding program would have a direct effect on the amount of consumption (x_t^f) and the nutritional value of the food being consumed by the household (N). If the program contained an educational component, then the program could also change knowledge of preparation techniques (I_t) to allow for more nutrients to be retained through the food preparation process. An example of this might be reducing boiling time on vegetables to prevent nutrient loss. Additionally, Barrett's model allows the researcher to follow through likely indirect effects of the program through the incorporation of the current nutrition (n_t) parameter into Equation 2. Basically, by increasing nutritional status in the current time period, the program has the potential to increase future well-being of the participants, subject to the other parameters on future well-being (current well-being, shocks to health, current activities, health shocks and other unknowns). The contribution to food security is made through the obvious impact of raising current nutritional status in the current period (n_t) and through increasing physical well-being (w) over the longer term.

The Barrett model also helps to work through the logic of how agricultural development programs may improve food security. A popular agricultural development program is the dissemination of a higher-yielding seed variety, such as the introduction of hybrid maize into western Kenya (Mango, 2000). This type of program would primarily operate through Equation 5.

$$p_t^{x'}(x_t + s_t) = p_t^{q'}(q_t) + b_t + g_t, \quad \forall x, s, \in T, \quad \text{(5) Budget constraint for tradeable goods}$$

The primary objective of the program would be to improve agricultural output, thus allowing a smallholder to have more income to spend upon consumption (relaxing the budget constraint), assuming

that labor and inputs are held constant[5]. In addition to affecting the budget constraint, agricultural development programs may also operate through Equations 2 and 3, especially because these programs are households consuming some of their own product. Specifically, the yield gain should mean greater food consumption by the household (x), either through allowing the household to hold more production back from sale or by earning more income by which to purchase food. However, this would need to be carefully estimated empirically as even individuals with low food intake tend to spend an increase in income on other goods, reflecting the low income elasticity for agricultural products (Barrett, 2001). A low income elasticity should likely be expected with a staple good, as maize represents in western Kenya and eastern Uganda[6]. Should the household spend the income increase on durables, then the income increase would allow for increased stockbuilding (*s*). Through either or both channels, the program has the potential to work through to lowering the probability of household food insecurity through the increase in stockbuilding and or physical well-being. Through this potential positive impact on nutrition, the program may eventually also increase future physical well-being. As in the nutrition model, these would primarily operate to improve the probability of food security through increasing physical well-being.

A shortcoming in this model is that it does not offer the opportunity to identify the mechanisms by which households act to reduce risk of food insecurity or actively engage in processes of social learning to adapt to systematic shocks. As Barrett himself recognizes, efforts made by the household to manage risk are inherently endogenous to the model (Barrett, 2002). Conditions of social learning and activities of risk management are facilitated and constrained by the structure of social networks. In the following sections, I explore the possible entry points for social networks into Barrett's model.

[5] This may not be a strong assumption for the introduction of hybrid maize varieties, as such varieties typically require increased fertilizer inputs to achieve yield gains, but for the sake of simplicity in demonstrating this example, these are held constant.

[6] The cultural value and significance of maize in the Mount Elgon region likely eliminates maize from acting as an inferior good, or decreased consumption of maize resulting from an increase in income.

Social Networks and Household Food Security

Especially in the absence of formal institutions for the extension of credit and/or basic services, local structures of support services arranged through networks of sharing and reciprocity can be crucial to allowing the household to smooth consumption over time. In the Barrett model, many of these operations would enter into the budget constraint for tradeables, Equation 5. As pointed out by Fafchamps (1992), local solidarity networks can be utilized to manage food insecurity *ex ante* and *ex post*. Such solidarity networks are a key source of unrequited gifts or transfers, (g_t), even if membership implies that these transactions would also necessitate a future obligation to the network. In a more complex application, Fafchamps also points out that members of solidarity networks may pool together labor to work the fields for a household who has a sick family member *ex ante* to prevent them from having to provide food after a poor harvest *ex post.* Here, the household has been prevented from experiencing a shortfall in consumption (X), and many or may not have a future debt to repay to the network depending on the local context (Fafchamps, 1992).

Social networks are often crucial to the adaptive capacity of households through holding a strong influence over the norms and ideals held by individuals. This is because the structure of social networks tends to direct and concentrate resources to particular locations in the network, fostering the development for shared norms and values about a certain practice (Knoke and Yang, 2008). This particular characteristic of networks is likely to enter the Barrett model at multiple points. For example, knowledge regarding cooking and the preparation of food, (*I)* in Equation 3 is typically embedded in intergenerational gendered networks (Lemke et al, 2003).

Processes of social learning within networks are also often crucial to whether producers choose to adopt and adapt particular agricultural technologies, Equation 7. As demonstrated by Conley and Udry (2010), pineapple farmers in Ghana were more likely to try a new practice when a close contact carried out the practice successfully. Kiptot et al (2006) examine the diffusion of agroforestry technologies through kinship and friendship networks in Western Kenya. Bandiera and Rasoul (2006) demonstrate that

different types of social networks, such as networks of religious affiliation, can have different influences on adoption at different points in the dissemination of a technology. As exemplified in the Barrett model, decisions regarding production technologies have especially important implications for smallholders through direct effects on consumption (X) and labor (l) activities within and outside of the household.

Qualitative research has documented that social networks can also play a key role in the decisions of smallholders to manage ecological risk through the application of particular agricultural technologies. Primary evidence of this comes from Burkina Faso, where Mazzucato et al (2001) identify land, labor, women's natal, cattle, technology, and cash networks as key to accessing different types of resources necessary to apply sustainable technologies. While a number of different soil improvement technologies are identified, it is shown that different techniques are applied adaptively, as farmers respond to ecological changes in the landscape. Different networks, such as labor for an activity or cash to purchase food, are accessed through their respective networks when needed; with recognition by the recipient that they now owe a future debt in their reciprocity network. Similarly, social networks are hypothesized to play a key role in facilitating the adoption CAPS technologies in the SANREM CRSP Technology Networks Cross Cutting Research Activity (Lamb, et al 2010).

Despite this varying range of evidence suggesting a strong relationship between social networks and the ability of smallholders to manage food insecurity risk, the role of social networks in affecting household food security status has not been empirically tested. In the following chapter, I draw upon literature from social network analysis and insights from microeconomic theory toward the development of a practical model to measure the impact of social networks upon food security.

Chapter 4: Data and Methods

Integrating Modeling and Data Collection

Data collection for this thesis occurred in two stages. First, from June to September 2010 LTRA 10 conducted a baseline survey of 790 households (SANREM CRSP 2010; Odhiamba et al 2011; Wyoming SANREM project 2011; LTRA 10: CAPS for smallholder farms in eastern Uganda and western Kenya 2011). Of these households, 395 were administered surveys which contained an additional module for the collection of data on Technology Networks, developed from the SANREM CRSP Working Paper "Research Framework for Technology Network and Gendered Knowledge Analyses" (Lamb, et al 2010). From February through April 2011, I collected data on household food security and household networks for acquiring food following up with these same households. Upon completing this data collection phase, the two datasets were merged using the household reference numbers.

This two phase data collection process presented me the opportunity to be very intentional in the decisions of what type of data to collect, the best way to collect that data in the face of gender and cultural considerations, and to anticipate some of the problems that might be encountered in modeling that data econometrically. As such, there is a significant level of integration between the modeling and data collection methods employed in this thesis research. This chapter describes the basic empirical model, justification for selecting particular measures of food security and social networks, and how the process of collecting this data was managed in the field.

A Basic Empirical Model for use with Cross-Sectional Data

As detailed in the previous literature review, the management of household food security and social networks are inherently dynamic processes which evolve with exposure to different

shocks. Given this insight, the relationship between the two should be estimated using panel data. However, in areas where there are high levels of food insecurity, panel data is extremely difficult and expensive to collect, especially combined with the additional challenge of measuring social networks. Moreover, constraining analyses of food security and vulnerability to food security to the availability of panel data presents a significant moral opportunity cost. The time and expense of collecting panel data is traded off for efforts which could be made to help those suffering from food security and vulnerable to suffering from food insecurity in the future. Thus, the development of methods which can sufficiently estimate food security and vulnerability to food security from cross sectional data is highly important and the focus of this modeling and estimation strategy. Drawing upon literature on vulnerability to poverty and the influence of social networks on other dynamic processes, such as technological change, I develop the following model to relate social networks to household food security status using cross-sectional data:

$$y_i = z_i^{'} + \alpha_i + N_i + \varepsilon_i$$

Here, y_i is food security status for household (i), $z_i^{'}$ is a collection of control attributes which would affect household food security status, α_i represents those variables which indicate the strength of the household's networks for agricultural production (commonly referred to in this study as technology networks), and N_i represents those variables which measure of the strength of the household's networks for food acquisition.

Several issues arise in the specification of the empirical model. First, between the numerous control, food security and social network variables; the model requires a significant undertaking in data collection. Fortunately, the baseline household survey data collected in 2010 by the

LTRA 10 team provided the control variables and agricultural production network variables, leaving me free to focus upon the collection of data for the social network and food security variables in following up with the same households six months later. A second significant concern is the potential endogeneity of social networks to food security. Basically, it may be difficult to show the directionality of the relationship between food insecurity and social networks. Do individuals enhance their networks for food acquisition *because* they are food insecure? Due to this suggested endogeneity, a potential instrumental variable was collected during the fieldwork for the specification of an alternative model to demonstrate the relationship between food security and social networks. A discussion of sampling, enumeration, and how and what variables were collected, and the suitability of those variables for econometric modeling is the focus of the first part of the data section. The second part of the section describes how I handled the merging and cleaning process with the baseline data.

Sampling

While data collection occurred in a two phase process, the sample design for this research relied upon the previously set forth framework by each of the sites during the 2010 baseline survey. Sampling methods differed between sites as the process was headed up by three different NGOs, each tailoring the process toward their selected research communities. This section describes and reflects upon these differences with regard to modeling the relationship between networks and food security.

In Uganda, the NGO Appropriate Technology Uganda (AT Uganda) developed a quasi-experiment. In Kapchorwa and Tororo sites, two sub-counties were selected, and within each sub-county trials were established in one or two parishes, with a total of four parishes surveyed in every site. In Tororo, the two sub-counties were Molo and Kisoko. In Molo, the two parishes

selected were Kidoko and Kipangor and in Kisoko, Gwara-Gwara and Kisoko parish were selected. In Kapchorwa, the research actually spanned two districts, Kapchorwa and Kween. In Kapchorwa District, the surveyed parishes were Kaplak and Kapeschombe, and in Kween District the surveyed parishes were Kwosir and Kere. Kween formerly belonged to Kapchorwa, but was designated as a separate district in 2010. Kapchorwa town, meanwhile continues to serve as the main urban center accessed by the residents of Kween. Throughout this text I will commonly refer to this entire area as Kapchorwa, as this name is still more readily recognized, especially in agricultural development research.

During the 2010 baseline, a list frame was created by obtaining records from the sub-county level and then preforming a random selection from the list of which households to survey, with particular attention to ensuring that female headed households were included in the sample. This was accomplished by first identifying 50 households in which the male household head would be interviewed. Secondly, all the solely female headed households were interviewed and these made up the first households of the group of 50 households where women were to be interviewed. When a household could not be located during the survey, substitutions were made in the field for similar households. Molo sub-county and Kwosir sub-county were selected for the technology networks survey, so I only worked extensively in these two areas.

In Kenya, the process was different in Bungoma and Kitale. In Bungoma, the NGO SACRED Africa identified farmer groups with whom it had worked with previously and used these groups as a base from which to build their sample outward. The resulting surveyed population was widely geographically distributed between Bungoma South and Bungoma West and clustered around two different market centers. In Bungoma South, the main trade center was Bungoma

town, but Bungoma West utilized the Chwele market. Enumerators were instructed to tradeoff interviewing men and women in a particular geographic area in order to ensure gender balance.

In the Kitale area of Trans-Nzoia District, Kenya; the peri-urban populations of the Kibomet and Milimani sub-locations were selected for the technology network study, so research efforts were focused on this population in the network and food security surveys. As in Uganda, list-frames were created from local records, female household heads identified, and substitutions made in the field if households could not be located.

Across the sites, mixed teams of men and women were employed from the area of each of the sites for the enumeration of the survey in order to hire people with knowledge of the local language and geography. The enumerators were trained by the staff of the respective NGOs managing the projects in each of the sites. Despite the differences between the methodologies adopted by the different organizations, I believe that the processes followed by each of the NGOs were sufficiently thorough to create a random sample of the populations for each of these regions.

Returning to the sites for the food security and social networks survey, I began by obtaining the list of households surveyed from the respective NGOs responsible for each of the sites, or in the case of Bungoma, regenerated the sample by examining the actual baseline surveys themselves for the households who were given the technology networks surveys. I then hired a local team of two to four people to serve as enumerators, and in some cases an additional guide for helping to coordinate the enumerators in the field and identify the households in each location. While this meant the survey involved a high total number of enumerators at thirteen, the expertise of these local teams was critical to the success of the research. The majority of the time, the enumerators

had worked on the previous baseline and/or focus groups conducted in the area and thus had a basic familiarity with the sites being surveyed. Moreover, the enumerators also had knowledge of locally specific dialects and tribal languages. Indeed, the extreme diversity in these local languages in sites would likely have made it nearly impossible to work with a single team of enumerators for all of the sites.

For the second survey, only female heads of household were interviewed. I argue that surveying the female household head (as opposed to the male) is more likely to accurately reflect food insecurity and food relations experienced at the household level. This is due to the fact that women are primarily responsible for acquiring and preparing food in East Africa. As discussed in the focus groups held across the sites, women's consumption is most likely to track that of the household as she is less likely to consume food away from home and is primarily responsible for what food is prepared for the households. Additional research demonstrates that women's food intake is also more likely to be affected by distributional effects, such as mother to child buffering in which women report reducing their food intake so that their children may eat enough (Tasuruk 2001; Lemke et al 2003). In this manner, women's consumption can be seen as a "canary in the mine" for the targeted diagnosis of a household food insecurity problem.

Given that only women were to be surveyed, I did my best to hire only female enumerators for this survey. I believed that the female household heads would be more comfortable and honest in sharing sensitive information on household consumption and their food networks with women rather than men. In two sites, hiring only women was not possible. In Bungoma, the most experienced enumerator was a man who had assisted in the baseline survey process and data entry, and thus had critical knowledge for being able to identify households in the field. A male enumerator was also hired to survey the households in Kapchorwa. Of all of the sites, the

parishes of Kwosir and Kere presented the greatest challenge for data collection. The area where the surveys were completed is remote and mountainous (some 30-45 minutes by motorcycle from Kapchorwa town) and the surveys were being conducted during the height of land preparation and planting season. Given these conditions, it was very difficult to find qualified enumerators interested in the work. As such, one male and one female enumerator were hired to complete the survey in this site.

Despite the differences in gender and team size, I made a number of efforts in to control for error in the data collection process. Standardizing my training of the enumerators was a critical aspect of collecting quality data. In each site, I took one afternoon to go over the instrument with the enumerators and have them work in pairs practicing where one person was the enumerator and the second the respondent and work through the entirety of the survey instrument. This activity helped to identify words for particular foods in the local language and helped ensure that enumerators asked each of the questions in the same way. During the execution of the surveys in the field, an important aspect of controlling error was randomizing the location of the enumerators in the sites. The first day, I sat in on one interview with each enumerator in order to catch any mistakes or misunderstandings about how to conduct the surveys and sat in on a total of 5 interviews with each enumerator in total. Seasonal variation in data collection was also accounted for through appropriate staggering of the surveys between locations. By working in Bungoma and Tororo first, interviews were conducted at the start of planting season. Likewise, the later planting season in Kapchorwa and Kitale's meant that I was arriving in the same seasonal period in all the sites.

As can be expected, it was not possible to follow up with every one of the households which had been interviewed during the baseline survey. Households were dropped for a number of reasons.

Solely male headed households were not interviewed, nor were households where the female household head would be absent for the length of time I was working in a site, nor in incidences where the household had moved. However, should be noted that these were a very small numbers of households; one household in Bungoma, two households in Tororo, and three households in Kitale. In Tororo, three more households were dropped as one woman had passed away and two were too ill to be interviewed. In Kitale, several households could not be identified and some refused to be interviewed a second time. In Tororo and Kapchorwa, the interviewees often asked for money in exchange for their interviews, but typically consented when it was explained that I was a student working on a long term research project in their area. Overall, the data collection effort was largely successful. Of the 100 surveys in each sight, 86 were collected in Bungoma, 93 in Tororo, 98 in Kapchorwa (Kween) and 81 in Kitale for a total sample of 357 surveys.

Variable Selection and Data Collection

Application of Household Food Security Measures

As presented in Chapter 2, clearly there is no single perfect measure of food security which effectively captures all dimensions of the food insecurity experience. No matter which Class of measures is selected, the measurement of household food security is difficult and highly subject to measurement error. This thesis focuses on Class 2 measures of food security and dietary quality. Primarily, I believed that Class 2 indicators would be the most likely to offer data of adequate variation in which to study the relative impact on food insecurity, and were a more attractive option from a financial and modeling perspective than Class 1 or Class 3 indicators. Specifically, the collection of anthropometric indicators or Class 1 indicators generally must involve some type of measurement on the physical body and are thus more invasive, expensive, and time intensive to collect. Additionally, the baseline dataset available offers only a limited

opportunity to control for the factors other than food insecurity frequently captured in anthropometric measures, such as access to health care and clean water which have a direct impact on physical health. While I had originally proposed to use a Class 3 measure for measuring food security, the Coping Strategies Index (CSI), I was concerned that this indicator would be endogenous to social network activity. This concern was confirmed when I developed the CSI with the focus groups, as relying on friends and relatives for food was cited as a coping strategy to deal with food insecurity.

The calculation for the food insecurity and dietary quality indicators utilized in this thesis is described below:

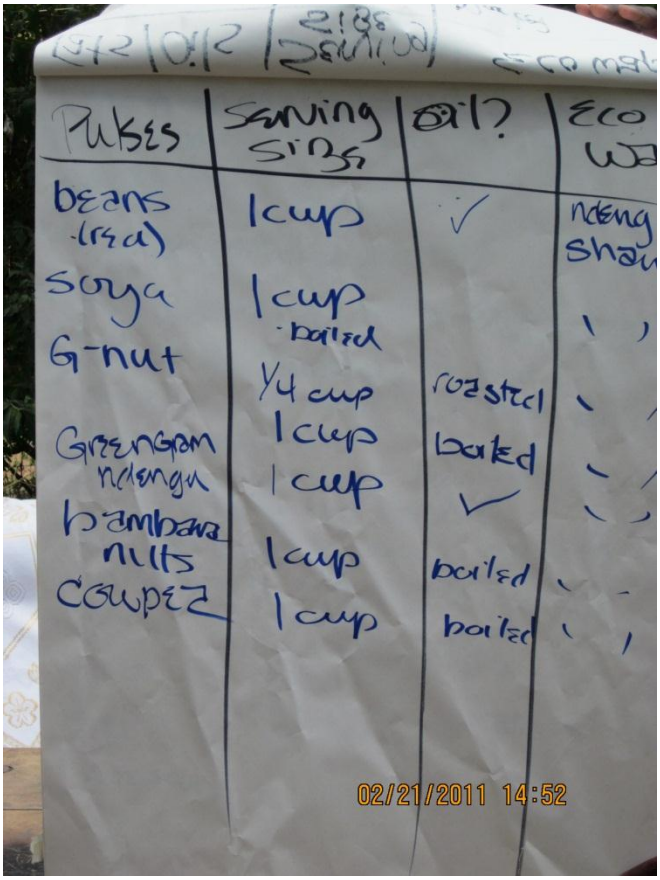
Table 2: Food Security Measures and Thresholds

	Measure	Calculation	Test	Scale
Food Security	24 Hour Dietary Recall	Calories consumed over 24 hour period	1. <2350 2. 2350-3000 3. >3000	1. Insufficient 2. Borderline 3. Acceptable
	Food Consumption Score (WFP)	Number of days on which different food groups were consumed	1. 0-28.5 2. 29-41.5 3. >42	1. Poor 2. Borderline 3. Acceptable
Dietary Quality	Percent Energy from Staples	Percent of calories consumed from staples	75% + very high 60-75 high 40-60 med <40 low	1. Very Poor diet quality 2. Poor diet quality 3. Adequate diet quality 4. Very good diet quality

Sources: (Smith and Subandoro 2008, World Food Program, 2008)

Using a Consumption Approach to Estimate Caloric Sufficiency

Figure 3: List of Legumes in Bungoma



Generally, economic analyses of food security tend to utilize measures of calories available at the household level based upon expenditure data. However, increasingly researchers have tried to integrate methods from the fields of nutrition and public health to improve the level of accuracy and more closely track what households actually consume, rather than what they have the ability to consume based upon their income (Smith and Subandoro, 2008).

In an effort to adopt a consumption approach, focus groups were held in each site to create a local consumption basket to ensure that the survey contained culturally appropriate foods and to determine approximate local serving sizes of different foods. In every focus group, we began by identifying the types of foods consumed from each basic food group (staples, pulses, etc.) An example can be viewed in Figure 3. I also asked the participants to explain any special circumstances with preparing a particular food and what a

Figure 4: Women use a local cup to demonstrate serving sizes

typical serving size of the food was for an adult woman. This was accomplished by using a half liter mug which the local communities were commonly familiar with to measure volume. From the food list, I developed a customized survey instrument for each site asking how many servings had been consumed in the past 24 hours and how many times in the past week the food was eaten (this was used for the calculation of the Food Consumption Score). Examples of the survey instruments developed for each site can be located in Appendix 1.

Once the data was collected and entered, the calories per serving were calculated by matching the foods reported to be consumed to food composition tables. Unfortunately, no comprehensive food composition tables have been developed for Kenya or Uganda. However, a joint effort of the Harvard School of Public Health and the University of Dar es Salaam produced Food Composition tables for neighboring Tanzania in 2008. The composition tables include macro and micro nutrient analyses of common Tanzanian foods and prepared dishes as well as a table of typically recorded adult serving sizes and are especially comprehensive (Lukmanji et al, 2008). However, some foods, such as Githeri (a typically Luhya dish prepared in Western Kenya) and a number of local vegetables and fruits were not recorded in the Tanzania Food Composition tables. As such, a 1991 set of basic food composition tables developed in Embu, Kenya developed by the Nutrition CRSP (Murphy et al, 1991) and a paper documenting nutritional values of African leafy vegetables (Oldhay, et al 2007), and some reputable online resources, such as nutritiondata.com were used to fill in the remaining gaps. A detailed record of these matches and substitutions can be reviewed in Appendix II.

As reported, in working with the focus groups, I asked the women to indicate a typical serving size for herself by using locally available half kilogram mugs. However, when the reported serving sizes seemed especially high, I utilized the Tanzania serving sizes. I also made this

substitution for all fruits, which were nearly impossible to record serving for based on the cup method. Serving sizes and adjustments made are also noted in Appendix II. Nevertheless, a number of substitutions and estimations needed to be made in an effort to provide the best match to locally reported consumption. Following from this, a key recommendation of the research is that effort be dedicated toward the production of food composition tables for Kenya and Uganda.

To calculate the final total calories, a MATLAB script[7] was developed to multiply the number of servings by the calories per serving. The resulting output created a calorie matrix, a total amount of calories consumed by each female household head in each food group category and a total sum of calories consumed in the past 24 hours. This development of disaggregated consumption data was instrumental to the analysis in several ways. First, it allowed for the identification of recalls that seemed particularly suspect or problematic so that they could easily by identified as a computational or data entry error and also allowed for more exploration of measures of dietary quality, such as percent energy derived from staples.

Approximating the WFP Consumption Score Calculation

The WFP Food Consumption Score is a relatively recently developed indicator which attempts to account for sufficiency of consumption and dietary diversity at the household level (WFP, 2008). Based upon the nutritional value of different food groups, the FCS assigns weights to different food groups, as described in the table on the following page. A household is given that value for every day a particular food group was consumed in the past week to develop an additive score. Finally, household consumption is classified as poor, borderline or adequate based upon their score range for societies which regularly consume oils and sugars as reported in the preceding table. To ensure some level of dietary diversity in achieving an adequate consumption level,

[7] The script is pasted into Appendix II and also available from the author on request.

each food group cannot be consumed more than seven days. As an example, this means that because staples are worth two points per day, no more than fourteen points are allowed to come from the consumption of staple foods toward the total score.

Table 3: Explanation of Food Group Weights for Calculation of the WFP FCS

Food Group	Score	Explanation
Main staples	2	Energy dense, protein content lower and poorer quality than legumes, micronutrients
Pulses	3	Energy dense, high amounts of protein but of lower quality than meats, micronutrients (inhibited by phytates), low fat
Vegetables	1	Low energy, low protein, no fat, micronutrients
Fruit	1	Low energy, low protein, no fat, micronutrients
Meat and fish	4	Highest quality protein, easily absorbable micronutrients (no phytates), energy dense, fat. Even when consumed in small quantities, improvements to the quality of diet are large.
Milk	4	Highest quality protein, micronutrients, vitamin A, energy. However, milk could be consumed only in very small amounts and should then be treated as condiment, and therefore reclassification in such cases is needed.
Sugar	.5	Empty calories. Usually consumed in small quantities.
Oil	.5	Energy dense but usually no other micronutrients. Usually consumed in small quantities.

Source: (World Food Program, 2008)

Traditionally, data is collected for the FCS by asking a family to report how many days in the past week each of the different food groups were consumed. In an effort to collect more disaggregated data and to have a better understanding of what individuals were actually consuming regularly within these categories, data was collected by individual food. The score was approximated by taking the highest single value of consumption reported within a given food group. In other words, if someone reported eating ugali five days, porridge three days and bread two days, the highest reported daily consumption was five. In some ways, this has the potential to underestimate consumption, however the actual findings of the data would seem to demonstrate that this was not the case as the reported FCS was generally high. A detailed

exploration of these data for measures of food insecurity and dietary quality will be the subject of later chapters.

Measuring Strength of Social Networks

Data on social networks was collected using egocentric methods, which measure relative network strength based on individual reporting of their direct contacts in social networks. Data was collected on networks to obtain information and resources on agricultural production, networks for acquiring food, and friendship networks. As the measures were seeking very different information, the data collection instruments were also different. The separate instruments and processes to collect the different types of network data are described in this section.

For the Technology Networks module, a position generator method was used to collect data on farmer contacts for obtaining agricultural information, advice and resources. The position generator method asks individuals about their relationships with members of different occupations, which in this case are occupations associated with agricultural production (Lin and Erickson, 2008). As such, developing a locally adapted list which makes sense to the local people is crucial to the survey. In order to do this, a list of agricultural support sector providers was generated with the Advisory Committees (a group of farmers and NGO representatives that LTRA 10 has consulted with throughout the research process). The list was then validated in focus group work in Kenya and Uganda conducted by members of the SANREM Managing Entity in conjunction with local country personnel in June and July 2010 (Christie 2010; Moore 2010). The contributions of the local advisory committee and the focus groups indicated that a wide variety of individuals often contribute to providing agricultural information, advice, and resources which extends well beyond the typically studied technology transfer network of

extension agents, agricultural researchers, and farmers. These included members of the local community such as shopkeepers, market vendors, teachers, government parastatals, teachers, preachers, and local community group leaders. The module included in the 2010 baseline survey conducted July through September 2010 asked farmers about different aspects of their relationships with these agents, including measures of frequency and trust emphasized in this research.

For data collection on food acquisition networks, a resource generator was utilized. A resource generator asks a respondent to report names of individuals who provide a particular type of resource, in this case food (Van der Gaag and Snijders, 2004). Not surprisingly, this was difficult data to collect and often enumerators had to do significant probing to get full answers to these questions. While the enumerators opened the section by asking about the individuals from which the women obtained food, often women would deflect this question, saying that they got food from their husbands or that they grew all of their food on the farm. Fortunately, in the section on the 24 hour and weekly dietary recall, I asked households to also report where a food came from, with a range from all the food being sourced from the farm, mostly from the farm, about half and half from the market or other sources or all the food from the market or other sources in order to develop a sense of the level of access to a particular food (World Food Program, 2008). I then asked the enumerators to star the foods sourced outside the household and inquire about these foods in particular in the food networks section. This method increased the reporting of food network activity. Nevertheless, this was exceptionally sensitive data to collect, and will be a key point in of discussions relating to gender and cultural dynamics and data analysis in subsequent chapters.

The final type of network data to be collected for this thesis was on the friendship networks of the female household heads. These networks were identified using a name generator method (Knoke and Yang, 2008). The name generator method of researching friendship networks is one of the most widely utilized social network data collection methods. The individual is asked to list the names of persons with which they would "feel comfortable discussing important matters" (Knoke and Yang, 2008). This is intentionally vague, leaving it up the respondent to interpret the notion of important matters. However, when asked I instructed the enumerators to explain by asking people to report the first names of people that they would go to if something was pressing them or bothering them.

Friendship Networks as a Potential Instrumental Variable

As briefly mentioned, there is some concern that there may be an endogenous relationship between food security and food acquisition networks. Female household heads may participate in networks because they are food insecure, meaning that the causation could run both ways. One way of accommodating for endogeneity in the estimation of an econometric model is to use an instrumental variables (IV) approach to estimating the econometric model. In an IV specification, another variable is used to instrument or estimate fitted values for the suspected endogenous variable in the model. An effective instrumental variable is one that is strongly correlated with the potentially endogenous variable (food acquisition networks), but should have no direct impact upon the dependent variable (food security). Data on friendship networks were collected for instrumentation purposes in the econometric analysis. Logically, whether someone has a strong friendship network is likely to be highly correlated with the strength of their food acquisition network, reflective of their ability to develop meaningful social ties. Meanwhile, it was hypothesized that the strength of friendship networks should not be directly correlated to

household food security status, and the only way it should be correlated is through the potential overlap of food and friendship networks.

A potential issue with this instrument is that there is limited literature regarding social isolation and food insecurity, which would potentially produce a direct correlation between friendship networks and food insecurity (Locher et al, 2005). However, this research mostly concerns the elderly in developed countries, where food insecurity is less prevalent and an inherently more stigmatized condition than in areas where food insecurity is more common (Lee and Frongilo, 2006). As such, it was proposed that measurement of friendship networks should result in an effective instrument for social networks of food acquisition to demonstrate an impact on food security.

Developing Network Variables

From the various network modules, measures to describe the strength of networks needed to be calculated. Generally, egocentric network data is assessed according to three criteria: degree, composition, and structure (Knoke and Yang, 2008). This analysis focuses on degree and composition, because an analysis of structure requires more in depth exploration of the contact between the nodes reported by the ego. The simplest criteria upon which networks are being evaluated is degree. This is simply a count of the number of contacts a person reports for each type of network. Composition is a bit more complex, and includes the descriptive qualities of a network. The primary interest of this thesis is the level of trust and frequency of contact between persons. For the data analysis, variables were developed for average trust and average frequency of contact for the agricultural production networks, food networks, and friendship networks.

Table 4: Network Variables and their Calculation

Technology Network Variable	Description
Agricultural Resource Network Degree	Count of number of different contacts for agricultural resources
Agricultural Information Network Degree	Count of number of different contacts for agricultural information
Average Agricultural Network Degree	Average of the Agricultural Information Network Degree and Agricultural Resource Network Degree
Average Agricultural Network Trust	Total of the Trust scores for the agricultural network divided by Average Agricultural Network Degree
Average Agricultural Network Frequency	Total of the frequency scores for the agricultural network divided by Average Agricultural Network Degree
Food Acquisition Network Variable	**Description**
Food Acquisition Network Degree	Count of total Food Acquisition Network Contacts
Average Food Acquisition Network Trust	Total of food acquisition network trust scores divided by Food Acquisition Network Degree
Average Food Acquisition Network Frequency	Total of food acquisition network frequency scores divided by Food Acquisition Network Degree
Friendship Network Variable	**Description**
Friendship Network Degree	Count of total Friendship Network Contacts
Average Friendship Network Frequency	Total of frequency scores divided by Friendship Network Degree

Control Variables

As described in the literature review, there are a number of control variables which are important to the food security status of smallholders. Key variables suggested by Barrett (2002) include access to credit, physical well-being, production technologies utilized, access to assets and ability to save. While the majority of these variables were collected by the 2010 baseline, the survey was missing a measure of physical well-being. Recognizing this, a measure for self-reported health was incorporated into the second survey where individuals were asked to report

their health as compared to those they knew. Did they feel they were healthier or not as healthy? Their responses were reported as poor, average, and above average. While self-reported health is obviously not a perfect measure of physical well-being, it has been demonstrated that self-reported health can approximate health in a relatively inexpensive manner across cultural contexts (Jurges, 2007).

Imputing Missing Data

Upon merging the food security dataset with the baseline dataset from the LTRA 10 project, it became very apparent that missing data would be a major issue in developing the regression model because of a number of control variables I had anticipated utilizing in my regression were missing observations. All methods for imputing missing data were conducted in STATA. In particular, the Kitale data had a high frequency of missing data, especially for particular sections of the survey. For example, in the livestock section up to two-thirds of the data was missing for various types of stock. This limited my ability to use particular variables in the regression. Fortunately, two of the most important types livestock to food security, poultry and dairy cattle, had high enough values that adequate procedures could be developed to impute the missing data. For dairy cattle, I imputed 10 missing entries through calculating the average number of dairy cattle per household per site and making the appropriate substitution. After this transformation to the data, dummy variable was also calculated for whether a household owned dairy cattle. For poultry, there seemed to be a clearer pattern in which some households were engaged in poultry production on a commercial scale and other households were raising poultry for home slaughter. In examining a frequency distribution of the data, it seemed that a household with more than 50 chickens was one of these commercial outliers. I then dropped these producers, and took an average of the remaining smallholders. This average of nine chickens was substituted for sixteen

missing entries across Bungoma and Kitale. However, the remainder of the livestock data had too many missing values concentrated in Kitale to justify methods of imputing data.

Fortunately, the data was much more complete for other sections of the survey, where I found other appropriate methods for imputing the missing data. For access to credit and animal traction variables, I took a general approach by calculating the mean for each site (Tororo, Kapchorwa, Bungoma, Kitale) and rounding to the nearest whole number and then substituting in the appropriate mean according to the site in which the household with the missing data was located. I accounted for this imputation of data by including additional dummy variables, so that any bias introduced from the imputed data could be accounted for in estimating the coefficients of these dummies.

Regarding the household head education variable, overall education appeared to be very low across the sites. Fifteen observations were missing overall and the missing data evenly distributed between the sites. With the belief that those who were well educated would be less likely to have missing entries, a dummy variable to represent "high education" was created to signify those who had an education above primary school level, thus eliminating the problem of missing data for this variable. For amount of land owned, total hectares cultivated and distance to the market, and presence of a household kitchen garden variables I clustered the households by village, took an average of those households from the same village, and substituted this average for the missing observations. With the kitchen garden importance variable, missing data was imputed by also accounting for whether a house reported to have a kitchen garden. If no, this variable was given a 0. As for all of these variables less than ten entries were missing across the data set, I did not feel that it was necessary to create a dummy variable to account for the potential impact of the missing data for use in the regression analysis.

Significance of Data Collection to the Research

Being heavily involved in the data collection process was one of the most valuable learning experiences of this thesis. Not only could I control for a number of factors that I would have needed to otherwise simply assume had been controlled for in the data collection process, but I also gained insight into how the different sampling methods, enumerators, and local site conditions may have impacted the data. Integrating the data collection and modeling process allows me to be confident that the assumptions for linear regression can be fully satisfied. The variables collected are all expected to be linear in their parameters. This means that variables utilized are continuous and should relate to one another through a constant level of increase or decrease across their range. I can further be confident that the data collected was obtained through a random sampling procedure. In the next chapter, I discuss how I used focus groups to conduct qualitative research to motivate many of the quantitative hypotheses I explore in the latter half of this thesis.

Chapter 5: Qualitative Contributions to Studying Food Security

Qualitative work conducted through focus groups and semi-structured interviews with technology network service providers played a critical role in getting to know the various research sites and for making predictions regarding the quantitative data. This chapter summarizes qualitative methodologies applied and major findings from the qualitative research activities. A concluding discussion develops hypotheses about the network and control variables to be tested in the subsequent chapters.

Focus Groups

Aside from helping to develop the survey instruments for each site, focus groups with local women had two important purposes in the research process. First, they served an introductory function toward building a relationship with the community and a cohesive team with my enumerators and guides in the location. The second major role of the focus groups, and the focus of this section is that they established a food security and agricultural production narrative for each of the sites. Through listening to the people describe what they grow and what they eat, important differences and commonalities between people in the different locations emerged regarding food security and agricultural production processes. Across the sites, the focus groups followed a standardized format and consisted of four main activities:

1. Identifying local consumption basket
2. Gendered food security mapping
3. Coping Strategies Index
4. Dietary Timeline

Focus groups were conducted in each of the sites, with an additional focus group in Kapeschombe, Kaplak parish in Kapchorwa, for a total of five focus group workshops overall.

Details of each focus group are provided in table 5. The following sections work through some of the interesting insights provided by each activity.

Table 5: Focus Group Participation

Location	Date	Number of Participants	Age range
Kapchorwa, Uganda Kaplak Parish	12 February 2011	18	23-71
Bungoma, Kenya- Ndengelwa Village	22 February 2011	57	18-78
Tororo, Uganda-Kidoko Village	11 March 2011	15	21-73
Kween, Uganda-Kwosir Parish	26 March 2011	20	20-58
Trans-Nzoia, Kenya-Naisambu Village	12 April 2011	20	22-70

Consumption Basket

In addition to helping develop site specific survey instruments, focus group discussions regarding the local consumption basket indicated important qualitative differences between the sites. For one, the main staple food consumed varies across locations. In Kenya, the staple is overwhelmingly maize, which is finely ground into flour and prepared as *ugali*. *Ugali* is a stiff maize porridge made from boiling the maize flour with water. In Uganda, this dish is called *posho*. The mountains of Kapchorwa also allow for the production of *matooke* or cooking banana, which combined with *posho* serves as the main staple food for this region. In Tororo the main staple food is cassava, which is grown all the year round and harvested continuously (whether fully mature or not) as a buffer against food insecurity. *Matooke* is also consumed in Tororo, but is more commonly reserved for special occasions. Rice is also commonly consumed across the sites, but is not considered a "staple" but rather a food for guests.

I also learned that the varieties of maize planted and consumed differed from site to site. While Kapchorwa and Kitale had fully adopted hybrid maize for its yield advantages, the Tororo producers did not purchase hybrid seed, but a variety called Longe 5, a lower yielding high

lysine maize which has higher levels of protein. While the focus group in Bungoma reported growing hybrid maize seed, the members also knew of people who tried to keep local varieties and the women brought up that it was important to also consume millet and sorghum *ugali*.

Legume consumption was another key point of variation. Red beans are grown unilaterally and are generally agreed to be an important crop consumed by children. Of the sites, Tororo is the best region for peanut production, and not surprisingly peanuts are a key component of the diet. The focus groups in Tororo also reported commonly consuming *magira,* a sauce made from the broken and weevil attacked cowpeas. Preparing *magira* allowed the good cowpeas to be sold at relatively high prices in the market. In Kitale and Bungoma, soya beans have been increasing steadily in popularity. Kapchorwa was the most limited in legume production, reflected in the smallest numbers of varieties and dishes reported where beans were consumed.

Across sites, patterns of vegetable consumption had moved from consuming primarily local greens toward a number of exotic greens, such as spinach and kales. Nearly all greens are prepared with a combination of boiling and frying in oil. Most local greens are soaked in calcium bicarbonate before preparation to soften them and remove some of their bitter flavor before preparation. The gathering of wild greens was often identified in the Coping Strategies Index activity as a mechanism to cope with food insecurity.

Meat and dairy consumption varied widely between the sites. Milk consumption, alone and as a part of morning and afternoon tea is standard in Kitale. In other sites, milk is consumed less frequently and incorporated into the diet largely through drinking tea. While milk tea is common in Bungoma and Kapchorwa, strong tea[8] is also consumed regularly and is considered as a

[8] Tea prepared without milk and generally large amounts of sugar.

culturally appropriate substitute. In Tororo, the lack of dairy production means that strong tea is the standard with milk tea and consumption of milk by itself a much rarer treat.

Moreover, most households in Tororo cannot afford to purchase meat frequently. Thus, the majority of meat consumption comes from *omena* (Kiswahili) or *dagaa* (Kiluhya), which are small dried fish with a very strong odor that can be purchased inexpensively in the market. In Bungoma, Kapchorwa and Tororo, *omena* prepared with a tomato and onion relish is commonly consumed in times of food shortage. While nutritious, many people associate eating *omena* with poverty and consider it a less preferred, even if necessary food for household consumption.

Discussions regarding *omena*, the preparation of *magira* and local greens, and the gathering of wild greens as famine foods alerted me to several significant aspects of food security which would be missed in the data collection effort. By focusing on Class 2 measures, the measures of food security collected in the household survey do not reflect the social acceptability of foods consumed. Moreover, the food composition tables available do not reflect the impact of different techniques for preparing vegetables, such as soaking in calcium bicarbonate, boiling and frying or the effect of using the low quality legumes for household consumption. As it is common knowledge that preparing foods which are of poor quality, boiling, frying, decreases nutritional value, the nutritional contribution from a number of foods will likely be overestimated in the analysis.

Gendered Food Security Mapping

In the gendered food security mapping, I asked the community members to identify the different ways that men and women interacted to obtain food and tried to develop a sense of which members of the household were responsible for what product. Methodology for the food security mapping activity was adapted from the Gender and Technology Networks Working

Paper (Lamb, et al 2010).When building the local consumption basket, I also asked focus group participants to identify where and from whom different foods came from. Upon completing the consumption basket activity, I would then divide the groups up into 3-4 groups and give them 1-2 food groups to then map. I asked them to identify which household member was responsible for getting the food, then draw where it was brought into the household from, and if the item was produced for sale to also show where the item was sold, and who did the selling.

The main purpose of this activity was to identify places where foods were exchanged and the household members responsible for the individual food toward building an effective module for inquiring about food networks in each of the communities. The activity also provided a qualitative sense of the level of control women felt they exercised over these food acquisition networks.

Figure 5: Food Security Mapping in Tororo

Across the sites, a common pattern emerged regarding gendered access and control. Basically, when a food crop was identified as highly valuable and played an important role in household income, the crop buying/selling decisions were controlled by men. As was rationalized by men in Bungoma and Kapchorwa when they were asked to explain this finding, women were not to be trusted with valuable crops for there was fear that women would sell the crops and spend the money on her own things. However, this activity provided some important insights about foods that were under women's control. For instance, in Tororo it was common for women to make gifts of legumes or a small amount of

cassava to their friends. In Kapchorwa, women reported to exercise control over small fruit and *matooke* entrepreneurial activities. Specifically, women would travel to the Kapchorwa or Kamus market and buy fruits and *matooke* in bulk, and bring it back to their communities to sell at a slightly higher price to their networks of family, friends, and neighbors. The proximity of the Kenyan sites to Bungoma and Kitale markets seemed to limit the demand for this type of activity, as households could easily access fruits and vegetables that they did not grow themselves from these nearby markets.

In general, women exercised very limited control over livestock assets. For the most part, livestock were sold to a local butcher and meat purchased outside home, with men making both buying and selling decisions, though women are responsible for caring for the stock and often sent to do the actual purchasing. The two livestock assets over which women exercised some control were dairy and poultry production. Poultry production was especially important to women in Uganda. In Kapchorwa, a peculiar pattern was reported regarding this relationship. Eggs were rarely prepared by women, because the women usually brought these to market for sale. Men would purchase the eggs, bring them home and prepare the eggs for themselves. Likewise, in Kapchorwa women contributed the labor for milk production and decided how milk would be utilized. This said, a significant finding here was that of all the different types of livestock, dairy and poultry production contributed the most directly to household food security as the only products produced and consumed within the home.

Coping Strategies Index, Food Network and Seasonality discussion

The third activity in the focus group was a Coping Strategies Index (CSI). In this activity, focus groups were asked what community members did when food was not enough or money to buy food was not enough. This was a difficult activity to facilitate, and worked better in some sites

than others. Across the sites, the selling of livestock was listed as a key coping strategy to deal with food insecurity, as was borrowing food from a more well off relative. As revealed in the data section, this confirmed my concern with the potentially endogenous relationship between the Coping Strategies Index and network strength.

Nevertheless, the CSI provided a good foundation to ask some exploratory questions about food network activity and food scarcity. The geographic variation between the sites means that times of food scarcity are very different between sites. In Tororo, it was acknowledged that food was very scarce at the moment (mid-March) as most households were running out of their stores from the previous season and the rains were coming late to Tororo, but that the situation would be much worse in April or May once the crops were in the ground. In the meantime, families could survive off of continuous cultivation of cassava, harvesting small portions of the field for drying and immediate consumption. Bungoma, which is more climatically similar to Tororo, was also experiencing some food shortage with the delay of the rains pushing back the planting season and recognized that food scarcity would be the highest after the crops were in the ground.

In Kapchorwa, a similar pattern was recognized, food would be most scarce in June, just after crops were in the ground and before the early maturing crops were coming out of the fields. The focus group reported that people would currently be working in wealthier households fields in exchange for maize and small money. The women described this as a vicious cycle. Because the poor households were out of food, they needed to work in the fields for others, neglecting their own. But the fields in Kapchorwa needed two diggings or two plowings to be their most productive, and because the poor households were working for others during the first plowing, many households would only be able to get in one plowing, and thus have lower yields and find themselves in the same position the following year. This seems like a significant point where

conservation agriculture, by eliminating the need for two plowings might be able to contribute to improving food security for the poor households in the region. This activity did not work well in Kitale, as the cross section of women I worked with in the focus group appeared to be some of the wealthiest members of the community and said that they could not describe food insecurity conditions.

As part of the discussion, I posed the question: "When do people exchange food in neighbor and friendship networks most often?" Universally, the focus groups reported the highest levels of exchange when food was most plentiful, after the harvest. Conversely, when food is most scarce, these networks are the least active, because households prefer to keep what limited supplies they have. This was an important finding with the previously expressed concern about the endogeneity of food exchange networks to food insecurity. This finding would seem to contradict the idea that people would be reaching into their food acquisition networks because of food insecurity and the possibility of a negative correlation between food acquisition network activity and food security. Rather, the qualitative evidence supports that food acquisition networks operate independently of food insecurity or that network activity and food security would even be positively correlated.

Dietary Timeline

The final activity was a dietary timeline, which encouraged the focus groups to discuss how the local diet had changed within their lifetimes. The activity began with the oldest member of the group, and asked her to describe what the diet was like when she was growing up. In each of the sites, this activity took on a life of its own and varied significantly from place to place.

In Tororo, I was told a story of decline. As described by the eldest woman of the group, "when I was growing up, food was plentiful. There were antelope, lions, and large sturgeon in the rivers

and we grew sorghum, and had cattle from which we obtained milk and blood". In the late 1980's and early 1990's, Tororo was producing good maize, bean and cassava crops; but these were devastated by weeds, pests, and disease. Straiga makes it almost impossible to grow maize and sorghum, and cassava was attacked by Cassava mosaic in 1996. Cassava varieties were imported from Nigeria with disease resistance, but many of these varieties are poisonous and required special handling and drying processes before they are safe to eat. Lack of training or knowledge about these new varieties contributed to a number of unnecessary deaths. Agricultural yields have declined over time, and the soils are much poorer than they were ten years ago. Today, cassava grows best in the soil and has become the staple food. Farmers do not receive adequate support from extension agents, and feel that inputs from the National Agricultural Advisory Services (NAADS) do not flow to those who need it, but to those who are most well connected. Farmers do not trust extension workers or loan providers and mostly avoid working with them.

In Kwosir, this activity took a very different direction from the outset. When I attempted to identify the oldest woman in the group, we only found a woman in her late fifties. The women of the group told me that there were simply very few older people in the area, as most of them had moved here in the 1980's with their families. In fact no one had lived in Kwosir before 1988. The people had come to settle in the forest after bloody conflicts on the plains during the Museveni coup. The President had promised the people that he would protect their safety and that they could settle within Mount Elgon National Forest. However, this appears to have set up decades of conflict between communities and the Uganda Wildlife Authority (UWA). The government has prohibited the communities from erecting any permanent structures, meaning that as the population has grown, the community has not been able to build good schools or bring

in a clinic. Community members are in constant conflict with the UWA, which prohibits the people from harvesting honey and bamboo and from running their livestock in the forest. People caught by the authority are turned over to the police, and livestock captured are held with community members asked to pay exorbitant amounts for their return.

The diet of the people in Kween changed because the soils and climate in the mountains is so different than the plains in which they grew up. In Kapchorwa and Kween, the predominant rotation is wheat, maize and Irish potatoes. While the soils are fertile, it is much cooler in the mountains, making it more difficult to grow beans and fruits. As a result, the common meal is a combination of maize/Irish potatoes/ mingoled[9] wheat with greens, and meat when people can afford it. Many families keep livestock for milk and meat production.

Moreover, the Ugandan sites reported a decline in bean production, and a pattern of selling beans because they fetched a higher price in order to buy more staple foods which made them 'feel full'. Such a pattern was confirmed in Kapchorwa in an interview with Dr. Masai Siraji, a former clinician in Kapchorwa's hospital. Dr. Siraji emphasized that beans had been moved from a food security to a cash crop and were more often seen as a way of bringing money into the household to buy other items. Protein was obtained from meats on an infrequent basis, when the family had enough to purchase from the butcher every few weeks.

In Bungoma, the dietary timeline exercise reported mostly changes in diet due to increasing Western influence. The oldest members of the group reported eating a combination of local greens, sorghum, millet, and maize ugali and drinking milk and cow's blood. Western influence had discouraged people from drinking blood, and introduced exotic greens such as spinach and

[9] The women described a dish of mingoled wheat which is prepared similarly to *ugali*, but with wheat flour.

kales, which now are the primary greens consumed by households as *sukumawiki*. As in Tororo, households described food as being more plentiful in the 1980's and 1990's, but for very different reasons. A number of small households now engage in sugarcane production, which requires a commitment of at least two hectares to production for a year and a half. During this time households have less land on which to produce food crops. Women also described pressures from their children to eat differently. The children view eating sorghum and millet ugali and local greens as backward, poor people foods associated with being a poor farmer who comes from a village. The youth want to eat only maize *ugali.*

In Kitale, changes in diet were linked with increased commercialization in agricultural production. Both dairy and maize are produced at a large scale, and these two products fittingly dominate the local diet, and the sales generated from agricultural surplus afford formers the opportunity to purchase a variety of foods. Women in Kitale expected that the diet would grow increasingly more diverse, and as in Bungoma western influence would become increasingly more present through the availability of convenience foods and increased ability to purchase food in the supermarkets in Kitale town.

In Bungoma and Tororo, the women described a trend of the youth preferring to eat fried foods, especially chips and fried chicken instead of boiled or roasted meat. Youth were also eating fewer greens than their parents. Despite the seeming conflict inspired with the demand for fried foods from the youth, the introduction of oil was identified as key to reducing women's labor burden in cooking. Frying in oil allows foods to be prepared much more quickly than boiling, especially with greens. A further cross cutting theme was that to be food secure, households needed to produce their own food, and to be able to sell some surplus in order to purchase more food.

Technology Network Interviews

While the main purpose of interviews with agricultural service sector providers was to collect additional quantitative data for the Technology Networks Cross Cutting Research Activity, these interviews also provided interesting insights from agricultural service providers regarding how they felt their work and the work of other service providers in the region impacted local food security. A snowball sampling method was utilized in order generate a list of who to contact for these interviews. The final module of the Food Security and Social Networks survey listed all of the agricultural service providers about which the households had been previously surveyed in the fall, and the female household head, often with the male household heads input would provide the name of a service provider and where/how to contact this person. These lists were screened and any individual whose name was reported more than five times was interviewed. Agricultural service providers were also asked about their contacts, and if a name came up more than three times with the service providers these individuals were also interviewed.

Tororo

In Tororo, this sampling method generated a total sample of 14 service providers of a variety of occupations. Of the sites, this was the smallest number of service sector providers identified and in many ways signifies the lack of development of this agricultural production network. Local actors, such as a local farmer group leader, shop owner, women's group leaders for agriculture and group savings, and a local preacher were the most commonly reported individuals for obtaining agricultural information. Few households reported contact with extension agents or the sub-county chief. Local NGO agents and consultants from organizations such as Africa 2000 Network and PLAN Uganda were also frequently reported by community members in Tororo.

These actors presented a broad range of ideas about local food security and dietary quality. One respondent told me that food security "was no longer a problem in Tororo" because most every

farmer could practice continuous cultivation of cassava and that farmers should shift their focus to producing profitable crops such as pineapple. However, the majority of the agents expressed that their work was targeted to promoting local food security. Such efforts included increased diversification in crop production (especially maize and beans), livestock production in goats, and local gardening projects, especially in schools.

Most of these efforts had a distinctly local orientation. While one agent was focused on increasing farmer knowledge about prevailing prices in local and major markets for different agricultural commodities toward commercial production, the majority of agents interviewed were focused on improving local food production through hand cultivation for consumption within the home and community. Resources for commercial production seemed to not be available locally. Not a single member of the Kidoko and Kipangor communities reported having a relationship to a credit organization to obtain loans for agricultural production and community leaders and members frequently pointed to the lack of oxen and the near complete disadoption of draft animal power in agricultural production.

Kapchorwa

Networks in Kapchorwa starkly contrasted with those in Tororo, and heavily focused on commercialized agricultural production—especially in the commodities of wheat, barley, maize, Irish potatoes, and more recently, sorghum. Despite the fact that Kapchorwa District is not heavily populated, there are more than ten agro-vet shops on the main street in Kapchorwa town. A distributor for Kenya Seed, Mt. Elgon Seed, is also located in the town. When interviewing local agents regarding conservation agriculture and local food security, I was commonly told that if conservation agriculture was profitable and could reduce erosion, it would be adopted. Soil erosion was reported across agents as a major impediment to agricultural production, and farmer

group leaders in the local communities identified extension agents as some of the key proponents of technologies to reduce soil erosion on their fields. In some cases, this erosion was linked to increased plowing practices with draft animals and tractors in commercial production. Nevertheless, it was commonly reported across agents that the best way to achieve household food security was to grow a marketable surplus of staple commodities. More recently, farmers have been turning to commercial production of greens. Reports of Mt. Elgon Seed and many of the local shops also confirm this pattern, as sale of seed for commercial production of greens such as cabbage and kales had also recently increased.

The Kapchorwa Commercial Farmers Association, KACOFA, is a farmer founded organization that now has more than 5000 members and has played a key role in scaling up commercial agricultural production in Kapchorwa. KACOFA has established strong relationships with seed and credit organizations, and played a key role in encouraging Centenary Bank, which offers loans to a broad range of producers, to open a branch in Kapchorwa. KACOFA recently received considerable funding from the World Food Program for the construction of a large storage facility for grain to be distributed as food aid by Purchase for Progress. In speaking with WFP agents touring the progress on the facility, they were incredulous that I was studying food security in this region with such clear success in the production of staples. Nevertheless, as insights from other agents and the focus groups implied, success in the promotion of staple crops may not have made great strides toward increasing dietary quality and has led to an increasingly starch and vegetable dominated diet.

Bungoma

The agricultural service sector providers surveyed in Bungoma span a broad range from local village level actors (Pastors, youth group leaders, women's group leaders, and teachers) to

actors based in Bungoma town, such as NGO and extension workers. Extension workers appear to be more involved and more trusted in the local community than in any other location as key sources of information. Moreover, local barazas, (weekly meetings with the Chief) were reported as a key occasion through which agricultural information and resources were transferred. Most felt that the process the Chief followed for giving agricultural inputs such as seed and fertilizer was fair and went to community members most in need, such as widows and very poor families.

Local farmer groups were also very developed. In particular I worked closely with the SENA women's group, which worked on a number of activities to improve local agricultural production in maize, beans, and vegetables. Extension projects work across a broad range of projects, such as improved stoves, livestock and animal health, and crop production with a special focus on what were identified as food security crops, such as maize and beans. Interviews with extension agents and the Chief also echoed the concern expressed by farmers regarding the growing tension between cash crop production and growing crops for food security.

Kitale

Agricultural production networks in Kitale were also oriented toward commercial agricultural production in Trans-Nzoia district. First, it should be noted that this is by far the most populated area. A total of 21 service providers were interviewed, but there are more than 100 agro-vet shops alone in Kitale town. The three interviewed were those most frequently reported by community members, along with Kenya Seed and a fertilizer distributor. Agricultural research is also very active in the Kitale area and conducted by fertilizer and chemical companies and the Kenya Agricultural Research Institute (KARI) center based in Kitale. Extension agents from the Ministry of Agriculture work on a paid basis, and thus serve mostly a clientele of larger scale commercial farmers.

Despite the scale of agricultural production, only a very few agricultural service providers seemed to support moving away from a "subsistence plus" production system. The expressed goal of even the largest farmers I interviewed was to first be self-sufficient in maize, vegetable, legume, and livestock production, and then profit by selling their surplus. Large scale farmers interviewed linked dietary changes and commercialization of agricultural production to the increasing prevalence of lifestyle diseases, such as diabetes and expressed support for government initiatives for research on orphan crops like cassava and local greens, which they believed to be more nutritious than the exotic varieties. Technology network interviews also highlighted the level of inequality existent in the Kibomet and Milimani communities where the surveys were conducted. As explained by a village elder, "the poor here are those who own no land or very little land and have to work the lands of others for food and money to provide for their families". The sampled population for Kitale cross cut both these very wealthy and very poor households, and in this manner, the technology network interviews helped to illustrate the relationships between them.

Discussion and Hypotheses for Quantitative Work

The interviews with agricultural service providers in each of the sites clearly demonstrate that not all production networks are created equal. For example, extension agents serve a very different role in each of the communities from environmental stewardship to promoting livelihood activities and consulting on increasing the profitability of farm businesses. Different crops are promoted within different networks, such as the promotion of commercial staple crop production in Kapchorwa and the focus on livestock, gardening projects, and crop diversity in Bungoma and Tororo. Moreover, perceptions of food security and dietary quality differ greatly between agents and across sites. These differences may offer critical insight in the later quantitative work.

The activities in the focus groups and technology networks helped me to understand important differences between the sites, and to highlight key variables which might be significant to modeling food security more accurately. Most distinctly, this qualitative work helped me to appreciate how different these sites are from one another. I have summarized these contributions in the form of network and food security hypotheses below.

Network Hypotheses:

1. Households with strong networks for agricultural production will be more food secure
2. Households with strong networks for food acquisition will be more food secure
3. Activity in food acquisition networks will not be endogenous to food security
4. Farmers in Kapchorwa and Kitale will have greater contact with Technology Networks
5. Farmers from Tororo will report the fewest Technology Network Contacts
6. Technology networks will have a different impact on dietary quality across sites

Food Security Hypotheses:

1. Dairy and poultry production, as household assets which women unilaterally exercise more control, may be important factors to household food security
2. Tororo will have the highest level of food insecurity
3. Kapchorwa will have a higher percentage of energy sourced from staples than other sites

Chapter 6: Food Security Analysis

The difficulty associated with measuring food insecurity in developing countries has produced a broad cross section of literature which documents, compares and evaluates different food security and dietary quality indicators across cultural contexts (Webb et al 2006, Coates et al 2006, Maxwell 2008, Weismann et al 2009). In an effort to contribute to this literature, the primary purposes of this chapter are to: 1) summarize the key indicators for food security and dietary quality measured in the various study sites and 2) describe the relationship between different indicators for food security and dietary quality. These tasks are accomplished through the analysis of a combination of graphs, summary statistics, and correlation coefficients.

Summarizing Food Security and Dietary Quality by Site

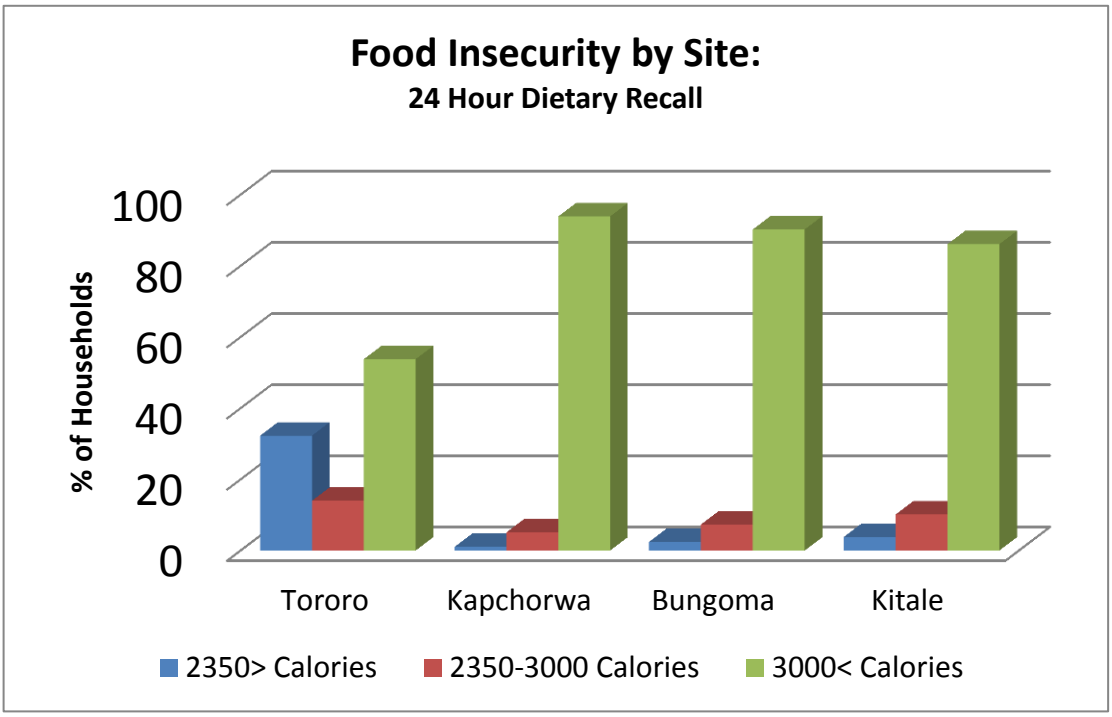
As described in Chapter 4, this thesis measures food security and dietary quality using daily calorie intake, a WFP FCS and the percent energy from staples. The table below reviews the calculation and thresholds for these measures.

Table 6: Food Security Measures and Thresholds

	Measure	Calculation	Test	Scale
Food Security	24 Hour Dietary Recall	Calories consumed over 24 hour period	1. <2350 2. 2350-3000 3. >3000	1. Insufficient 2. Borderline 3. Acceptable
	Food Consumption Score (WFP)	Number of days on which different food groups were consumed	1. 0-28.5 2. 29-41.5 3. >42	1. Poor 2. Borderline 3. Acceptable
Dietary Quality	Percent Energy from Staples	Percent of calories consumed from staples	75% + 60-75 40-60 <40	1. Very poor diet quality 2. Poor diet quality 3. Adequate diet quality 4. Very good diet quality

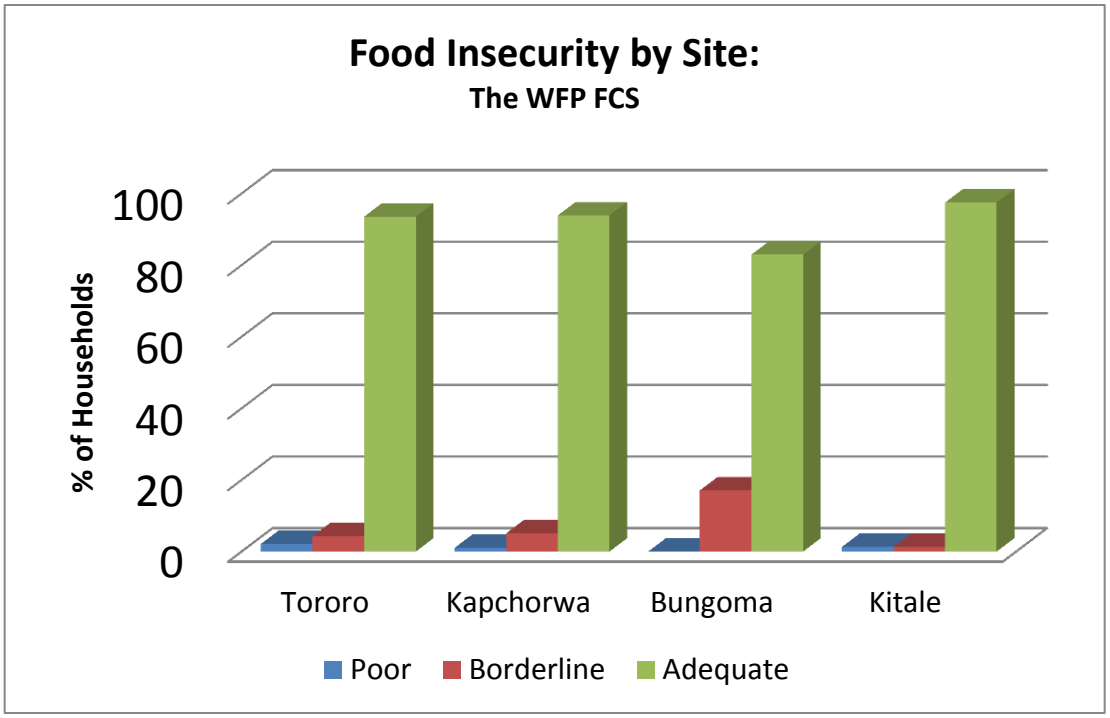
Sources: (Smith and Subandoro 2008, World Food Program 2008)

Figure 7: 24 Hour Dietary Recall



From the qualitative work with focus groups and observations made during the survey, I anticipated that there would be significant differences in food security and dietary quality between sites. Figures 6,7 and 8 present the percentage of households in each site classified into the various levels of food security and dietary quality. Figure 6 compares the results for 24 hour dietary recall. As displayed, every site has some proportion of women consuming less than the

Figure 6: WFP FCS



recommended calorie threshold, but that this proportion, consistent with the hypothesis offered at the conclusion of Chapter 5, is the largest in Tororo.

Figure 7 seems to indicate that, compared to the calorie indicator; the WFP FCS tends to underestimate populations of food insecure people. This finding is consistent with other researchers who compare the WFP FCS to caloric indicators (Weismann, et al 2009). An additional indication that the WFP FCS may be under-identifying individuals suffering from food insecurity is that 31% of the households in Tororo made a verbal report of food insecurity, whereas Figure 7 suggests that only about 6% of households in Tororo are food insecure. However, an interesting observation that can be made is that in Bungoma approximately 17% of the households surveyed move into the borderline category. In Kitale, I suspect that the lack of individuals who are classified as food insecure by the FCS is due to a combination of daily milk consumption and the availability of a variety of foods in the most urban location of all the sites. This finding is also consistent with the perceived low level of food insecurity by the women's focus group in Kitale.

Figure 8: Percent Energy from Staples

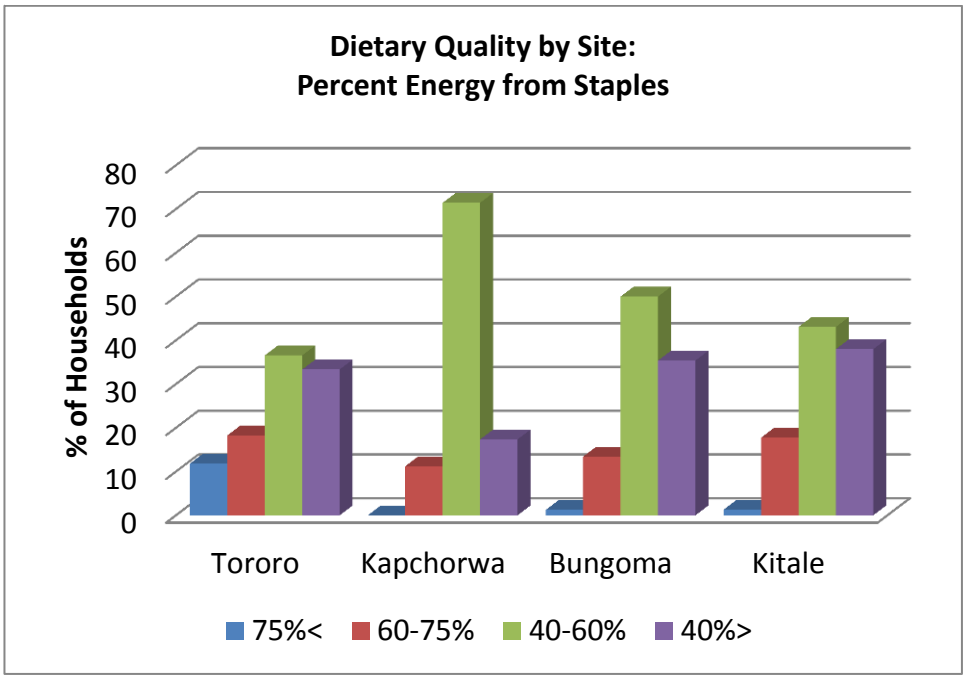


Figure 8 showcases the greatest degree of within site variation. In Tororo, there is a significant minority with very poor or poor diet quality as indicated by a heavy reliance on staples. Figure 8 also seems to confirm the qualitative description of Kapchorwa having the most carbohydrate dominated diet, with the majority of households concentrated in the 40-60% carbohydrate consumption category. While this is described as an acceptable range for developing country dietary quality (Smith and Subandoro, 2008), it is notable that Kapchorwa has the fewest number of people with what is described as high dietary quality (consuming less than 40% of their energy from staples). Country differences are also the most pronounced in Figure 8. While more similarity between the "high" and "low" potential areas has been previously observed, here Bungoma and Kitale are nearly identical in their profiles of dietary quality.

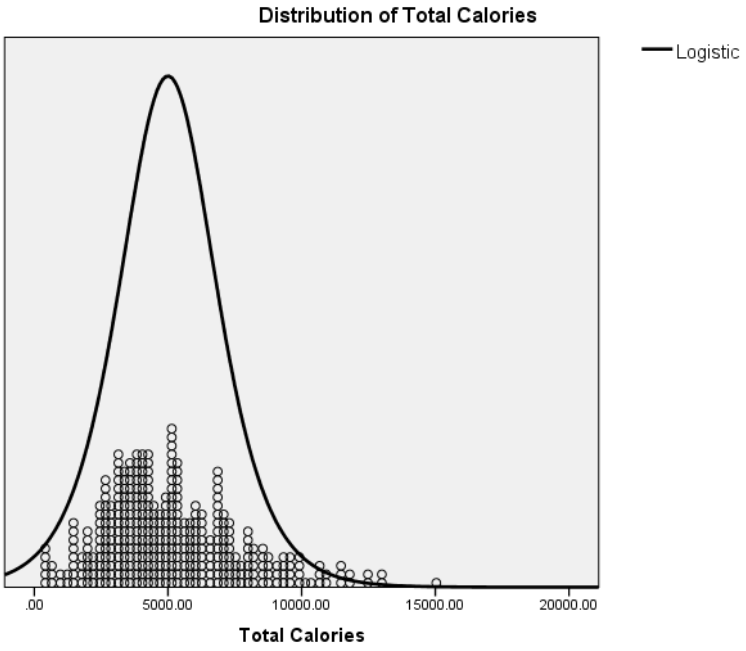
Is there an Upward Bias in Food Security Measures?

Something that can be easily observed from these charts is that both the average Food Consumption Scores and the total calories consumed by the female household heads seem to be very high. Subsequently, there is a possible disconnect between the reported food insecurity across the sites and the findings of the food security surveys. In attempting to explore this problem, I contacted several nutritional experts about what may be occurring in the data. First, it was suggested that this was likely a high consumption period as I conducted my surveys during planting season. While this tends to be a time of shortage, it is also a time of high caloric demand, where activity levels (especially for women who participate in much of the hand labor for land preparation and planting) are substantively increased. Secondly, the manner of collecting data in which individuals are asked to report in terms of frequency versus actual straight recall tends to result in over reporting rather than underreporting of consumption (Hertzmark and Barbeau pers. comm. June 2011).

Another potential source of error for calories is that I was matching the calories to the food composition tables for Tanzania and several other minor sources. This required some level of substitution and certainly has resulted in some of level of inaccuracy in reporting calories. However, I would not anticipate this error to be biased in a particular direction as expressed here.

Obtaining appropriate serving sizes in focus groups may have been problematic as groups may provide upwardly biased serving sizes. In order to correct for this, I cross checked all of the serving sizes reported by the focus groups with those presented in the Tanzania Food Composition Tables. When a serving seemed particularly high, I adjusted the figures downward to more closely represent the figures in the food composition tables. The accuracy of reported serving size may have improved if each female household head was asked to show with the cup how much they had consumed of a particular food on the previous day. Nevertheless, this procedural change may have increased survey fatigue and created further measurement error.

Figure 9: Total Calories

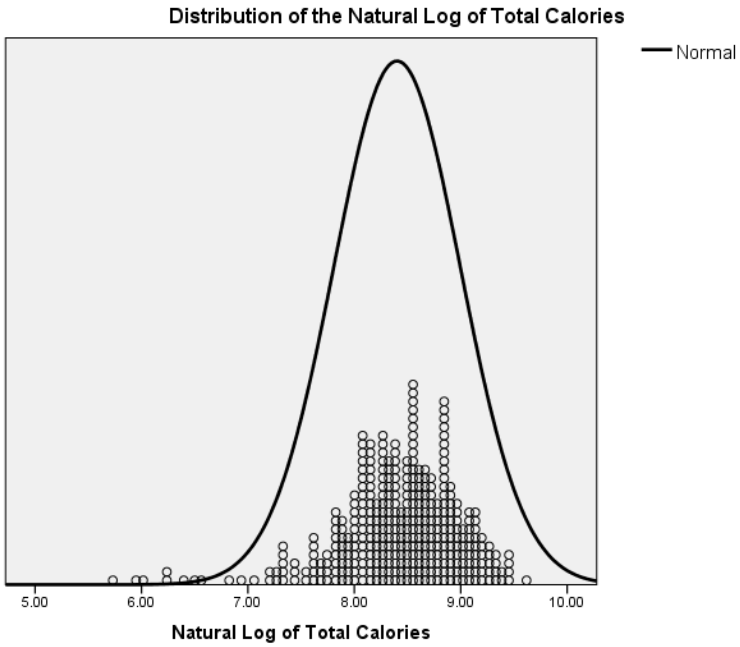


Measurement Error and Appropriate Functional Form for Modeling Food Security

Probing further into this issue of potential measurement error, I have created a frequency distribution of the total calories. There are several key observations we can take from this calorie distribution. First, there seems to be several extreme

outliers in the data of women who are reporting more than 12,000 calories per day. This is four to five times the allotment recommended for a woman in heavy physical activity used in this analysis. The clustering of data at the lower end of the distribution at under 1000 calories per day also signifies that there is likely measurement error for the lower end of the population. This is also not surprising, as the poor and food insecure can often be the most difficult individuals from which to obtain good data during the survey process.

Figure 10: Natural Log of Calories

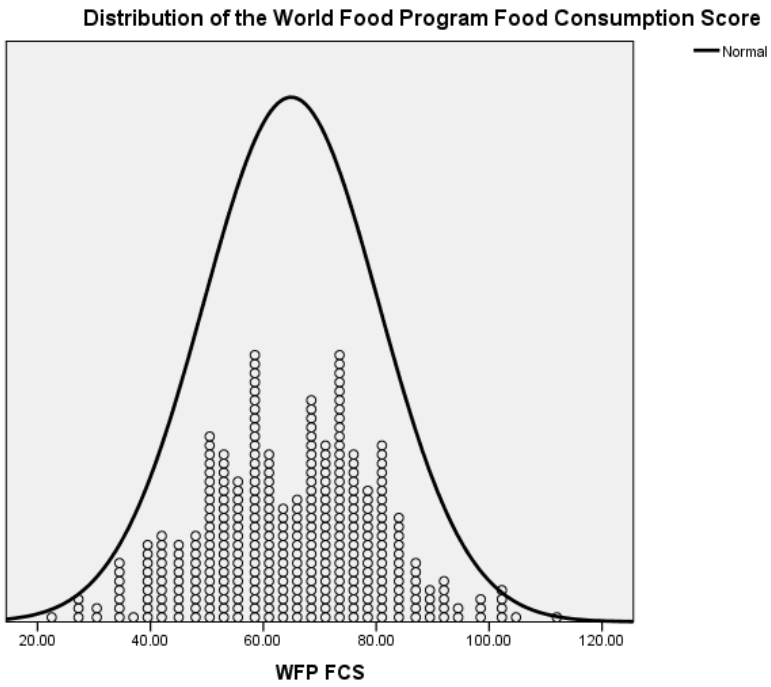


Nevertheless, even with this potential measurement error it appears from Figure 10 that total calories follow a log normal distribution and that there is certainly adequate variation in the sample. This suggests that before the variable be utilized in linear regression that it be given a log transformation. As such, while there is certainly measurement error, it is anticipated that the error is likely to be normally distributed, especially after transformation with a log. The potentially significant measurement error in the total calories also suggests that an alternative approach may be appropriate in the multivariate modeling of food insecurity. Instead of framing analyses in terms of food security or insecurity, the analysis can focus on whether variables contribute to or detract from calorie

procurement. This assumes that measurement error is random after conditioning on explanatory variables.

Summarizing the WFP FCS

Figure 11: WFP Food Consumption Score



Several other factors may be coming into play with the calculation of the World Food Program Food Consumption Score. As described in Chapter 4, this thesis approximates the WFP FCS by taking the highest reported number of servings for a single food out of a food group. One would expect that this method would produce lower food consumption scores rather than the generally high scores shown in the frequency distribution. Bearing in mind that the current thresholds set for the WFP FCS are 42 and 28.5 for borderline and very poor diet quality, it can be easily observed that only very small portion of the surveyed population have values below these thresholds. Recalling Figure 7 (which compares the FCS across sites), it is clear that the FCS is underestimating the population of food insecure persons compared to the total calories variable. This result is contrary to the expectation that an indicator for dietary quality should pick up higher levels of food insecurity, as in the order of the food security experience sufficient quantity is typically achieved more easily than adequate variety (quality) in the diet.

Similar findings have been documented by a number of researchers who have attempted to apply the WFP FCS in the field. Weismann et al (2009) tested the WFP FCS in Burundi, Haiti and Sri Lanka through comparing the calculation to measures of dietary diversity and daily calorie consumption. While the FCS tracks well with the other indicators in two of the sites, the indicator performed poorly in Burundi.[10] In particular, the WFP FCS tended to strongly underestimate levels of food insecurity compared to caloric indicators. As a result of their study, the authors make several suggestions to attempt to improve the WFP FCS correlation with the caloric indicators and the efficiency of the WFP FCS in estimating food insecurity. First, they recommend including a quantity restriction to ensure that foods consumed in small quantities do not provide a disproportionate contribution to increasing the score. The threshold suggested by Weismann et al (2009) is 15 grams. Second, the authors recommend either raising the FCS thresholds or altering the WFP FCS from an 8 category classification to a 12 category classification in order to improve the quality of the instrument for classifying households. Third, the authors advise experimenting with removing the truncations which cap the contribution of any one food group. Fourth, the authors suggest doing away with the weights on the various food groups, but are cautious about doing so as they believe that the weights have some merit in expressing differences of dietary quality. Following these recommendations, McBride (unpublished mimeo) calculates a non-weighted FCS to compare to caloric measures in a pilot project in Niger, and finds the non-weighted FCS to be more highly correlated to caloric measures than the traditional FCS.

This research has attempted to incorporate these suggestions to improve the quality of the indicator and to conduct a more thorough examination of the relationship between the different

[10] Notably, this is the location most geographically and culturally comparable to Kenya and Uganda. This might suggest that particular circumstances in East Africa affect the WFP FCS as an indicator of food security.

indicators of food security and dietary quality. No servings of less than 15 grams are included in the calculation of the FCS. Additionally, a non–weighted score (FCSnw) is calculated alongside the weighted score for testing against the calorie indicator.

Relationships Between Measures of Food Security and Dietary Quality

Despite the evidence of the upward bias in the measurement of food security by caloric data and measurement of the FCS, it is still important to investigate the relationship between the calorie and WFP FCS data collected. Recognizing that the weighted WFP FCS is also supposed to represent dietary quality, I also investigate the relationship between the FCS and Percent Energy from Staples. If the FCS is measuring what it should, then a positive correlation with calories is expected. However, since dietary quality decreases as the Percent Energy from Staples in the diet increases, a negative correlation with Percent Energy from Staples would indicate that the FCS is also capturing some elements of dietary quality. In order to justify the use of a parametric correlation statistic, I have used the log(calories) functional form, which more nearly approximates a normal distribution and thus is the appropriate for a Pearson Correlation.

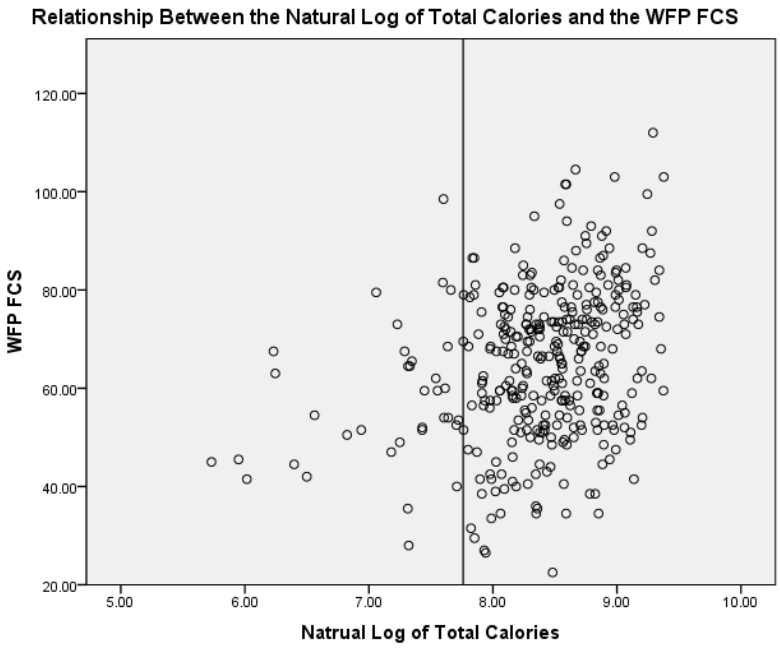
Table 7: Correlations Between Food Security and Dietary Quality Measures

Variable	WFP FCS	WFP FCSnw	Log(Calories)
WFP FCSnw	.900**		
Log (Calories)	.305**	.245**	
Percent Energy from Staples	-.132*	-.128*	.012

**Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

These correlations presented in Table 7 are consistent with many previous findings about the relationships between food security and dietary quality. First, there is not a statistically significant relationship between total calories and percent energy from staples. This is consistent with previous research which finds that sufficient quantity does not necessitate sufficient quality in the diet. However, table 7 does present a number of interesting insights about the relationship between the FCS, calorie consumption, and dietary quality as measured by the Percent Energy from Staples. There is a significant positive relationship at the .01 level between the log of calories and the weighted WFP FCS and a significant negative relationship at the .05 level between the Percent Energy from Staples and the weighted WFP FCS. These results suggest that the WFP FCS is at least partially accomplishing its dual objectives of serving as an indicator of sufficient quantity and quality of the diet. Moreover, unlike the findings of McBride (unpublished mimeo), the non-weighted scores do not seem to improve the correlation with total calorie intake as the non-weighted score does not appear to have a significantly stronger correlation with calorie intake.

Figure 12: WFP FCS and the Natural Log of Calories



Recognizing that there was a statistically significant positive relationship between the WFP Food Consumption Score and Total Calories, I hoped to be able to find evidence to suggest a recalibration of the food security thresholds for use in this study, as suggested by Weismann et al (2009). Toward this end, a scatter plots of WFP FCS and the natural log of calories was constructed. A reference line on the x-axis indicates the food security cutoff at 2350 calories used in this thesis. However, as demonstrated, the range of food consumption scores for households behind this line is very broad, from as low as a score of 30 up to a score of 100. By contrast, there seems to be more convergence between the calories and food consumption scores at a higher level, a pattern which becomes especially visible with the log functional form. This is the range of observations likely driving the statistically significant correlation between calories and the WFP FCS.

In figure 12, the broad range and the relatively even distribution of the WFP FCS below the caloric threshold for food security, suggests two major factors may be at work. First, there is likely significant measurement error present at the lower levels of consumption. Second, the WFP FCS indicator may be less precise at these lower ranges. This is not encouraging for the further application of the FCS, as the indicator is meant to be a quick assessment tool for

diagnosing food insecure peoples. Subsequently, the figures do not provide any strong evidence that there might be a natural break at which to relocate the WFP FCS thresholds.

Conclusions and Contributions for Model Development

This analysis of the food security and dietary quality indicators presents several significant findings toward the development of a model for food security and dietary quality. Most clearly, there is little doubt that there is some error in measuring daily caloric intake and the WFP FCS. Moreover, this measurement error is likely concentrated in the lower and upper ranges of the observations for both indicators. In particular, the measurement error at the lower range of the observations makes it difficult to use either the caloric measure or the FCS for the classification of households as food secure or insecure for modeling purposes. However, the adequate variation, approximately normal distributions, and statistically significant relationship between the two indicators suggests that both may be used for developing models of calorie procurement and dietary quality in a multivariate regression analysis.

Chapter 7: Social Networks and Enumerator Effects

Building on the work begun in Chapter 6, this chapter applies statistical techniques to investigate remaining hypotheses developed during the qualitative work and field observations regarding social networks and site differences. Initial analysis of summary statistics regarding social networks highlights key differences between network composition across the sites. Later sections follow up on concerns with potential gender bias introduced in Chapter 4 by using mixed teams of male and female enumerators. Subsequent regression analysis examines the impacts of enumerators on both food security and food network variables. Through these activities, this

chapter identifies several key factors to be controlled for in developing the final model specification for estimating the impact of social networks on food security.

Social Network Data

As discussed in the data section, data was gathered on three types of networks in all sites: food acquisition networks, friendship networks, and technology networks. The technology networks may be further disaggregated to study different patterns for networks to access agricultural resources and agricultural knowledge. The different measures presented in table 8 are provided for reference in this chapter for interpreting graphs which summarize many of these measures by locality and the calculation of Pearson Correlations between network measures in later sections.

Table 8: Measurements of Network Strength and Their Calculation

Technology Network Variable	Description
Agricultural Resource Network Degree	Count of number of different contacts for agricultural resources
Agricultural Information Network Degree	Count of number of different contacts for agricultural information
Average Agricultural Network Degree	Average of the Agricultural Information Network Degree and Agricultural Resource Network Degree
Average Agricultural Network Trust	Total of the Trust scores for the agricultural network divided by Average Agricultural Network Degree
Average Agricultural Network Frequency	Total of the frequency scores for the agricultural network divided by Average Agricultural Network Degree
Food Acquisition Network Variable	**Description**
Food Acquisition Network Degree	Count of total Food Acquisition Network Contacts
Average Food Acquisition Network Trust	Total of food acquisition network trust scores divided by Food Acquisition Network Degree
Average Food Acquisition Network Frequency	Total of food acquisition network frequency scores divided by Food Acquisition Network Degree
Friendship Network Variable	**Description**
Friendship Network Degree	Count of total Friendship Network Contacts
Average Friendship Network Frequency	Total of frequency scores divided by Friendship Network Degree

Summarizing Networks by Site

Figure 13 reports the average degree or number of contacts for each type of network across the four sites. This figure reveals several important characteristics of networks in each site. The most notable observation is that Tororo seems to be the most socially isolated site, with the lowest average number of contacts for every type of network, although there is not a significant difference between the size of food acquisition and friendship networks compared to the other sites. Nevertheless, the low number of agricultural contacts in Tororo is consistent with the observations made in the focus groups and technology networks surveys, and with the hypothesis that farmers in Tororo would report the fewest technology network contacts.

Figure 13: Network Degree

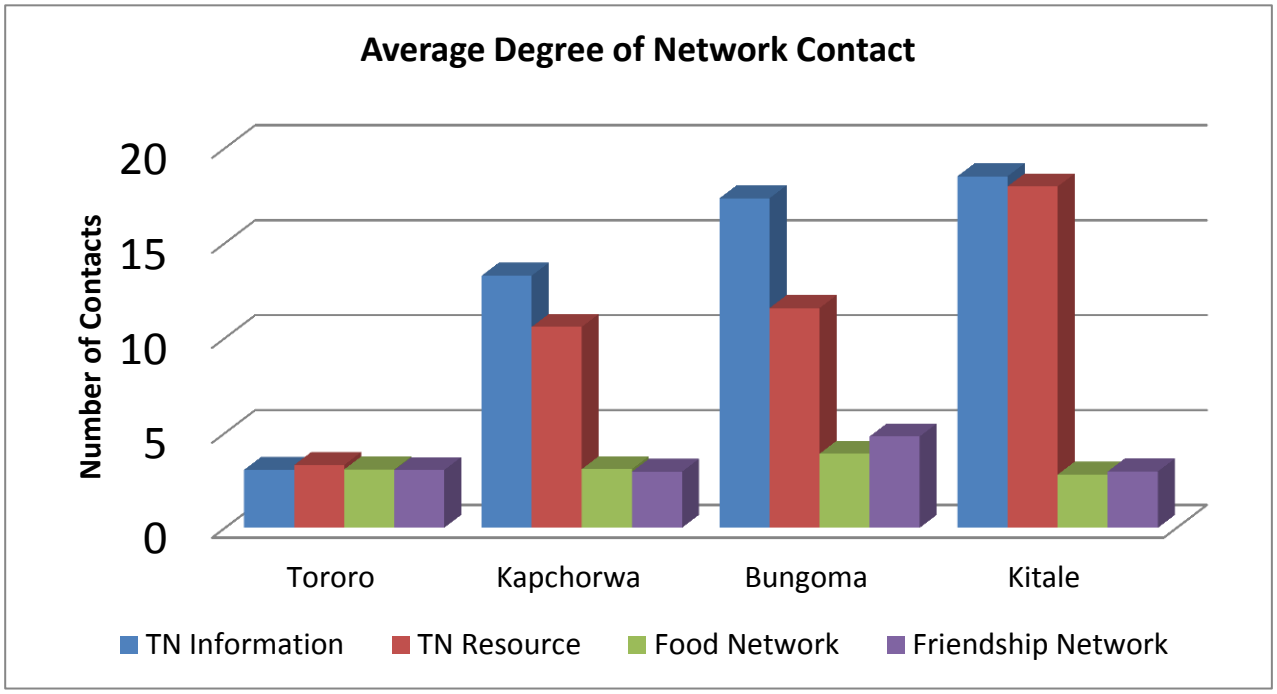


Figure 14: Trust and Frequency of Contact

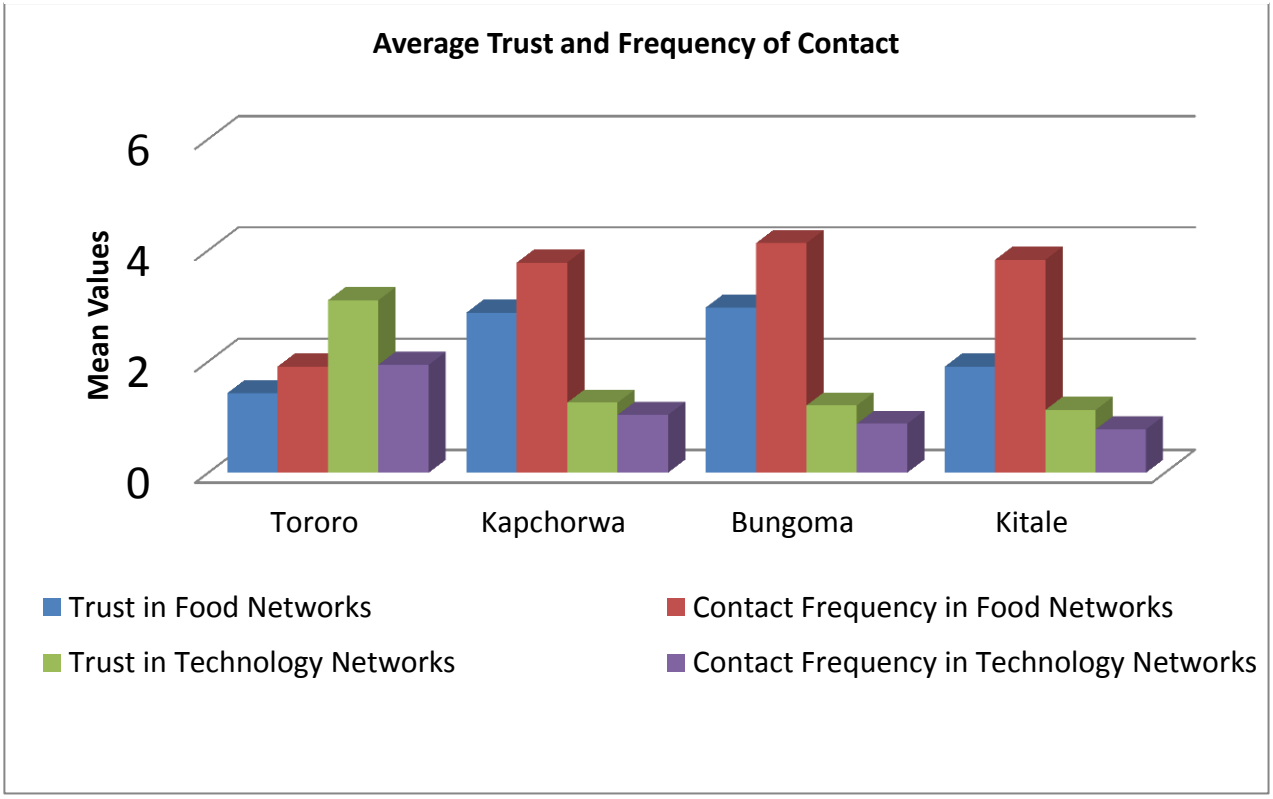


Figure 14 summarizes the means for average trust and frequency of contact in the food acquisition networks and agricultural production networks. The figure presents a much more consistent picture of the networks across sites. In particular, Bungoma, Kapchorwa, and Kitale are very similar. However it is notable that Kitale has a lower mean for trust in the food network. The increased measures for trust and frequency of contact in the agricultural production network might suggest a negative relationship between number of network contacts and levels of trust. This is highlighted in the means presented for Tororo, where it appears people seem to have fewer agricultural production contacts on average, but they see them more frequently and are more trusting of these contacts than in other sites.

Correlations Between Network Measures

Basic examination of the data suggests that there will be some complimentary relationships between different types of networks and network strengths. Understanding these relationships is paramount to specifying an intuitive model for the impact of networks upon food security. In order to explore these relationships, table 9 displays the Pearson Correlations between every type of network variable collected.

Table 9: Correlations between Network Measures

TN = Technology Network
FN= Food Acquisition Network
SN= Friendship (Social) Network

Variable	TN Info Deg	TN Res Deg	TN Avg deg	TN Freq Avg	TN Trust Avg	FN Total	FN Freq Avg	FN Trust Avg	SN Total
TN Resource Degree	.748**								
TN Average Degree	.972**	.882**							
TN Frequency Average	-.593**	.471**	-.587**						
TN Trust Average	-.722**	-.546**	-.705**	.843**					
FN Degree	.122**	-.011	.082	-.070	-.049				
FN Frequency Average	.034	.026	.033	-.039	-.031	-.073			
FN Trust Average	.330**	.165**	-.292**	-.173**	-.281**	-.098	.424**		
SN Degree	.210**	.081	.177**	-.154**	-.186**	.331**	.111*	.032	
SN Frequency Average	-.449**	-.347**	-.441**	.273**	.414**	.060	.010	-.249**	.012

**Correlation significant at the .01 level (2 tailed).
* Correlation significant at the .05 level (2 tailed).

These correlations provide some interesting information about the relationships between different measures of network strength. For the agricultural production networks, there are significant negative relationships between number of contacts to frequency of contact and trust in those persons. In other words, as might be expected from the examination of the means presented

in the previous charts, as the number of contacts increases, the average frequency of seeing those contacts decreases. This might suggest that farmers have limited time to dedicate toward building their agricultural networks, and tend to trade-off between making a number of connections and developing fewer strong connections. Likewise, the more frequent a person is in contact with their agricultural production network, the more trust they have in their contacts, as evidenced by a high and statistically significant correlation of .843 between trust and frequency of contact in the technology network. This pattern between trust and frequency of contact also holds across the food acquisition network. However, there is not a statistically significant relationship between number of contacts and frequency of contact for either the food acquisition or friendship network.

Correlations between network variables may also have implications for estimating a model of food security and social networks. Specifically, a high level of correlation between technology and food network variables may limit the ability of Ordinary Least Squares Regression to identify the unique impact of each type of network on food security or dietary quality. Fortunately, most of the correlations are relatively low. Issues of multicollinearity should not prevent food acquisition and technology network variables from being simultaneously included in food security and dietary quality in regression equations.

A final point of interest here is the relationship between food networks and friendship networks. As can be recalled from Chapter 4, the data on friendship networks was collected as a collection of potential instrumental variables due to the suspected endogeneity between the food network and food insecurity. The significant correlations between the friendship network and the food network variables suggests that several variables may have the ability to serve as an instrument for food networks should the need arise.

Gender Impacts for Collecting Sensitive Social Data

As mentioned in the data collection section, I attempted to hire female enumerators because it was believed that women would feel more comfortable talking about their own consumption, household consumption, and their food networks with other women than with men. However, in two of the sites, Bungoma and Kapchorwa it was not possible to hire only female enumerators. I became suspicious that this was impacting the data in both locations during the execution of the surveys. First, in Bungoma, I noticed that my male enumerator, who was the most experienced and well educated of the four enumerators hired, seemed to be reporting far fewer food network contacts on his surveys than the female enumerators. On one day, the trend was so significant that I sent my best female enumerator back to each of the households the following day to inquire if the households had any additional food network contacts and to ask why they had not reported them to the male enumerator the day before.

That afternoon, this female enumerator returned with more food network contacts for each of the nine respondents the male enumerator had visited the day before. When she had inquired as to why the women did not share these contacts before, she received a couple of different answers. Several of the women expressed concern that this man would tell their husbands that they were getting food without his knowledge. Others voiced a more general discomfort about speaking to a man about their private networks. With this experience in Bungoma, I became concerned that something similar might occur with the male enumerator that had already been hired in Kapchorwa. Moreover, when I was entering the Kapchorwa data and calculating the total calories consumed by each woman, I found that the male enumerator in the site seemed to have higher calorie counts as well.

In this section the Kapchorwa and Bungoma cases are used to explore the potential impact of enumerator gender on the reporting of calories and social networks. Table 10 compares calories and total food network relations variables for male and female enumerators in Kapchorwa.

Table 10: Compare Means Testing for Gender Differences in Kapchorwa, Uganda

Variable	Enum. Gender	N	Mean	Mean Difference	T-Statisitic
Log (calories)	M	46	6341.05+	2252.69	7.665**
	F	52	4088.36+		
Total Food Network Relations	M	46	2.41	-1.279	-5.691**
	F	52	3.69		

+Exponeniated to report calories instead of log value
**Significant at the .01 level

As demonstrated, in Kapchorwa it appears that there is a significant difference between the means for number of food network contacts reported and total calories. Women under-report their networks and over-report their calorie consumption to the male enumerator. Table 11 tests whether this pattern holds in Bungoma utilizing the calorie data and network data collected by the male enumerator.

Table 11: Compare Means Testing for Gender Differences in Bungoma, Kenya

Variable	Enum. Gender	N	Mean	Mean Difference	T-Statisitic
Log(calories)	M	22	4337.6+	-1228.76	2.837**
	F	63	5566.36+		
Total Food Network Relations	M	22	3.36	-.78	-3.025**
	F	63	4.14		

+ Exponeniated to report calories instead of log value
**significant at .01 level

The compare means for Bungoma only partially confirm the pattern found in Kapchorwa. While in both sites women seem to be underreporting their food networks to the male enumerators, the male enumerator in Bungoma actually reports significantly fewer calories than his female counterparts. Given this mixed result and that there only two cases to examine, a number of

factors must be considered. Specifically, there is no way of knowing for sure that the differences here are not a result of enumerator ability. I do not think that this is the case, because in both sites the male enumerators were the most educated and seemed to understand the survey instruments well. The male enumerator in Kapchorwa has an especially good rapport with the communities in Kwosir and Kere, and serves the communities in several different capacities. He regularly consults for various NGOs and farmer groups for various projects, and is a SANREM field coordinator for the experimental plots for conservation agriculture on several of the interviewed farmers' land. Given his close relationship with the community, commitment to the SANREM project work, and his high level of experience; the case for the fact that gender bias as opposed to enumerator ability is impacting the data becomes more compelling.

These results suggest that there may be some gender dynamics emerging in the data collection process, especially with regard to the reporting of food networks. To test whether enumerator gender makes a significant impact, a quasi-experimental design and a larger sample size would be needed. However, the evidence for the potential bias introduced by gender is enough to justify a recommendation of using all female enumerators in future studies working with female household heads, social networks and food security measures.

Sensitivity of Different Measures to Enumerator Differences

The results of tests examining differences between the male and female enumerators merit further exploration of the potential effects of the enumerators upon food security measures. Toward this end, I decided to regress the different enumerators on the log of calories, the WFP FCS, and food network variables collected during the spring 2011 survey. It is not possible to look at whether enumerators may have influenced the technology network indicators as these questions were enumerated in the fall 2010 baseline.

One of the immediate difficulties with this analysis is that the different enumerators are also bringing in the effects of the different locations. However, adding the site effects over specifies the model as there were only a few enumerators in each site. Including the site effects eliminates the ability to observe enumerator impact for one enumerator in each site, making it difficult to compare whether enumerators are having significant impacts within their respective sites. As such, the regressions are completed for the different variables are taken as a starting point for determining which variables might merit further examination.

In total for the 2011 data collection, there were thirteen enumerators, twelve of which were utilized for each regression. As the number of enumerators was constant for each variable, calculating the R-squared values to estimate the impact of the enumerators is an appropriate method of comparison.

Table 12: R-Squared Values for Enumerator Regressions on Food Security and Network Variables

Variable	Log (Calories)	WFP FCS	Food Network Degree	Food Network Frequency Average	Food Network Trust Average
R-Squared	.4297	.2184	.2762	.1677	.5419

The R-Squared values suggest that the enumerators have a very large impact on the Food Network Trust Average and the Log (Calories) variables, and a relatively large impact on the Food Network Degree and a lesser impact on the FCS and Food Network Frequency Average. The following paragraphs analyze several factors which are likely influencing the enumerator driven variation in the food network and food security variables.

The large impact of the enumerators on the Food Network Trust Average is most likely due to the fact that the enumerators interpreted and presented this variable to female household heads

differently from one another. This is not surprising, as measurements of trust are some of the most difficult to obtain in network research (Knoke and Yang 2008, Matsaert et al 2005). The proportion of variation in this variable explained by enumerators suggests that training was not of adequate quality for this variable to be presented in a consistent fashion by the different enumerators. Should a similar study be conducted in the future, improved training methods and/or other options should be explored to measure trust in the food network.

The R-Squared value for Food Network Degree is also relatively high. I believe that this is a function of the fact that some enumerators were simply better than others at making women feel comfortable discussing their food acquisition networks. As previously discussed, it seems that both male enumerators were not as good at encouraging female household heads to discuss their networks as the female enumerators in their respective sites. There also seems to be some variation in enumerator ability within gender in allowing women to feel comfortable and be open about sharing their food acquisition networks. By contrast the relatively low R-Squared value for the enumerator impact on frequency of contact indicates that this variable was probably more straightforward for enumerators to explain. Taking the average frequency of contact may have also helped to control for differences between enumerators in their ability to get female household heads to discuss their networks.

The high R-Squared value for the log of calories is a significant concern, and merits further investigation. In order to evaluate if there was a pattern to which enumerators were making a significant impact, a linear regression of the enumerators on the log of calories was run thirteen times at an alpha level of .05 in STATA. This allowed every enumerator the opportunity to serve as the base enumerator so as to provide an unbiased benchmark for evaluating the impact of the enumerators against each other. Enumerators which had p-values of less than.01 were recorded

for each run of the regression. The total number of times each enumerator had a statistically significant impact by this rejection rule is recorded in the table below:

Table 13: Enumerator Impact on Calorie Reporting

Site	Enumerator ID	Number of Times Enumerator had a significant impact on the model
Tororo	1	7
	2	13*
	3	3
Kapchorwa	4-male	8*
	5	5
Bungoma	6-male	3
	7	2
	8	4
	9	6
Kitale	10	5
	11	8*
	12	3
	13	2

From Table 13, it can be observed that Enumerator 2, 4 and 11 have a higher rate of producing a statistically significant impact in the enumerator only regression. Enumerator 2 consistently reports lower calorie scores than anyone else, whereas Enumerator 4 and Enumerator 11 consistently report higher calories, contingent upon which enumerator is serving as the base group for the rest of the enumerator dummy variables.

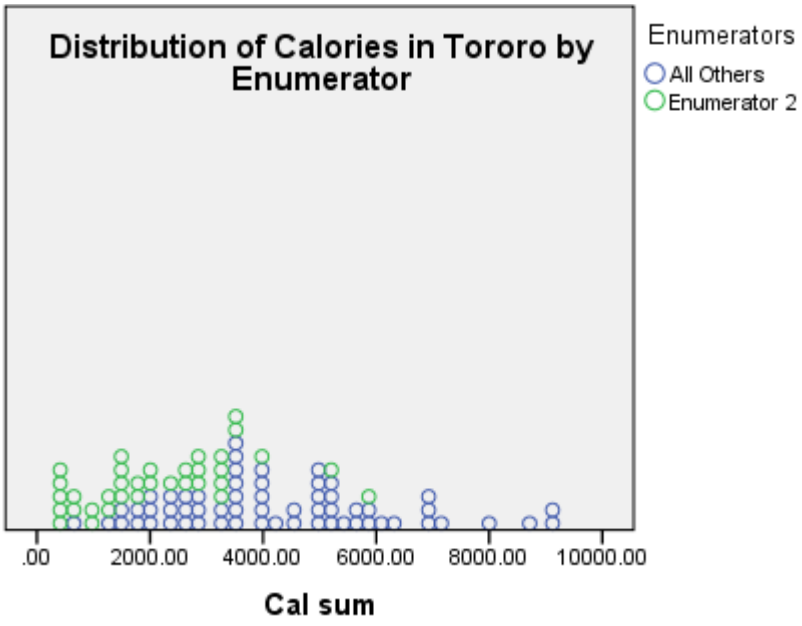
As mentioned, an obvious issue with this analysis is that the many different enumerators are also affiliated with particular sites, meaning that they are pulling in site effects as well as enumerator effects in running the basic regression of enumerators on food security variables. However, it is interesting to see that there seem to be "extreme" enumerators in each of the sites except Bungoma, rather than one site having enumerators with a great impact. As demonstrated, the top three enumerators with an impact on the log of calories are from three different areas: Tororo,

Kapchorwa, and Kitale. Nevertheless, it will be important to ensure that both site and enumerator effects are introduced together into the formulation of the regression model to ensure that one variable is not being skewed due to its correlation to the other.

Having narrowed down to these three, it is possible to more closely examine the circumstances surrounding each particular enumerator that might be influencing their impact upon calorie procurement. First, Enumerator 4 is the male enumerator from Kapchorwa, whom has already been shown to report higher calories than his female counterpart across the same geographic region discussed in the previous section. Given the anomalous results and the relatively high number of individuals he interviewed as there were only two enumerators in his region, it is thus not surprising that he is also having a significant impact compared with the rest of the enumerators from the survey research.

Looking more closely at Enumerator 2 from Tororo required checking some logical correlations which might at least partially explain her consistently low calorie reporting. Enumerator 2 interviewed 10.88% of all of the female headed households in the sample. This is the highest proportion of female headed households for any interviewer and she was located in what has been demonstrated to be clearly the poorest site. Compared to the other enumerators, she also interviewed the second

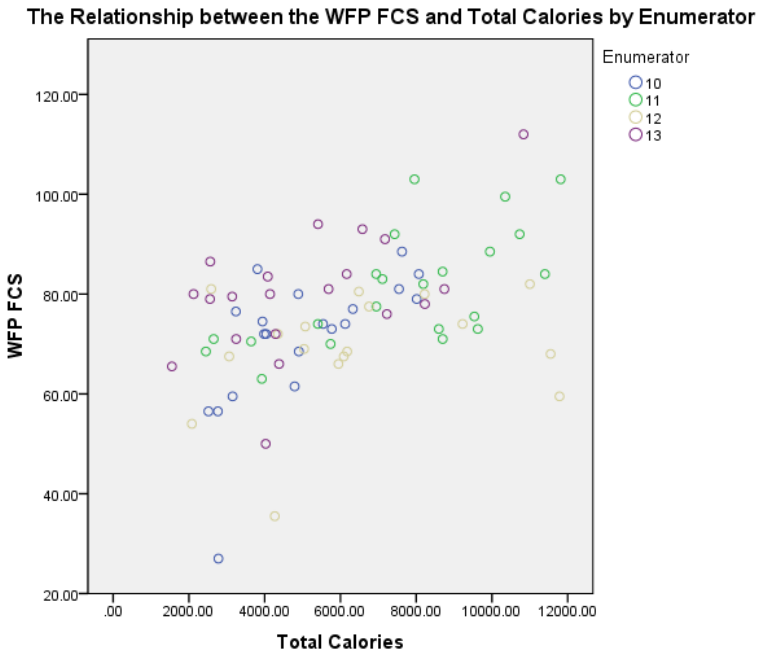
Figure 15: Comparing Enumerators in Tororo, Uganda



highest percentage of households who had made some verbal report of food insecurity at a total of 17%. This suggests that that this enumerator may have simply interviewed more genuinely food insecure female household heads.

However, examining a frequency distribution of the calories reported by different enumerators reveals another picture. There seems to be a pattern that this enumerator is reporting lower calorie consumption in general compared to the other enumerators in Tororo. This means that a combination of a tendency for low reporting and having interviewed some of the poorest people in Tororo are likely leading this enumerator to have such a high impact on the calorie indicator.

Figure 16: Enumerator Differences in Kitale, Kenya



Regarding Enumerator 11 in Kitale, it is most helpful to look at a chart which plots the WFP FCS against Total Calories. Here, Enumerator 11 is represented in green and it is observed that this enumerator's data is clustered in the upper range for both calories and the Food Consumption Score. As the enumerators were again randomly geographically distributed, and of a similar education level and even age, it is possible that this enumerator may simply have had a tendency to encourage exaggeration or over-reporting of food consumption.

Chapter 8: Model Specification and the Impact of Social Networks on Food Security

Final Model Specification

Both the qualitative research and the initial exploration of the quantitative data suggest several important factors which should be considered before building a larger model for the impact of social networks on food security. First, food security and social network data are difficult to collect accurately and are especially sensitive to contextual factors such as the locality and survey environment. In particular, it is clear that the sites are quite diverse and differences between the sites explain much of the variation in diet and network behavior. It was also demonstrated that some measures of food security and social networks are especially sensitive to enumerator differences. This chapter applies these findings regarding the food security and network variables presented in Chapters 4,5, and 6 toward the final specification of a model for the impact of social networks upon food insecurity. The econometric model specified for the impact of networks on calorie procurement is presented below.

$$\log(calories) = B_0 + B_1 FN + B_2 TN + B_3 Fhh + B_4 land + B_4 cattle + B_5 educ + B_6 poorhealth + B_7 Kitale + B_8 Tororo + B_9 Kapchorwa + B_{10} Enumerator2 + B_{11} Enumerator4 + B_{12} Enumerator11 + \varepsilon$$

In this model, the dependent variable is the log of calories, B_0 is a constant term, *FN* represents the frequency average of food network contact, *TN* is the average degree of network contacts, *FHH* is a dummy variable for female headed households, *land* is the total amount of land cultivated by a household, *cattle* is a dummy variable for households which own dairy cattle, *educ* is a dummy variable signifying the household head has an above primary school education, *poorhealth* signals households in which the female household head reported her health was poor relative to her peers. *Kitale, Tororo,*and *Kapchrowa* are dummy variables for the different sites, leaving Bungoma to serve as the base group. *Enumerator 2*, *Enumerator4*, and *Enumerator 11* represent the enumerators demonstrated to have

an extreme impact on calorie procurement in Chapter 7. OLS will be utilized to provide coefficient estimates for $B_0 - B_{12}$. Table 14 provides a more detailed description of each of these variables.

Table 14: Descriptions of Variables in Calorie Procurement Model

Variable Name	Description
FN-Frequency Avg	Total Frequency of Contact in the Food Production network divided by number of food network contacts Scale: 0 = New contact 1= Seasonally 2= Monthly 3= Weekly 4= 2-3 times weekly 5= Daily
TN-Average Degree	Average of the total number of information and resource contacts for agricultural production
Female Headed Household	Households where a woman is the household head. Usually widows.
Total Acres Cultivated	Number of acres on which crops are grown (could be borrowed. rented, leased, and/or owned land)
Own Dairy Cattle	Dummy variable for whether a household keeps at least one or more dairy cows
Highly Educated	Dummy variable signifying that the household head has obtained an education beyond the primary school level
Poor Self-Reported Health	Dummy variable where the female household head rated her health as poor compared to those she knew
Kitale	Dummy variable representing households from the Kitale site
Tororo	Dummy variable representing households from the Tororo site
Kapchorwa	Dummy variable representing households from the Kapchorwa site
Enumerator 2	Dummy variable representing female enumerator in Tororo demonstrated to have consistently lower calorie reports than the other enumerators within her locality
Enumerator 4	Dummy variable for male enumerator in Kapchorwa with consistently higher calorie reports than his female counterpart
Enumerator 11	Dummy variable for female enumerator in Kitale with consistently higher calorie reports for her locality

Alternative Models for Food Security and Dietary Quality

In the Results Section, alterations from this general model are presented in accordance with the different findings of Chapters 5 and 6. Specifically, an instrumental variable, total friendship network contacts, is used to estimate fitted values for frequency of contact in the food acquisition network in the calorie procurement model. The purpose of the instrumental variables estimation

is to further examine the suspected endogenous relationship between food acquisition networks and household food security.

In the WFP FCS model for examining the impact of networks on dietary quality, enumerator effects are removed due to the demonstrably smaller of impact of enumerator differences upon the WFP FCS variable as opposed to calorie procurement. Interaction terms between the technology network and site variables are also introduced in order to estimate whether these networks operate differently across localities.

Network Hypotheses

Within each model, two hypotheses will be tested regarding impact of food acquisition and technology networks upon household food security:

1) Increased frequency of contact of the female household head with her food acquisition network will have a positive impact on food security
2) Increased number of contacts/diversity in the agricultural production network for obtaining information and agricultural resources will increase food security.

Results

Calorie Procurement and Network Strength

Qualitative insights and trends identified through the data collection process have provided some important foundational information before applying Ordinary Least Squares regression to model calorie procurement. First, it was identified that there has likely been some measurement error in this variable. It is suspected that measurement error increases at both the lower and upper values, meaning that these observations could be unduly influential upon the model. Recognizing this, all of the extreme calorie outliers, those individuals who reported 12,000 or more calories in a single day are dropped, excluding a total of five observations from the data set. Observations

were not excluded from the lower end of the range as this is the population this thesis is most interested in understanding. It was also hypothesized that this measurement error in the dependent variable could lead to heteroskedasticity, or a non-constant variance of the error term. This concern increases with the acknowledgement of the impact of different sites and different enumerators upon calories identified in Chapters 6 and 7. Subsequently, it is not surprising that the null hypothesis of homoscedasticity was rejected by both the Breusch-Pagan test for linear forms of heteroskedasticity and White test for unrestricted heteroskedasticity when the model was estimated using OLS, as recorded in table 15.

Table 15: Results of Heteroskedasticity Testing

Test Type	Null Hypothesis	Chi-Square	P-value	Determination
Bresh-Pagan	Ho: Constant Variance	74.81	.0000	Reject Ho
White	Ho: Homoscedasticity	127.16	.0003	Reject Ho

All formulations of the model using the natural log of calories as the dependent variable are subsequently estimated with robust standard errors. Correction with robust standard errors allows for the t-statistics reported by the model to be considered valid for hypothesis testing. The table 16 presents a model for the relationship between calorie procurement and social networks for food acquisition and agricultural production. Estimation was completed using Ordinary Least Squares Regression with robust standard errors in STATA.

Table 16: OLS Regression with Robust Standard Errors for Calorie Procurement

Number of Observations = 352 **Adjusted R-squared = .4034**
R-squared = .4255 **Alpha = .05**

Log (Calories) (DV)	**Coefficient Estimate**	**Robust Std. Err.**	**T**
FN-Frequency Average	0.0685	0.0332	2.06*
TN-Average Degree	0.0117	0.0056	2.08*
Female Headed Household	-0.0889	0.0985	-0.9
Total Acres Cultivated	0.0061	0.0011	5.73**
Own Dairy Cattle	0.0510	0.0501	1.02
Highly Educated	0.0542	0.0518	1.05
Poor Self-Reported Health	-0.0314	0.0614	-0.51
Kitale	-0.1173	0.0798	-1.47
Tororo	-0.0275	0.1218	-0.23
Kapchorwa	-0.1546	0.0652	-2.37*
Enumerator 2 (Tororo)	-0.8040	0.1496	-5.38**
Enumerator 4 (Kapchorwa)	0.4312	0.0585	7.37**
Enumerator 11 (Kitale)	0.3410	0.1195	2.85**
Constant	7.9199	0.2029	39.03

Interpreting the Results for Networks and Calorie Procurement

Upon reviewing the results of the model, a high R-squared indicates that the model is able to explain approximately 43% of the variation in the log of Calories. However, there are a number of variables in the model, so it is also encouraging that the Adjusted R-squared remains higher than .4. As the dependent variable is in a log formulation, the coefficient estimates should be interpreted as representing a percent change in the calories procured, all other factors held constant. For example, for a one unit increase in the frequency of contact (such as moving from monthly to weekly contact) with members of the food acquisition network, calorie procurement will increase 6.8%, ceteris paribus. This linear regression was conducted at an alpha level of .05. Therefore, the null hypothesis that the variables do not have an impact upon calorie procurement may be rejected with strong evidence when the p-value reported is less than .05. For ease of identification, the t-statistics for variables which are significant by this rejection rule are tagged

with a single asterisk and those with values of less than .01 are signaled with two asterisks as providing even stronger evidence for rejecting the null hypothesis at the 95% level of confidence.

Analyzing Regression Results

With these guidelines in mind, it is now possible to begin interpreting the results of the regression. Consistent with the findings of the previous chapter, the frequency of contact with the food network is utilized in the regression as the Food Network variable least impacted by enumerator and site effects while Agricultural Production Network Degree provides insight into both the number and diversity of contacts for agricultural information and resources. It is notable that both the network variables are statistically significant and that the coefficient estimates demonstrate a positive impact on calorie procurement. As previously described, the model estimates increasing frequency of contact with the food acquisition network by one level will increase calorie procurement by 6.8%, while adding a single agricultural production network contact will increase calorie procurement by 1.7%.

The positive impact of food acquisition networks on food security is a particularly exciting finding. First, the fact that frequency of contact has a positive impact on the model contradicts the initial concern that food networks would be endogenous to food security. As stated throughout this thesis, there was some unease that measures of the strength of the food network might bear a negative coefficient, reflecting that women were mobilizing these networks of exchange because they were suffering from food insecurity. Rather, this finding states that people who regularly engage in local food networks actually have higher calorie procurement than those who do not. In combination with the qualitative findings that these networks are present year round and most active when food is most available, perhaps the statistically

significant positive impact may even be a false positive. In attempt to further investigate this relationship, an instrumental variables approach is investigated in the next section.

Such local food networks are not often incorporated into efforts to reduce food insecurity, stemming from the logic that if the more basic causes of food insecurity such as low yields, low education, and low income are addressed then the need for these networks is reduced. Despite remaining concern about the potentially endogenous relationship between local food networks and food security, the results suggest suggests that policies and programs wishing to combat food insecurity should be looking into ways to identify and strengthen these community networks for obtaining food.

The positive impact of the agricultural production network on food security is also an important finding. As detailed in the variable description, this measure is calculated as an average of the contact with individuals to obtain agricultural resources and information, suggesting that a high combination of both types of contacts contributes to improving food security. Moreover, the position generator method off which the survey instrument was designed for these questions also means that individuals have to show diversity in their networks in order to have a high number of agricultural network contacts. The positive relationship between food security and network strength by this measure also confirms some conventional wisdom about smallholder farming: to be a successful farmer, one must work hard. People do not obtain a higher number of contacts by sitting back and waiting for programs and policy makers to come to them. By contrast, building extensive social networks for agricultural production requires farmers to be proactive.

It is also interesting to observe that these variables are statistically significant in the model, whereas a number of the demographic variables expected to have a decisive impact are not. In

other words, the strength of food acquisition networks and the agricultural production networks is not dependent of these other controls. Specifically, households do not necessarily need to fit a particular profile as wealthy, highly educated and possessing large land holdings in order to build strong networks for food acquisition and for agricultural production.

Following this logic, the evidence that food security can be improved through network activity should be empowering to smallholder households and the organizations and policy makers who seek to assist them. Households exercise a much greater degree of control over the networks they build for food acquisition and agricultural production than many of the structural factors associated with food insecurity, such as poor health or belonging to a female headed household. Moreover, the policies and programs which target structural factors of food insecurity can be stigmatizing for populations, and can often encourage cycles of dependence rather than development. By contrast, activities which promote the strengthening of local networks for agricultural production and food acquisition are likely to leave households with skills that contribute to a sustainable improvement in household food security.

Moving onto the control variables, it is notable that the only statistically significant variable is the amount of land cultivated by a household. This variable has a small positive impact upon calorie procurement, logically indicating that cultivating more land increases calorie procurement. Despite the fact that the other controls presented in this model are not statistically significant, they are nevertheless important as they are grounded in theory. The signs of the variables are also consistent with how they are expected to impact food security. Specifically, the coefficients for poor health and female headed households are negative, while high education, owning dairy cattle and total acres cultivated all have positive coefficients. A number of controls were experimented with in the model, ranging from access to credit and different agricultural

production technologies to the ownership of other types of livestock such as poultry. However, none of these alternative controls were found to be statistically significant.

The final two groups of variables, site and enumerator controls, are certainly related. As detailed in the previous section, both the enumerator and location of a household between the four sites are likely to impact the calories reported by the individual. As these variables are highly correlated with one another, it is important to include both in the model. The coefficients should also be interpreted together, as interpreting the coefficients alone may be misleading. For example, a straight interpretation of the coefficients would indicate that being interviewed by Enumerator 2 reduces calorie procurement by an estimated 80%, but being from Tororo (as opposed to the base group Bungoma) does not have a statistically significant impact. In reality, it is known that enumerator two was responsible for one third of the interviews in Tororo, so individual interpretations should be taken somewhat lightly and not be given exaggerated importance. What is important is that when the effects of location and enumerator effect are controlled for, the food network and agricultural production network variables remain significant.

Exploring a Potential Instrumental Variable for Food Network Frequency of Contact

In order to accommodate the suspected endogeneity between social networks and food security, an Instrumental Variables (IV) approach was also used to estimate the impact of networks on food security. Unfortunately, of the variables collected regarding food network activity, Food Network Frequency Average was least strongly correlated with the Friendship Network variables for average frequency of contact and degree with correlation coefficients of .0095 and .1110, respectively. Nevertheless, once correlation with the other exogenous variables in the model has been controlled for, friendship network degree presents the strongest correlation with Food

Network Frequency Average, and is utilized to instrument for Food Acquisition networks in table 17. Below, the food network frequency average is now the fitted values for food network frequency average obtained from the regression of the instruments.

Table 17: Instrumental Variables Estimation of Calorie Procurement Model

Log(calories) (DV)	**Coefficient Estimate**	**Robust Std. Err.**	**T**
Food Network Frequency Average	-0.1915	0.2930	-0.65
TN-Average Degree	0.0093	0.0077	1.2
Female Headed Household	-0.0723	0.1088	-0.66
Total Acres Cultivated	0.0049	0.0019	2.65**
Own Dairy Cattle	0.0734	0.0640	1.15
Highly Educated	0.1003	0.0785	1.28
Poor Self-Reported Health	-0.0138	0.0725	-0.19
Kitale	-0.1355	0.0962	-1.41
Tororo	-0.0925	0.1742	-0.53
Kapchorwa	-0.1123	0.0855	-1.31
Enumerator 2 (Tororo)	-0.7790	0.1598	-4.87**
Enumerator 4 (Kapchorwa)	0.4532	0.0735	6.17**
Enumerator 11 (Kitale)	0.3481	0.1180	2.95**
Constant	8.9523	1.1934	7.5
Instrumented	FNFreqavg		
Instruments	TN-Average Degree Female Headed Household Total acres cultivated Own Dairy Cattle Highly Educated Poor Self-Reported Health Kitale Tororo Kapchorwa Enumerator2 Enumerator4 Enumerator11 Friendship Network Degree		

The instrumental variable regression does not strengthen the argument for that food network frequency of contact is exogenous to food security, as the results above do not echo the findings of the initial specification for calorie procurement. Specifically, the instrumented Food Network Frequency Average Variable does not demonstrate a statistically significant impact upon calorie procurement. This is probably due in part to the relatively weak correlation between food network frequency of contact and friendship network degree (.11). The large standard error

relative to the size of the coefficient is further evidence that friendship network degree is likely only a weak instrument for average frequency of contact with the food network. The fact that in the instrumental variables estimation Food Acquisition networks loses its positive effect on food security strengthens the suspicion that the original specification for calorie procurement might be delivering a false positive. This is because the results seem to indicate that there may be some element of network building as an activity to resist food insecurity, despite the relative weakness of the instrument.

Notably, the technology networks variable is also no longer significant. This is likely a product of the significant correlation between technology network average degree and friendship network degree (.17). Due to this significant correlation between the Friendship Networks and Technology Networks Average Degree, it was suspected that friendship network degree may actually serve as a better instrument for technology networks than the food acquisition network. However, when this model is run the impact of the instrument is also not statistically significant, though the impact of the food acquisition network remains significant at the .05 level.

In order to further explore the potentially endogenous relationship between food acquisition networks and food security, a better instrument for frequency of contact with the food network needs to be identified. As demonstrated from this discussion, this instrument would have a stronger correlation with frequency of contact in the food network and not be correlated with the technology networks variable; while retaining the characteristics of a good instrument in not having a direct impact upon food security.

Dietary Quality and Social Networks

As discussed at length in Chapter 6, the findings in calculating the WFP FCS indicate that the thresholds for food security underestimate the presence of food security in the population

compared with caloric indicators and verbal reports of food insecurity. For this reason, the WFP FCS thresholds are not used to classify households as secure or insecure in modeling the relationship between food security and social networks. Instead, this thesis experiments with using the WFP FCS as a continuous variable to account for dietary quality.

Given the presence of heteroskedasticity in the log of calories regression with OLS, I remained concerned that heteroskedasticity might also be present in regressions with the WFP FCS. While enumerators has a less demonstrable impact on the WFP FCS data, the considerable variation in the diet between locations documented in the qualitative chapter suggests that FCS might be especially affected by differences between sites. Nevertheless, in testing for heteroskedasticity under the Breush-Pagan and White test there was not sufficient evidence to reject the null hypothesis of homoscedasticity for any of the formulations of the model presented. Table 17 presents the results of the OLS regression utilizing the same variables as utilized in the calorie procurement model:

Table 18: Ordinary Least Squares Regression for Dietary Quality

Number of Observations = 352 **Adjusted R-Square= .173**
R-Square= .1966 **Alpha = .05**

WFP FCS (DV)	**Coefficient Estimate**	**Standard Error**	**T**
FN-Frequency Average	1.9328	1.0485	1.8400
TN-Average Degree	0.3188	0.2282	1.4000
Female Headed Household	1.8374	2.5100	0.7300
Total Acres Cultivated	-0.0058	0.0903	-0.0600
Own Dairy Cattle	-2.9713	1.9322	-1.5400
Highly Educated	-1.0842	1.6440	-0.6600
Poor Self-Reported Health	-2.4205	1.8159	-1.3300
Kitale	18.5601	2.5168	7.3700**
Tororo	12.4991	4.7361	2.6400**
Kapchorwa	7.8076	2.4343	3.2100**
Constant	44.6595	6.9436	6.4300

Interpreting the Regression Results for Networks and Dietary Quality

Interpreting the results of the regression for the WFP FCS is more straightforward than the model for calorie procurement. Basically, the model estimates a constant term off of which the above factors exercise a positive or negative impact based on the coefficient estimates in the first column. These estimates can be translated directly to an increase or decrease in the score by value of the coefficient estimate. For example, all other factors held constant, a household from Kitale will have a Food Consumption Score 18.5 points higher than a household from Bungoma, the base group for the model. Estimation at the alpha level of .05 produces t-statistics and p-values to determine whether or not the estimated impact is significant at the level of 95% confidence. Again, p-values below .05 are considered as providing strong evidence against the null hypothesis that the variable has statistically significant impact and their t-statistics are marked with an asterisk. Two asterisks denote a p-value below .01 is observed, which provides even more compelling evidence that the null hypothesis is not true.

Analyzing Regression Results

From the regression results it can be easily observed that many of the variables which impacted calorie procurement do not impact the WFP FCS in the same manner. In fact, very few variables have a statistically significant impact in the model. The model also has a low adjusted R-squared value, meaning that that only about 17% of the variation in the FCS is explained when the number of parameters in the model is taken into account. The immediate reaction to this was to move back to the drawing board in experimenting with different control variables, but no additional control variables could be identified with statistical significance or that substantively improved the explanatory power of the model through the adjusted R-squared value. This low R-Squared means that the interpretation should be cautious about putting too much weight in the statistical significance of the coefficients as they are only explaining a limited portion of the

variation in error in the model. Nevertheless, the only variables which seem to have a statistically significant impact are the site controls. This confirms suspicion that this indicator may be more sensitive to the differences in dietary customs between sites.

The significance of the site variables in the model also leads me to question whether the indicator may be unduly discriminatory or rewarding to certain cultural values regarding the diet which may or may not reward the best way of giving dietary quality. For example, the high coefficient estimate and statistical significance of the Kitale site control may be a product of the culture of daily milk consumption in Kitale. Across the sites, the consumption of large quantities of dairy was confined to three types of products: milk, sour milk and yoghurt. By comparison, there is a wide variety of options for the consumption of meat and fish, and are more likely to provide a diversity of micronutrients to the diet. However, both milk and meat are given the same value for one day's consumption at four points and counted separately toward the creation of the score. As such the cultural custom of daily milk consumption of the Kalenjin people in Kitale may be being given a disproportionate weight in the analysis and may actually conceal a lack of dietary diversity in other areas. Moreover, these site variables don't bear the signs which would be expected from the previous analyses. Tororo has a statistically significant and large positive impact upon the model, which is contrary to the findings that Tororo compares poorly to Bungoma (the base group for the regression) in dietary quality as measured by percent energy from staples and calorie procurement. Nevertheless, this finding is not entirely inconsistent with the summary statistics in Chapter 6. In the comparison of the WFP FCS across sites Bungoma did have the largest proportion of individuals classified into the borderline consumption category.

Given the significance of the site effects, interaction terms were tested for each of the network variables for all sites. The following regressions demonstrate that when interaction terms are introduced for the technology network variable there is a significant impact upon dietary quality in Tororo and Kapchorwa.

Table 19: OLS Regression Results for Technology Networks in Tororo

Number of Observations = 352 **Adjusted R-Sqaure= .1851**
R-Square= .2106 **Alpha = .05**

WFP FCS	**Coefficient Estimates**	**Standard Error**	**T**
FN-Frequency Average	1.6246	1.0484	1.55
TN-Average Degree	-0.1395	0.2934	-0.48
Tororo*TN-Average Degree	1.1318	0.4604	2.46*
Female Headed Household	1.7728	2.4917	0.71
Total Acres Cultivated	-0.0035	0.0896	-0.04
Own Dairy Cattle	-3.0617	1.9184	-1.60
Highly Educated	-1.0300	1.6321	-0.63
Poor Self-Reported Health	-2.4579	1.8027	-1.36
Kitale	20.5434	2.6255	7.82**
Tororo	-1.3326	7.3323	-0.18
Kapchorwa	5.8049	2.5502	2.28*
Constant	56.5057	8.4103	6.72

Table 20: OLS Regression Results for Technology Networks in Kapchorwa

Number of Observations = 352 **Adjusted R-Square= .1850**
R-Square= .2105 **Alpha = .05**

WFP FCS (DV)	**Coefficient Estimates**	**Standard Error**	**T**
FN-Frequency Average	1.7004	1.0452	1.63
TN-Average Degree	0.5727	0.2491	2.3*
Kapchorwa*TN-Average Degree	-1.4691	0.5994	-2.45*
Female Headed Household	2.1789	2.4956	0.87
Total Acres Cultivated	-0.0052	0.0896	-0.06
Own Dairy Cattle	-3.1521	1.9196	-1.64
Highly Educated	-1.1583	1.6323	-0.71
Poor Self-Reported Health	-2.2514	1.8040	-1.25
Kitale	17.4924	2.5363	6.9**
Tororo	16.9756	5.0440	3.37**
Kapchorwa	36.2686	11.8614	3.06**
Constant	39.7972	7.1729	5.55

Regression Results with Site Interactions

The results of these two regressions indicate that the technology networks are working in opposite directions in Tororo and Kapchorwa. The first model demonstrates that the technology networks in Tororo have a differential from the average network effect by improving dietary quality and sufficiency by about 1.3 points, while these same networks in Kapchorwa are reducing the score of by about the same margin. While these changes are small, the findings are consistent with the qualitative observations I made while working in the two sites. Namely, well connected farmers in Tororo appeared to be utilizing these networks to diversify into livestock and other crops beyond the main staple cassava. Meanwhile, the agricultural production network in Kitale is largely focused on increasing the production of maize, wheat, and Irish potatoes. It is also notable that when the negative impact of the agricultural production network upon dietary quality in Kapchorwa is controlled for, the technology network variable has a positive impact on dietary quality for the rest of the sites.

That said, it is important to temper these findings with the recognition that both models continue to exhibit a low adjusted R-squared, and thus the analysis must continue to be cautious of putting too much weight in the statistical significance of the interactions exhibited above. Nevertheless, they do provide evidence that technology networks for agricultural production are having impacts on dietary quality. The findings provide evidence for further research on the impact of networks on dietary quality by alternative indicators and in other cultural contexts.

Alternative Specifications

A number of alternative specifications were attempted in order to further explore the impact of food acquisition and agricultural production networks upon food security. First, the different measures representing network strength in both the food networks and agricultural production networks were all experimented with in each of the models, with those presented showing the

strongest impact. Combinations of the network variables, such as additive and multiplicative forms of combining network degree, frequency and/or trust were also tested for both the calorie procurement and WFP FCS models. However, these variables were not found to be significant and seemed to mute, rather than enhance the impact of the network variables.

Bearing in mind the significant results obtained through introducing site and network interactions in the WFP FCS model, interaction terms were also tested for all of the sites for both types of network variables in the calorie procurement specification. These were not found to be statistically significant, indicating that these networks function similarly across sites to increase calorie procurement. This result is not inconsistent with the significant findings for the network and site interactions in the WFP FCS model for Tororo and Kapchorwa, because as documented in the qualitative research, agricultural networks in different sites tend to promote different combinations of crops and livestock. While all of these activities may increase calorie procurement, they may not have the same impacts on dietary quality.

The lack of statistical significance of the site and network interactions for calorie procurement is an important finding because it increases the generalizability of this research. As detailed in the qualitative chapter, the sites present a relatively wide range of geographic and cultural attributes. The fact that networks seem to behave similarly across them provides evidence that the operation of these networks is not village specific. As such, these findings encourage the broader support of social networks by policies and programs in East Africa seeking to increase calorie procurement. The complimentary finding regarding the different impacts of local networks on dietary quality suggests that these efforts should also take into consideration the production systems being promoted through these networks in order to ensure that projects result in an increase in both sufficiency and quality of diet.

Chapter 9: Summary and Conclusion

Summary

This thesis set out to investigate the relationship between smallholder farm household networks for food acquisition and agricultural production, food security and dietary quality in the Mount Elgon region of western Kenya and Eastern Uganda. Food security and dietary quality were measured through a 24 hour dietary recall with the female household head, the calculation of the WFP FCS, and the calculation of the percent energy sourced from staples from the calorie data. Through developing correlations between these three indicators, it was determined that the WFP FCS was capturing elements of both sufficiency and quality of diet. Comparison of these statistics across sites indicated that Tororo had the highest prevalence of food insecurity and poor dietary quality and that the measure for total calories was universally affected by some degree of measurement error.

The subsequent application of Ordinary Least Squares regression determined that both food acquisition networks and technology networks for agricultural production have a statistically significant positive impact upon calorie procurement across the sites included in the study. However, networks for agricultural production operate differently in different locations with regard to dietary quality. Specifically, an increased number of network contacts for agricultural production in Tororo makes a small, but statistically significant positive impact on dietary quality, relative to similar networks in other areas. Technology networks in Kapchorwa, by contrast slightly reduce dietary quality and a have a small but statically significant positive impact elsewhere. Interpretation of qualitative data gathered through interviews with agricultural service sector providers and focus groups about these local networks for agricultural production suggests that this might be due to the differences in the types of crops and attitudes held

regarding food security and dietary quality across localities. As such, this thesis makes a contribution to the food security literature through two primary mediums: testing and development of methods to measure food security and social networks and demonstrating the impact of networks on food security.

Methodological Contributions and Recommendations for Further Research

This thesis was a successful experiment in applying new techniques to the measurement of food security and social networks. Variations in the local diet across western Kenya and eastern Uganda were documented and efforts were made to incorporate methods from the nutrition and public health disciplines to measure caloric intake more accurately among female heads of household. Egocentric network measurement tools were also applied to the development context and utilized to develop appropriate measures for strength of networks for use with other cross sectional data.

These innovations aside, undoubtedly a significant degree of measurement error entered into the calculation of food security measures, especially the 24 hour dietary recall. A simple way to improve the measure is to change the module for the survey from a frequency module to a 24 hour recall in which the enumerator asked the female household head to simply recall what she ate as opposed to asking for every food in the consumption basket. This would shorten the survey time considerably. The resulting time savings might also make it possible to use one of the local serving cups to obtain approximate serving sizes of each food with the women surveyed on an individual basis. A potential problem with this adaptation may be that certain foods could be overlooked, fitting with the fact that strict recall data can tend to underestimate consumption. Nevertheless, these procedural adjustments would likely only make a marginal difference compared to correcting the most major assumption made by this study: that the food composition

tables for Tanzania could provide approximations for the diverse dishes represented in both the Kenyan and Ugandan diet.

The production of food composition tables for Kenya and Uganda is essential to better understanding patterns of food security within both countries. With the shifting emphasis from improving quantity towards improving quality of diet, specific knowledge of what the nutritional composition from the foods actually consumed in these areas is needed. Accurate food composition tables will significantly reduce measurement error due to inappropriate substitutions for local dishes and will provide a much more accurate picture of micronutrient as well as macronutrient nutritional security. It is encouraging that the Nutrition CRSP is expanding its activities in Uganda, and perhaps through some of these efforts more specific knowledge can be acquired about the nutritional value of Ugandan dishes.

Regarding the WFP FCS, this research demonstrated that the indicator may have some additional value as a continuous variable to express overall dietary quality. Correlations between caloric and dietary quality indicators support many of the findings of Weisman et al (2009), and add the contribution that the WFP FCS seems to be less reliable at lower levels of consumption. Subsequently, thorough investigation of the score at low caloric levels is particularly important for improving the indicator as a tool to measure food insecurity. To more accurately reflect the level of food security in the populations compared to caloric indicators, it is likely that the food security score thresholds need to be raised to a higher level. That said, it must be recognized that the WFP FCS is somewhat of a crude measure for dietary quality as it does not account for diversity within food groups and the contribution of this diversity to overall dietary quality. Improved indicators for accounting for such diversity should be developed. These findings also support current efforts spearheaded by a number of agricultural development and hunger

advocates to develop an effective indicator for diagnosing micronutrient malnutrition (AED and FAO, 2011).

On a similar note, the measurements of food security utilized by this thesis fail to capture dimensions of dietary preferences and social acceptability of consumed foods. This issue was raised in the qualitative discussions regarding omena consumption in Chapter 5. Incorporating a Class 3 indicator into future studies of food security and social networks has the potential to capture whether these networks also have an impact on this important dimension of food security. However, as suggested by the analysis of the Coping Strategies Index activity conducted with focus groups, the CSI may not be the most appropriate tool to study the relationship between food security and social networks. This is because of the potentially endogenous relationship between networks and food security created by this tool. Alternatively, applying the Household Food Insecurity Access Scale might be more suitable for attempting to incorporate a dimension of social acceptability of foods consumed into the food security analysis (Coates et al, 2007).

Regarding social network measurement, the research has demonstrated that a number of social network measurement methods; such as the position and resource generator (Lin and Erickson 2009; Van der Gaag and Snijders 2004), can be successfully applied in developing countries and incorporated into econometric modeling procedures. Experience in applying these measurement tools also revealed that it can be difficult to encourage female household heads to freely discuss their personal networks for bringing food into the household. Two cases where male enumerators were used instead of female enumerators indicated that women may feel less comfortable discussing these networks with men rather than other women. Subsequently, it is recommended that future network research with female household heads should utilize female enumerators.

Another obstacle confronted in field research is that measurements of trust were more difficult to apply in this cross-cultural context. Further research regarding the application of social network measures in developing countries should consider experimenting with alternative methods of measuring trust that may be more meaningful to local respondents.

The Impact of Social Networks on Food Security and Recommendations for Development Interventions

The general finding that networks for agricultural production and food acquisition have a positive impact on food security is both timely and significant to research and development efforts which seek to improve food security for smallholders. First, the conclusion that increased contacts for agricultural production confirms that working with smallholders to improve farming practices is a way to improve food security. Second, the position generator method through which these results were obtained indicates that this need not only be accomplished through the usual technology transfer network of agricultural researchers, extension agents, and farmers. Rather, increased contact with a wide variety of local actors who provide information and resources for agricultural production, such as religious leaders, teachers, and local women and farmer group leaders is what delivers an increased impact upon food security.

The complimentary finding that these networks had differing impacts on dietary quality implies that some technology networks promote a healthier diet than others. This suggests there is a need for an educational component in agricultural network development activities so that the importance of promoting dietary quality within these networks is also realized.

With regard to local networks for food acquisition, the conclusions are equally if not more, important. Specifically, local food acquisition networks for the exchange of food within women's household networks are often labeled as "food stress" networks and as a result

disregarded in efforts to improve food security in farm communities. This research implies that both the label and corresponding action are not well informed. First, these local food acquisition networks operate to increase household consumption. This contradicts the concern that these networks are endogenous to and exist because of food insecurity. Subsequently, improving food security in these areas will not likely eliminate the existence of these networks. Therefore, integrating these networks into efforts to improve local food security may be an important mechanism to ensure that food security programs are more effective. As these networks are managed by women, these networks also present a potential opportunity to deliver direct benefits to women and children in food security programs.

Both findings are highly timely as development efforts have been increasingly focused on the application of social networks to improve the welfare of the poor. An example is in Uganda, where the USAID Mission is currently scaling up its Community Connector program, which seeks to improve local networks, especially for particular value chains across Uganda (USAID, 2011). These findings provide support that the establishment of such programs is worthwhile. Most encouragingly, the findings regarding the impact of social networks on food security present an opportunity for farmers to improve food security in their communities. Smallholder farmers, in exercising control over their social networks for both agricultural production and food acquisition have direct avenues by which they can help themselves in improving food security.

References:

AED and FAO. 2011. *Deepening the Dialogue: Agriculture and Nutrition Collaboration to Enhance Global Food Security Summary Report from the Open Forum Held on November 1, 2010*. Washington, DC: AED.

Alinovi, L. M. D'Errico., E. Mane and D. Romano. 2009. Livelihoods Strategies and Household Resilience to Food Insecurity: An Empirical Analysis to Kenya. Paper prepared for the Conference on "Promoting Resilience through Social Protection in Sub-Saharan Africa" 28-30 June, Dakar, Senegal.

Anderson, D. and D. Throup. 1985. Africans and Agricultural Production in Colonial Kenya: The Myth of the War as a Watershed. 26(4): 327-345.

Bandiera, O. and I. Rasul. 2006. Social Networks and Technology Adoption in Northern Mozambique. *The Economic Journal* 116(514): 869–902.

Barrett, C. B. 2002. Food Security and Food Assistance Programs, *Handbook of Agricultural Economics.* vol. 2, B. Gardener and G. Rausser, eds. Elsevier BV, pp. 2103-2135.

Becker, G.S. 1965. "A theory of the allocation of time" *Economic Journal* 75: 493-517

Chavas, J.P. 2000. The mircoeconomics of food security. *The Australian Journal of Agriculture and Resource Economics* 44(1): 1-29.

Christie, M.E. Trip Report: Uganda 24-29 June 2010. SANREM CRSP Trip Report. http://www.oired.vt.edu/sanremcrsp/documents/tripreports/2010/Maria%20Elisa%20Christie,%20Uganda,%20June2010.pdf, accessed 3 October 2011.

Coates, J. E. A. Frongillo., B. L. Rogers, P. Webb, P. E. Wilde and R. Houser. 2006. Commonalities in the experience of household food insecurity across cultures: What are measures missing? *American Society for Nutrition* 136, Special Issue: Advances in Developing Country Food Security Measurement: 1438S-1448S.

Coates, J., A. Swindale, and P. Bilinsky. 2007. Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide. Version 3. Food and Nutrition Technical Assistance Project (FANTA). Academy for Educational Development, Washington, D.C.

Crisis in Kenya: Land, displacement, and the search for durable solutions. 2008. Overseas Development Institute, Humanitarian Policy Group. Policy Brief 31.

Ekboir, J., K. Boa and A. Dankyi. "Impact of no-till technologies in Ghana." CIMMYT.

Fafchamps, M. 1992. Solidarity Networks in Preindustrial Societies: Rational Peasants with a Moral Economy. *Economic Development and Cultural Change* 41(1): 147-174.

Food Consumption Analysis: Calculation and Use of the food consumption score in food security analysis. 2008. World Food Program, Vulnerability Analysis and Mapping Branch.

Food Security Statistics 2010. Rome, Food and Agriculture Organization of the United Nations.

Frankenberger, T. 1992. "Indicators and data collection methods for measuring food security" In: Maxwell, S. Frankenberger, T. (eds) *Household Food Security: Concepts, Indicators, and Measurements. A Technical Review.* UNICEF, New York and IFAD, Rome.

García-Torres, L., J. Benites and A. Martínez-Vilela. 2003. *Conservation agriculture, a worldwide challenge: environment, farmers experiences, innovations, socio-economy, policy.* Dordrecht: Kluwer Academic Publishers.

Guha-Khasnobis, B. and G. Hazarika. 2006. Women's Status and Children's Food Security in Pakistan. United Nations University World Institute for Economic Development Research, Discussion Paper No. 2006/3

Habicht, J. P., L.D Meyers and C. Brownie. 1982. Indicators for identifying and counting the improperly malnourished. *American Journal of Clinical Nutrition* 35(5): 1241-1254.

http://uwyosanrem.wordpress.com/. Accessed 19 October 2011.

in Vihiga District, Western Kenya, TSBF-CIAT Academy Publishers, pp. 535–544.

Jurges, H. 2007. True health vs response styles: exploring cross -country differences in self-reported health. *Health Economics* 16(2):163-178.

Kipsat, M.J. H.K. Maritim and J.R. Okalebo. 2004. Economic Analysis of Non-Conventional Fertilizers

Kiptot, E. S. Franzel, P. Hebinck, and P. Richards. 2006. Sharing seed and knowledge: Farmer to farmer dissemination of agroforestry technologies in western Kenya. *Agroforestry Systems* 68(3): 167-179.

Knoke, D. and S. Yang. 2008. *Social Network Analysis: Second Edition.*. SAGE Publications.

Lamb, J., K.M. Moore and M.E. Christie. 2010. Research Framework for Technology Networks and Gendered Analyses. SANREM CRSP Working Paper Series 1-10.

Lee, J.S. and E. Frongilo (2006) Factors Associated With Food Insecurity Among U.S. Elderly Persons. The Journals of Gerontology: Series B 56(2): S94-S99.

Lemke, S., H.H. Vorster, N.S. Jansen van Rensburg and J. Ziche. 2003. Empowered women, social networks and the contribution of qualitative research: broadening our understanding of underlying causes for food and nutrition insecurity. *Public Health Nutrition* 6(8): 759-764.

Lin, N. and B. Erickson. 2008. *Social Capital: An International Research Program*. New York: Oxford University Press.

McBride, L. 2011. Mimeo on WFP FCS Performance against caloric indicators. Unpublished.

Locher, J., Ritchie, C.S, Roth, D.L. Baker, P.S. 2005. Social isolation, support, and capital and nutritional risk and gender differences. *Social Science & Medicine* 60(4): 747-761

Løvendal, C.R., M. Knowles and N. Horii. 2004. Understanding Vulnerability to Food Insecurity: Lessons from Vulnerable Livelihood Profiling. Food and Agricultural Organization, ESA working paper no. 04-18.

LTRA 10: CAPS for smallholder farms in eastern Uganda and western Kenya. Available: http://www.oired.vt.edu/sanremcrsp/professionals/research-activities/phase4/ltras/ltra10/. Accessed: 25 October 2011.

Lukmanji, Z., E. Hertzmark, N. Mlingi, V. Assey, G. Ndossi and W. Fawzi. 2008. Tanzania Food Composition Tables. Muhimibili University of Health and Allied Sciences (MUHAS)and Tanzania Food and Nutrition Center (TFNC) and Harvard School of Public Health (HSPH). Dar es Salaam, Tanzania and Boston, MA, USA.

Mango, N. 2002. Husbanding the land: Agricultural development and socio-technical change in Luoland, Kenya. PhD Dissertation, Wangingen University.

Mardsen, P. 2002. Egocentric and sociocentric measures of network centrality. *Social Networks* 24: 407-422.

Maxwell, D., A. Clement, C. Levin, M. Armar-Klemesu, S. Zakaraiah, G. M. Lamptey.1999. Alternative food-security indicators: Revisiting the frequency and severity of coping strategies. *Food Policy* 24(4): 411-429.

Maxwell, D., K. Sadler, A. Sim, M. Mutonyi, R. Egan and M. Webster. 2008. Emergency food security interventions. Overseas Development Institute: Good Practice Reviews, 10.

Mazzucato, V. D. Niemeijer, L. Stroosnijder and N. Röling. 2001. Social Networks and the Dynamics of Soil and Water Conservation in the Sahel. International Institute for Environment and Development, Gatekeeper Series no. 101

Moore, K.M. Trip Report: Kenya 18-25 July 2010. SANREM CRSP Trip Report. http://www.oired.vt.edu/sanremcrsp/documents/tripreports/2010/Keith%20M.%20Moore,%20Kenya,%20July%202010.pdf, accessed 3 October 2011.

Murphy, S.P., S. Weinberg-Andersson, C. Neumann, K. Mulligan and D.H. Calloway. 1991. Development of research nutrient data bases: An example using foods from rural Kenya. *Journal of Food Composition and Analysis* 4: 2-17.

Nelles Map. 2011. Uganda. Books R Us Limited. Nairobi, Kenya.

Niggli, U.; Fließbach, A.; Hepperly, P. and Scialabba, N. 2009. Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems. Food and Agriculture Organization of the United Nations, Rome.

Odhiamba, J., U.Norton and J. Norton. 2011. Conservation Agriculture Production Systems (CAPS) Impact on Greenhouse Gas Emissions Carbon and Nitrogen in Small Holder Farms in Kenya and Uganda. Poster Presented at the Agronomy Society of America Annual Meeting, 17 October 2011.

Oldhav, B., S. Beekrum, Us. Akula and H. Baijnath. (2007). Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis* 20 (2007): 4

Radimer, K.L., C.M. Olson and C.C. Campbell. (1990). Development of indicators to assess hunger 120:1544-8

Sadoulet, E. and A. de Janvry. 1995. Household Models In: Quantitative Development Policy Analysis E. Sadoulet. and A. de Janvry, eds. Baltimore, Johns Hopkins University Press.

SANREM CRSP. Managing Entity. SANREM CRSP Phase IV Concept Paper 15 June 2009. http://www.oired.vt.edu/sanremcrsp/documents/research-activities/phase4/PhaseIVConceptPaper.pdf, Accessed 3 October 2011.

Sen, A. *Poverty and famines: an essay on entitlement and deprivation*. Oxford: Clarendon Press, 1981.

Smith, L.C. and A. Subandoro. 2008. Measuring Food Security Using Household Expenditure Surveys. Washington, D.C., IFPRI.

Swenson, S. and K. M. Moore. 2009. Developing conservation agriculture production systems: An analysis of local networks SANREM CRSP Working Paper Series 10-09.

Tasaruk, V. (2001) Household Food Insecurity with Hunger Is Associated with Women's Food Intakes, Health and Household Circumstances. *Journal of Nutrition.* (2001);131:2670-2676.

Udry, C. and T.Conley. 2010. Learning about a new technology: Pineapple in Ghana. *American Economic Review* 100(1): 35-69.

Uri, N.D. 2000. Perceptions on the use of no-till farming in production agriculture in the United States: an analysis of survey results. 77(3): 263-266.

USAID. 2011. Community Connector Final Statement of Work. Posted 1 July 2011. Available online: https://www.fbo.gov/index?s=opportunity&mode=form&id=c4e63646f3b0da63e33300dec7bd5231&tab=core&_cview=1. Retrieved: 7 October 2011

USDA. 2000. Food Security in the United States: Measuring Household Food Security. Food and Nutrition Service. Washington, D.C.

Van Der Gaag, M. and T. Snijders. 2005. The resource generator: Social capital quantification with concrete items. *Social Networks* 27(1): 1-29.

Webb, P., J. Coates, E. Frongillo, B. L. Rogers, A. Swindale and P. Bilinsky. 2006. Measuring household food insecurity: Why it's so important and yet so difficult to do. *American Society for Nutrition* 136, Special Issue: Advances in Developing Country Food Security Measurement: 1404S-1408S.

Wiesmann, D. L. Bassett., T. Benson, and J. Hoddinott. 2009. Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of Household Food Security. International Food Policy Research Institute, Discussion Paper 00870

Wyoming SANREM Project: Sustainable Agriculture for Kenya and Uganda. Available: http://uwyosanrem.wordpress.com/. Accessed 19 October 2011.

Appendix A: Survey Instruments

HH Ref Number: _____

Baseline Survey

Conservation Agriculture Production System for Food Security

0.1 Date of Interview: ___/____/____ 0.2 Enumerator: _____

Location: 0.3 Province/District _____ 0.4 Subcounty/Location _____

0.5 Parish/Sublocation: _____0.6 Village_____

0.7 Distance to nearest trading center _____ kilometers

0.8 GPS readings: _Alt:_____ Eastings:_____ Northings_____.

KEY FARM HOUSEHOLD DEMOGRAPHICS 1.0 Person interviewed: _____HHmale _____HH female _____spouse female _____other specify _____

1.1 Name of Head of Household: _____ 1.2 Gender:____ M _____F

1.3 Age: _____ 1.4 Level of education:_____ 1.5 Primary occupation: _____

0=None 1=Pre-school 2=Primary 3= O level or Jr certificate 4= A level or Sr. certificate 5= Tertiary 6=Non-formal 7=Other specify	1=Crop production 2=Tree crop production 3=Livestock 4=Fishing 5=Crop product marketing 6=Livestock marketing 7=Petty trading 8=Salaried worker 9=other: Specify

1.6 Name of Spouse: _____

1.7 Age: _____ 1.8 Level of education:_____ 1.9 Primary occupation: _____

Observe housing conditions and note the following: (Only ask what is not observable.)

2.1. For your primary residence, what is the roof made of?	2.2. What is the floor made of?	2.3. What are the walls made of?	2.4. Are the walls painted?	2.5. Do you have a latrine / toilet?	2.6. Do you have electricity?	2.7. How many rooms in house (used by the HH)?	2.8. What is your primary water source?	2.9. Distance to water in KM
1=Iron Sheets/ Mabati 2=Thatch (grass/leaves/ bamboo etc.) 3=wood/earth 4=other (specify)	1=earth 2=brick 3=board/wooden 4=cement/tile 5=other (specify)	1=earth/mud 2=earthen brick 3=board 4=cement 5=burnt brick 6=other (specify)	0=no 1=yes	0=no 1=yes	0=no 1=yes	number of rooms	1=Tap 2=Borehole 3=Open well 4=river, pond, lake, swamp 5=protected spring 6= rainwater tank	0= In compound Otherwise enter distance in km. (use decimals)
Code	Code	Code	Code	Code	Code	#	Code	Dist.

How many people live in your household? _____Total _____ Male _____Female

Number by category	Male		Female	
Children below age 6	3.1		3.2	
Children 6-17	3.3	# in School? Primary_____ Secondary_____	3.4	# in School? Primary_____ Secondary_____
People 18-65	3.5	# in secondary School?_____ Tertiary Inst?_____ How many help with agricultural	3.6	# in secondary school? _____ Tertiary Inst?_____ How many help with agricultural

		production? _____		production? ____
Over 65 or disabled	3.7		3.8	

3.9 How many people in the household tend animals? _____

LIVELIHOOD SYSTEM

KEY FARMING SYSTEM CHARACTERISTICS

Agriculture Production Unit - Land

How many owned (acres)? _____

How many acres do you rent in or borrow from other people? _____

Other land available (acres) _____

How many acres are cultivated in total? _____

How many of these acres are managed by the male HH this season? _____

How many of these acres are managed by female HH this season? _____

How many acres are under forest? _____

How many acres are for pastures and grazing _____

How many acres do you rent out or lend to others to farm? _____

How long has this family been cultivating on this land? _____

1= less than 5 years, 2= 5 to 20 years. 3= 20 to 30 years, 4=more than 30years

Do you have access to shared/communal resources? (1=yes; 0=no)

5.1 Pasture land _____

5.2 Forestry land _____

5.5 Surface water _____

Livestock production/Use

Record current numbers at the time of the survey. Past year for use.

	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	7.10	7.11	7.12
Livestock	Number	Number owned by Male HH?	Number owned by Female HH?	For HH food?	For farm work?	For sale?	For Manure?	For Biogas?	Estimated total value (shillings)	Do you confine these animals to a stable/ kraal	Do you purchase supple-mental feeds?	How much did you spend on supplement al feeds last year? (shillings)
Poultry/Birds												
Sheep/goats												
Bullocks/Oxen												
Dairy Cattle												
Beef Cattle												
Donkeys												
Pigs												
Other												
	Indicate			(0=no 1=yes)					Enter	0=No,	(0=no	Enter

	number		estimated amount	1=Yes 2=Night only	1=yes)	estimated amount

Access to physical assets/technology. (Don't count if broken)

Type of Assets	a. Number of working items Owned	b. IF no, Do you have access (rent /borrow)? (0=no 1=yes)
Hoes		
Machete/Panga		
Sickle		
Axe		
Spade		
Rake		
Jab planter – use picture		
Spray pump		
Wheelbarrow		
Animal-drawn plough		
Ox/donkey Cart		
Tractor and plough		
Micro irrigation equipment		
Chisel plough – use picture		
Harrow – use picture		
Maize Sheller (indicate type) ____hand ____motorized		
Other Mechanical equipment: list		
Radio		
Bicycle		
Mobile Phone		
Sewing machine		
Motorcycle		
Car		
Truck/Pickup		
TV		
Computer		

Organization membership & financial access

Does any family member participate in the following? (2= yes very active 1= yes, sometimes; 0=no)

Organization		a. Any male member	b. Any female member
9.1	Production association		
9.2	Marketing association		
9.3	Other form of cultural or social group		
9.4	Bank account		

9.5	Source of credit (village bank, sacco, microfinance org, etc.)		
9.6	Source of credit in the form of agricultural inputs		
9.7	Means of informal savings – rotational savings groups.		
9.8	Mobile money (m-pesa, mcente, zap etc.)		
9.9	Mobile phone market information system		

10. Sources of Income

Do you have income from forestry or tree products? _____ 0=no 1=yes

How important are forestry products to household income? ____ (0=none 1=low, 2=medium, 3=high)

Do you have a kitchen/vegetable garden? _____ 0=no 1=yes

How important is the production from the Kitchen/vegetable garden to household food consumption? ____ (0=none 1=low, 2=medium, 3=high)

How important is the production from the Kitchen/vegetable garden to household income? ____ (0=none 1=low, 2=medium, 3=high)

How important is field/staple crop production to your household income?____ (0=N/A 1=low, 2=medium, 3=high)

What is the principle crop you grow to generate cash? _____

How important is off-farm income to your household income?____ (0=none or N/A 1=low, 2=medium, 3=high)

Do you process or package any of your agricultural production before you sell it? How important are such value-added agricultural activities to you household income? _____ (0=none 1=low, 2=medium, 3=high)

What are your major sources of HH off-farm income? (tick all mentioned)

_____ 1. Formal Employment, _____ 2. Casual labour,

_____ 3. Petty trade (selling items you buy from someone else),

_____ 4. Sale of items you produce at home (bricks, charcoal, brewing, handicrafts etc.),

_____ 5. Sale of services (hair braiding, mobile phone service, tailoring)

_____ 6. Other business activities (specify)_____.

III. STAPLE CROP PRODUCTION SYSTEM (Collect information for the CURRENT maize field only)

Did you grow Maize this season? _____(1=yes, 2=no). If No, skip to questions 14.) If yes ask the following questions about the LARGEST maize plot.

11. MAIZE PARCEL INFORMATION:

Manager: _____ (1= male HHH; 2= Female HHH; 3= Other Male; 4= Other female)

Size: _____ acres

Distance from House: _____km

Slope of the field: _____

(1= on flat land; 2= on a hillside with Steep slope 3. Hillside with Moderate slope)

Is the field near a stream or river or wetland _____0=no, 1=yes.

Is the field irrigated or watered in any way? _____0=no, 1=yes.

IF yes, please explain: _____

Tenure: _____ (0=owned, 1=rented. 2=other specify_____

Soil type: _____ 1=sandy, 2= sandy loam, 3=loam, 4=clay, 5=clay loam

Are you intercropping this field? If yes, with what other crops ? List in order of proportion, largest first. a. _____ b. _____

c. _____ d. _____

What is the intercropping pattern? ____1. Between rows of staple crop ___ 2. Within rows of staple crop ____3. Random broadcast. ____4. Other explain _____

Are there any trees or shrubs grown in this field? _____ (0=no 1=yes)

If yes, list the types of trees/shrubs in order of numbers, most common first. a. _____ b. _____ c. _____ d. _____

Did you plant the trees or shrubs on purpose? _____(0=no 1=yes)

What are the functions of the tree and shrub in your field?_____ (1=biomass for soil improvement, 2= control of soil erosion, 3= fencing, 4=livestock feed, 5= Other _____.)

How many times do you use this field in a year? _____ (ie number of seasons crops are grown in this field is in a year.)

How long since this field was last fallowed: _____ (number of seasons); Fallow length _____ (seasons) (Note: Assume one year = 2 seasons.)

What crop did you grow on this parcel in previous seasons? (ONLY FOR THE CURRENT MAIZE PLOT)

2nd season 2009 a. Main crop_____ Intercrop b. _____ c. _____

1st season 2009 d. Main crop_____ Intercrop e. _____ f. _____

2nd season 2008 g. Main crop_____ Intercrop h. _____ i. _____

1s season 2008 j. Main crop_____ Intercrop k. _____ l. _____

In Transoia, the longer season maize counts in 1st season and in that case 2nd season becomes not applicable..

12. MAIZE PARCEL Production Details for most recently concluded season. (Include labour on all intercrops.)

LABOR USED IN MAIZE PLOT													
Activity	Method 1=hand 2=animal 3=mechanized /tractor	Family Labor						EXCHANGE Group Labor			Hired Labor		
		Adult male		Adult female		Child < 15		# of people	Days	Total cost of food etc (Shillings)	# of people	Days	Total cost (incl. food) Shillings
		#ppl	Days	#ppl	Days	# ppl	Days						
	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	k.	l.	m.
Land preparation													
Sowing/Planting													
Watering *													
Fertilizer application													
Herbicide application													
Other chemical spraying													
Weeding 1st													
Weeding 2nd													
Harvesting													
Threshing/shelling													
Drying													
Transport (field to home)													
Other specify:													

NOTE: If the task is done by animal traction or tractor, the cost includes the cost of hiring the equipment.

13. Collect input information on the major maize field only.

.	Crop	Type / Variety	SOURCE	Quantity#	Unit	Price/Unit (Shillings)	Codes
Seed	Maize						Seed Type 1=Traditional Variety, 2=Improved Open Pollinated, 3=Hybrid Fertiilzer 0= none 1= DAP, 2=NPK, 3= Sulphate of Ammonia 4=Urea, 5=CAN 6=TSP/SSP 7=Manure 8. Compost, 9=other (specify)
Fertilizer	Maize						

Herbicide	Maize						Herbicide: 0=Not used 1=pre-emergent 2= post emergent, 3= both Chemicals: 0=none 1=Insecticide, 2=Fungicide, 3= both, 3=other (specify)
Other chemicals	Maize						
	Maize						
Other specify	Maize						0= none

(SOURCE CODES) 1=Own Retained, 2= Another farmer, 3=local market 4=Input Dealer, 5=NGO, 6=Research organization 7=Extension/NAADS/Government

14. Maize Production & Utilization

What was the total Household maize production (all parcels) in 2009	First Season 2009	2nd Season 2009
14.1 Unit of measure_____ 14.2 Avg weight/unit _____ 14.3 Number of units_____First Season _____2nd Season (Number of units times average weight per unit gives Qty harvested in kg)	Kg	Kg
14.4 What % was consumed or given away (determine by asking how many units);	%	%
14.5 What percent was sold (determine by asking how many units);	%	%
14.6 What % was carried over as seed (determine by asking how many units)	%	%
14.7 What % was lost (determine by asking how many unit)	%	%

Characterize the season – with respect to the maize crop in 2009	First Season 2009	2nd Season 2009
14.8 Weather conditions for cycle/year:(0=didn't grow, 1= drought; 2=normal; 3= very wet)		
14.9 Disease pressure (0= didn't grow, 1=lower; 2= normal; 3= high)		
14.10 Insect pressure: (0=didn't grow, 1=lower; 2=normal; 3=high)		
14.11Weed pressure: 0=didn't grow, 1=lower; 2=normal; 3=high		

15. Other Major Crops Grown in 2009: List up to four major crops.

Crop	Who usually makes	Who usually makes	First Season 2009	2nd Season 2009

	production decisions?	Marketing Decision?								
	1=husband 2=wife 3=both 4=other female 5=other male		Area planted Acres	Quantity Produced (KG)	Quantity Sold (KG)	Price per Unit	Area planted Acres	Quantity Produced (KG)	Quantity Sold (KG)	Price per Unit
	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	15.10
A										
B										
C										
D										

IV. Agronomic Practices

16. Use of Crop Residues: What is done with maize stover and other crop residue?

(Enumerators use 20 beans and have the farmer allocate on the pictures)

Crop = Maize	a. How much is removed and used for fuel? %	b. How much is removed and used for compost %	c. How much is removed and fed to animals %	d. How much is burned in the field? %	e. How much is left and fed to animals in the field? %	f. How much is left in the field for residue cover? %	Are there other uses?	
							Use 0=none otherwise list	h. %
16.1 Stalks								
16.2 Leaves								
16.3 Cobs								

Soil fertility technologies Used on the farm – excluding maize

May indicate more than 1 response – if so enter multiple code in the box separated by a hyphen (-)

Fertilizer applied	a. Crops fertilized in this way	b. Source	c. Is it easily available?	e. Type used?	How much do you use?		h. When do you apply it?	i. How is it applied?	j. Major Constraints to use?
					f. Unit	g. Number			
17.1 Inorganic (purchased) 1									
17.2 Inorganic (purchased) 2									
17.3 Green manure									
17.4 Improved fallows									
17.5 Farmyard Manure									
17.6 Compost									
17.7 Fortified compost									
17.8 Other: Specify									
Codes	CROPS 1=cereals 2=legumes	SOURCE 1=own prod, 2= purchased	0 = no 1= yes	Type Fertilizer 0=none 1=DAP	Type Green Manures 0=none	Type Improved Fallows	Time 0=N/A 1=at land	Application 0=N/A 1= basal	Constraint 0=none 1=availability

	3=groundnuts 4=vegetables 5=coffee 6=bananas 7=root crops 8=cash crops	from shop, 3= other farmer, 4= collected communal sources		2=NPK, 3= Sulphate of Ammonia = 4=Urea, 5=CAN 6=TSP/SSP 7=other (specify)	1=Lablab 2=Mucuna 3=Desmodium4=Canavalia 5=Alfalfa 6=Other	0=none 1=Crotolaria 2=Pigeon Pea 3=Other	prep 2=at planting 3=after 1-2 months	2=banding 3=broadcast 4=side/furrow 5=foliar feeding 6=ploughed in 7= dry mulch 8=cover crop	2=cost 3=labour 4=transport 5= other (specify) _____

Unit of measure should be in Kg or Wheelbarrows. If other measure explain below. Quantity should be standardized to a per acre basis. So if the quantity used should be divided by the number of acres to get quantity per acre. (Example: 10kg in ¼ acre = 40 kg/acre.)

18. Weeding:
What weeds are problems in your fields? : _____ 0=none, _____ 1=grasses, _____2=herbaceous weeds, _____3= striga _____4=other (specify _____)
How is weeding done _____ 1=hand pulling, 2=hoeing under, 3=animal traction weeding, 4= herbicides, 5= other (specify_____)

19. Gardens:
How big is the kitchen (vegetable) garden? _____ meters by _____ meters
How far is it from the house? _____meters
Who provides the labor on the garden? _____ 1=Adult Men, 2=Adult women, 3=Children
(if more than one enter both numbers and separate with a hyphen (-))
Are you applying "sustainable agriculture/ bio-intensive" techniques in the garden? _____ 1= yes, 0=no

IV. ASSESSMENT OF OTHER PRODUCTION TRENDS OVER LAST DECADE
What is the trend in soil fertility on your farm over the last 10 years? _____
(1= decreasing in strength or fertility, 2= staying the same; 3=increasing)
How much is soil erosion a problem in this area? _____ (0=not a problem, 1=somewhat, 2=big problem)
Are new (high value) seeds available? _____(0=No, 1=Yes)
Distance to usual source of seed _____ km
If you have cash is there always enough food in the market to buy? _____(0=No, 1=Yes)

20.6 Perceptions of soil quality.
What are the most important criteria for evaluating soil quality? Read the list of criteria and ask the farmer to pick the three most important ones. Code a "3" for the most important; a "2" for the second most important; and a "1" for the third.
_____ a. water retention capacity
_____ b. the colour of the soil
_____ c. the quality of the crop it produces
_____ d. the quantity of organic material in the soil
_____ e. the quality of the soil when crumbled between one's fingers
_____ f. the quantity of the crop it produces
_____ g. the taste of the soil
_____ h. the effort needed to work the soil

V. KNOWLEDGE AND USE OF CONSERVATION AGRICULTURE PRACTICES
Minimum tillage means reducing the amount that the farmer disturbs the soil when cultivating. It means not turning the soil over or pulverizing it to a smooth seed bed.

21. Have you ever heard of this before? ____ (0=no 1=yes)
Does anyone in your family practice minimum tillage on any field? ____ (0=no 1=yes)
IF YES:
Who has tried it? ___ (0=male; 1=female; 2=both)

Which crop have you used it on? ____ 1=maize, 2=other cereal, 3=other (specify_____)
How long have you done it? ___ years
Where did you first learn of this practice? _____ (0= another farmer; 1=government extension service; 2=NGO, 3=other organization – list_____)
IF NO
WHY? _____
1= inadequate knowledge/information, 2=problems in controlling weeds, 3=poor soil structure, 4=lack of implements, 5=fear of risk or loss, 6=other _____

Does anyone in your family use cover crops (crops grown to be left on the surface without ploughing it into the soil) on any field? ____ (0=no 1=yes)

IF YES:
Which crop have you used it on? _____ list
Who has tried it? ___ (0=male; 1=female; 2=both)
How long have you done it? ___ years
Where did you first learn of this practice? _____ (0= another farmer; 1=government extension service; 2=NGO, 3=other organization – list_____)
Which cover crops are you using: List _____
IF NO
WHY? _____
1=inadequate knowledge/information, 2= lack of seeds, 3 it reduces yields of staple crop, 4=others specify

Have you experimented with any new crops recently? ____ (0=no 1=yes)
IF YES:
What crop?_____
How long have you been cultivating it? ____ seasons
Will you continue to cultivate this crop? _____ 0=no 1=yes
Why or why not?_____
Where did you first learn of this crop? _____ (0= another farmer; 1=government extension service; 2=NGO, 3=other organization – list_____)
IF NO
WHY? _____
(1=inadequate knowledge/information; 2=lack of seeds 3=Poor demand for other crops than staple 4=other specify _____)

Have you experimented with any other new farming tools or technologies recently? ____ (0=no 1=yes)
IF YES:
What tool or technology?_____
How long have you been using it? ____ seasons
Will you continue to use this tool or technology? _____ (0=no 1=yes)
Why or why not?_____

Where did you first learn of this technology? _____ (0= another farmer; 1=government extension service; 2=NGO, 3=other organization – list_____)

IF NO

WHY? _____

1=Inadequate knowledge/information; 2=High costs of tools; 3=Unavailability; 4=other specify

_____

22. STORAGE and MARKETING – answer for maize and up to three other crops usually stored

a. Crop	b.What type of storage? (see codes below)	c. Preserva-tives used to prevent post harvest loss	d. When do you normally sell? (see codes below)	e. Reason for sale (rank the most important reason from list below)	f. Distance to Market You usually sell at? (KM)	g. Type of sale
22.1 Maize						
22.2						
22.3						
22.4						
CROPS List	(STORE) 1= Bags 2=Maize Crib 3= Mud Granary/ silo 4= Thatch granary 5= Pots 6= Store under ground 7= No storage 8= Other (specify) _____	(TREAT) 1=Ashes 2=Neem extracts 3=Purchased chemical 4=Others (specify)	(MONTH) 1=January 2=February 3=March 4=April 5=May 6=June 7=July 8=August 9=September 10=October 11=November 12=December	(SELLREASON) 1=Buy food 2=Buy ag inputs 3=Education of Children 4=Medical care 5=Buy clothes 6=Buy household necessities 7=Pay back loan 8=Funerals 9=Marriage 10=Build house 11=Other (specify)	Enter Distance in Kilometers	SALE TYPE 0=N/A 1=farm gate 2= retail at local market 3=bulk sale at local market 4= bulk sale at distant market

22.5 What means do you usually use to take your crops to market? _____ 0=head load 1=bicycle, 2=motorcycle, 3=own vehicle 4=public transport/pickups 5=hired vehicle, 6=donkey/oxcart

22.6 What is the cost of transporting 100kg to the market? _____ shillings

23. Identification of the quality of relations within the agricultural production network

For both resource questions and the location and events question, only record the first response or primary interaction. If no resource or information (none) is accessed through interaction with a particular individual, code none and then go to the next individual.

People with which contact is made in order to conduct agricultural production activities (if no agricultural interaction, leave row blank)	a. What physical resources are accessed through interaction? 0. None 1. Seed 2. Fertilizer 3. Pesticide 4. Herbicide/ weedicide 1. Tractor 2. Crop finance/loans 3. Vet services AI 8. Other_____	b. What form of information is accessed through interaction? 0. None 1. Advice or consultation 2. Only information	c. Who Initiates the contact most of the time? 0. N/A 1. Always them 2. Mostly them 3. 50/50 4. Mostly respondent 5. Always respondent	d. Location and Events: Where do you interact? 0. N/A 1. Farm 2. Store 3. Office 4. Market 5. NGO Office 6. Community center 7. Farmer field day/event 8. Home garden 9. Collective garden 10. Other_____	e. Frequency: How often do you interact? 0. Never 1. Weekly 2. Biweekly 3. Monthly 4. Seasonally 5. Yearly	f. Quality: Can you trust resources/info from this source? 0. N/A 1. Always 2. Most of the time 3. Somewhat 4. Rarely 5. Never	g. Gender 0. N/A 1. All male 2. Mostly male 3. 50/50 4. Mostly female 5. All female
23.1. Village/Subcounty chief							
23.2. Family member							
23.3. Neighbor/friend							
23.4. Vendor in weekly market							
23.5. Vendor in a shop in urban center							
23.6. Vendor in a agro-vet shop							
23.7. Teacher in village							
23.8. Minister/Priest/Imam in village							
23.9. Government Extension agent							
23.10. NGO/ Development Agent							

People with which contact is made in order to conduct agricultural production activities (if no agricultural interaction, leave row blank)	a. What physical resources are accessed through interaction? 0. None 1. Seed 2. Fertilizer 3. Pesticide 4. Herbicide/ weedicide 1. Tractor 2. Crop finance/loans 3. Vet services AI 8. Other_____	b. What form of information is accessed through interaction? 0. None 1. Advice or consultation 2. Only information	c. Who Initiates the contact most of the time? 0. N/A 1. Always them 2. Mostly them 3. 50/50 4. Mostly respondent 5. Always respondent	d. Location and Events: Where do you interact? 0. N/A 1. Farm 2. Store 3. Office 4. Market 5. NGO Office 6. Community center 7. Farmer field day/event 8. Home garden 9. Collective garden 10. Other_____	e. Frequency: How often do you interact? 0. Never 1. Weekly 2. Biweekly 3. Monthly 4. Seasonally 5. Yearly	f. Quality: Can you trust resources/info from this source? 0. N/A 1. Always 2. Most of the time 3. Somewhat 4. Rarely 5. Never	g. Gender 0. N/A 1. All male 2. Mostly male 3. 50/50 4. Mostly female 5. All female
23.11. Veterinary Service provider							
23.12. Government Parastatals							
23.13. Agricultural researcher							
23.14. Agricultural/Micro Finance Representative							
23.15. Tractor owner/ animal Traction owner							
23.16. Leader of farmer organizations							
23.17. Leader of women's organization							
23.18. Leader of youth organisation							
23.19. Local Political leaders							
23.20. Other to be determined							

24. Knowledge, beliefs and perceptions concerning agricultural practices
(check the cell that most closely applies for each belief).

	Beliefs concerning agricultural practices	Strongly agree - 5	Agree – 4	Uncertain/neutral - 3	Disagree - 2	Strongly disagree - 1
24.1.	Land is one's heritage to be preserved for future generations					
24.2.	Farm labor should be replaced by more efficient herbicides and machines					
24.3.	Engaging in multiple productive activities is always better than doing just one					
24.4.	Farm income should always be reinvested to grow the business					
24.5.	One should maintain a permanent crop cover					
24.6.	It is better to grow staples within the household or community than purchase them.					
24.7.	Applying chemical pesticides is always necessary					
24.8.	Farm production is necessary to feed the family					
24.9.	Inorganic fertilizer is best to improve soil quality					
24.10.	Spreading crops and inputs across multiple plots is always necessary					
24.11.	Planting decisions are always based off of current market prices					
24.12.	Timely weeding (before setting of seed) is important to a successful harvest					
24.13.	Crops should only be grown for sale					
24.14.	Crop residues should only be fed to livestock and poultry					
24.15.	Tillage causes land degradation					
24.16.	One should always strive to grow the most on one's land					
24.17.	The staple crop should be planted on the majority of the land *every* growing season					
24.18.	Rotating crops is always best practice					
24.19.	Land preparation for crop production begins with plowing.					
24.20.	Earning off-farm income is more important than a large harvest					

Beliefs concerning agricultural practices	Strongly agree - 5	Agree – 4	Uncertain/neutral - 3	Disagree - 2	Strongly disagree - 1
24.21. Land preparation with crop production begins with plowing					

Enumerator's comments:

Please raise and questions or concerns or draw the supervisor's attention to any questions that you need assistance with coding or calculation:

Supervisor's comments:
Please respond with any corrections, calculations or concerns about data quality:

HH Ref Number: _____

Baseline Survey Supplement for Tororo, Uganda
Conservation Agriculture Production System for Food Security

0.1 Date of Interview: ___/____/____ 0.2 Enumerator: _____

Location: 0.3 Province/District _____ 0.4 Subcounty/Location _____
0.5 Parish/Sublocation: _____ 0.6 Village_____

Household Identification: 0.7 Name of Head of Household: _____
0.8 Name of Person Interviewed: _____
(Should be person primarily responsible for food preparation in the household—I.E. Spouse or Female HH Only Women should be interviewed.)

Section 1: Consumption Module

Was yesterday a 'normal' day regarding what you consumed? YES _____ NO_____

If "No", please explain what was abnormal and why: _____

_____

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did <u>YOU</u> consume in the past 24 hours?	4. How many **days** did the <u>HOUSEHOLD</u> consume in the past week?
	0. No 1. Yes	0. All from the farm 1. Mostly from farm 2. About half from the farm and half other sources 3. Mostly from other sources 4. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
Staples and Grains				
1. Maize Posho				
2. Sorghum Posho				
3. Matooke				
4. Irish Potatoes				
5. Sweet Potatoes				
6. Cassava Plain				
7. Cassava w/ Sorghum				
8. Cassava w/Millet				
9. Millet Posho				
10. Chapatti				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	0. No 1. Yes	0. All from the farm 1. Mostly from farm 2. About half from the farm and half other sources 3. Mostly from other sources 4. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
11. Bread				
12. Mandazi				
13. Rice				
14. Maize porridge				
15. Millet porridge				
16. Sorghum porridge				
17. Cassava porridge				
18. Other staples or grains _____				
Pulses				
19. Green Grams				
20. Cowpeas boiled				
21. Cowpeas sauce				
22. Groundnuts sauce				
23. Groundnuts roasted				
24. Groundnuts raw				
25. Groundnuts boiled				
26. Grounduts fried				
27. Groundnuts pasted				
28. Red Beans				
29. Soya (pounded into sauce)				
30. Pigeon pea mixed with potatoes				
31. Pigeon pea as sauce				
32. Bambara nuts				
33. Other pulses_____				
Vegetables				
34. *Sukumawiki* (kale)				
35. Dodo (Amaranthas)				
36. Carrots				
37. Cabbage				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	0. No 1. Yes	0. All from the farm 1. Mostly from farm 2. About half from the farm and half other sources 3. Mostly from other sources 4. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
38. Tomatoes (fresh)				
39. Tomatoes (cooked)				
40. Onions				
41. Cowpea leaves				
42. Pumpkin leaves				
43. Bean leaves				
44. Black night shade				
45. Crotalaria				
46. Eggplant prepared with groundnuts				
47. Pumpkin				
48. Garden eggs				
49. Other Local greens (prepared with oil)				
50. Other local greens (prepared with milk)				
51. Other local greens (prepared with milk and oil)				
52. Other vegetables _____				
Fruits				
53. Passion				
54. Guavas				
55. Mango				
56. Pineapple				
57. Paw paw				
58. Oranges				
59. Avocado small				
60. Avocado large				
61. Ripe bananas small				
62. Ripe bananas large				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	0. No 1. Yes	0. All from the farm 1. Mostly from farm 2. About half from the farm and half other sources 3. Mostly from other sources 4. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
63. Apples				
64. Jackfruit				
65. Guavas				
66. Tangerines				
67. Lemon Juice				
68. Tamarind				
69. Other Fruits: _____				
Meat, Fish, Eggs and Dairy				
70. Beef boiled				
71. Beef roasted				
72. Beef fried				
73. Goat boiled				
74. Goat roasted				
75. Goat fried				
76. Sheep boiled				
77. Sheep roasted				
78. Sheep fried				
79. Fish Omena				
80. Fish Tilapia				
81. Pork fried				
82. Chicken boiled				
83. Chicken fried				
84. Birds				
85. Turkey				
86. Rabbit				
87. Eggs fried				
88. Eggs boiled				
89. Eggs Spanish				
90. Milk cow fresh				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	0. No 1. Yes	0. All from the farm 1. Mostly from farm 2. About half from the farm and half other sources 3. Mostly from other sources 4. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
91. Milk cow sour				
92. Other Meat or Dairy _____				
Beverages				
93. African Tea (milk tea)				
94. Strong tea (black tea)				
95. Sodas			What kind? _____	
96. Local grain alcohol			How many glasses?	
97. Local beer			How many glasses?	
98. Bottled beers			What kind? How many?	
99. Other Beverages _____				
Processed Fats and Oils				
100. Blue band or other margarine				
101. Peanut butter				
102. Other processed fats or oils_____				

Section 2: Identification of the quality of relations within the food acquisition network (Use Section 2 Code Sheet)

Ask each female HH to talk about her networks for acquiring food (through purchasing, trading, gifts, borrowing, etc) listing the names of the persons. (These persons could be neighbors, friends, church members, relatives, an extension agent, market vendors, school teachers, etc). Reassure respondent that information will not be shared and is totally confidential

1.Over the past two weeks, with whom did you interact in order to obtain foods?	2.How do you know this person ?	3.In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? 4. What portion of your food from this food group came from this interaction? (Use 10 beans)	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7.Distance: How long did you have to travel in order to see this person?	8.In general, Do you discuss important matters with this person?	9.In general, do you exchange other resources?	10.In general, How often do you interact with this person?	11. Gender
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										

Section 3: Friendship Networks

1.What persons, other than those you listed above, do you discuss important matters with?	2.How do you know this person ?	3. Frequency: How often do you interact with this person?	4.Gender
(Please list names below)	1.Kinship 2.Farm org 3.Credit org 4.Women's group 5.Youth group 6.Church 7.School 8.Group labor exchange 9.Neighbor 10. Other _(Please list)____	0.Daily 1.2-3 x weekly 2.Once weekly 3.Once monthly 4.Seasonally	0. Female 1. Male
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Relative to those you know, how would you personally rate your health? Poor Average Better than average

Section 4: Who do you interact with to obtain agricultural information, advice, and resources?

Position	Name	Location or Contact : (mobile preferred)
23.21. Village/Subcounty chief		
23.22. Vendor in local market		
23.23. Vendor in weekly market		
23.24. Vendor in a shop in urban center		
23.25. Vendor in a agro-vet shop		
23.26. Teacher in village		
23.27. Minister/Priest in village		
23.28. Government Extension agent		
23.29. NGO/ Development Agent		
23.30. Veterinary Service provider		
23.31. Agricultural researcher		
23.32. Agricultural/Micro Finance Representative		
23.33. Animal Traction owner		
23.34. Leader of farmer organizations		
23.35. Leader of women's organization		
23.36. Leader of youth organization		

SECTION 2 Code Sheet: Tororo

1. Over the past two weeks, with whom did you interact in order to obtain foods?	2. How do you know this person ?	3. In the past 2 weeks, What kind of food products were accessed through the interaction?	4. In the past 2 weeks, How much food did you get from this person? What portion of your food from this food group came from this interaction?	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7. Distance: How long did you have to travel in order to see this person?	8. In general, Do you discuss important matters with this person?	9. In general, do you exchange other resources?	10. In general, How often do you interact with this person?	11. Gender
(List Name, first name only is okay)	0.N/A 1.Kinship 2.Farm org 3.Credit org 4.Women's group 5.Youth group 6.Church 7.School 8.Group labor exchange 9. Neighbor 10. Other ____	0.None 1.Staples and Grains 2.Pulses/Legumes 3.Vegetables 4.Fruits 5.Meat, fish, and eggs 6.Dairy products 7.Sugar 8.Oil 9. Beverages _____	Record as a fraction of 10, i.e if 10 is their total amount of product consumed in the past 2 weeks, what portion between 1 and 10 (signifying very little to all) came from this interaction	0.N/A 1. Gift 2. Food donation 3.Barter or trade 4.Exchange for individual labor 5.Exchange for group labor 6.Purchase on credit 7.Purchase with cash	0. N/A 1. Your farm 2. Neighbor's farm 3. Community center 4. Weekly Market 5. More distant market 6. Butcher 5. NGO Office 7. Farmer field day/event _____ 8. Other _____	0.Less than 5 minutes 1.5-30 minutes 2.30-1 hour minutes 3.1 hour or more	0.Never 1.Rarely 2.At times 3.Often 4.Always	0.N/A 1.Cash 2.Land 3.Plowing/ digging 4.Fertilizer 5.Seeds 6.Information 7.Advice 8. Pesticide, Herbicide/ Weedicide 9.Crop finance/ loans 10. Vet services AI 11. Other _____	0.Daily 1.2-3 x weekly 2.Once weekly 3.Once monthly 4.Seasonally 5. New relationship	0.Female 1. Male

HH Ref Number: _____

Baseline Survey Supplement for Kapchorwa, Uganda
Conservation Agriculture Production System for Food Security

0.1 Date of Interview: ___/____/____ 0.2 Enumerator: _____

Location: 0.3 Province/District _____ 0.4 Subcounty/Location _____
0.5 Parish/Sublocation: _____ 0.6 Village_____

Household Identification: 0.7 Name of Head of Household: _____
0.8 Name of Person Interviewed: _____
(Should be person primarily responsible for food preparation in the household)

Section 1: Consumption Module

Was yesterday a 'normal' day regarding what you consumed? YES _____ NO_____

If "No", please explain what was abnormal and why: _____

_____

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	2. No 3. Yes	5. All from the farm 6. Mostly from farm 7. About half from the farm and half other sources 8. Mostly from other sources 9. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
Staples and Grains				
103.Posho (corn meal)				
104.Mingoling (wheat)				
105.Matooke				
106.Irish Potatoes				
107.Sweet Potatoes				
108.Yams				
109.Millet				
110.Chapatti				
111.Bread				
112.Mandazi				
113.Rice				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	2. No 3. Yes	5. All from the farm 6. Mostly from farm 7. About half from the farm and half other sources 8. Mostly from other sources 9. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
114. Porridge _____				
115. Other staples or grains _____				
Pulses				
116. Lentils				
117. Cowpeas				
118. Groundnuts			Prepared how: _____	
119. TZ (Tanzania)				
120. Red Beans				
121. Natawa				
122. Taso				
123. Other pulses_____				
Vegetables				
124. *Sukumawiki* (kale)				
125. Local greens (prepared with oil)				
126. Local greens (prepared with milk)				
127. Dodo				
128. Carrots				
129. Cabbage				
130. Eggplant boiled				
131. Eggplant prepared				
132. Bamboo				
133. Tomatoes				
134. Peppers				
135. Other vegetables _____				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	2. No 3. Yes	5. All from the farm 6. Mostly from farm 7. About half from the farm and half other sources 8. Mostly from other sources 9. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
Fruits and Fruit Juices				
136. Passion				
137. Passion juice				
138. Oranges				
139. Orange juice				
140. Lemon				
141. Lemon juice				
142. Avocado small				
143. Avacado large				
144. Nasharundu				
145. Kumolick				
146. Ripe bananas				
147. Mutongulak				
148. Other Fruits: _____				
Meat, Fish, Eggs and Dairy				
149. Beef stew				
150. Beef dry				
151. Goat stew				
152. Goat dry				
153. Sheep stew				
154. Sheep Dry				
155. Fish_____				
156. Pork Stew				
157. Pork Dry				
158. Birds				
159. Eggs fried				
160. Eggs boiled				
161. Eggs Spanish				
162. Milk cow				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did <u>YOU</u> consume in the past 24 hours?	4. How many **days** did the <u>HOUSEHOLD</u> consume in the past week?
	2. No 3. Yes	5. All from the farm 6. Mostly from farm 7. About half from the farm and half other sources 8. Mostly from other sources 9. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
163. Milk goat				
164. Yoghurt				
165. Other Meat or Dairy _____				
Beverages				
166. African Tea				
167. Strong tea				
168. Chocolate (milk)				
169. Chocolate (milk)				
170. Soya beverage (milk)				
171. Soya beverage (milk)				
172. Local brew				
173. Local brew (honey)				
174. Sodas			What kind? _____	
175. Other Beverages _____				
Processed Fats and Oils				
176. Blue band or other margarine				
177. Peanut butter				
178. Other processed fats or oils_____				

Section 2: Identification of the quality of relations within the food acquisition network

Ask each female HH to talk about her networks for acquiring food (through purchasing, trading, gifts, borrowing, etc) listing the names of the persons. (These persons could be neighbors, friends, church members, relatives, an extension agent, market vendors, school teachers, etc). Reassure respondent that information will not be shared and is totally confidential

1.Over the past two weeks, with whom did you interact in order to obtain foods?	2.How do you know this person ?	3.In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? 4. What portion of your food from this food group came from this interaction? (Use 10 beans)	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7.Distance: How long did you have to travel in order to see this person?	8.In general, Do you discuss important matters with this person?	9.In general, do you exchange other resources?	10.In general, How often do you interact with this person?	11. Gender
1.										
2.										
3.										
4.										
5.										
6.										
7.										

Section 3: Friendship Networks

1.What persons, other than those you listed above, do you discuss important matters with?	2.How do you know this person ?	3. Frequency: How often do you interact with this person?	4.Gender
(Please list names below)	11. Kinship 12. Farm org 13. Credit org 14. Women's group 15. Youth group 16. Church 17. School 18. Group labor exchange 19. Other ____	1. Daily 2. 2-3 x weekly 3. Once weekly 3. Once monthly 4. Seasonally 5. Yearly	1.Female 2.Male
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Relative to those that you know, how healthy would you say that you are? Poor Average Better than average

Section 4: Most commonly Reported Agriculture support sector contacts

Position	Name	Location or Contact : (mobile preferred)
1. Village/Subcounty chief		
2. Vendor in market		
3. Vendor in a shop in urban center		
4. Vendor in a agro-vet shop		
5. Teacher in village		
6. Minister/Priest in village		
7. Government Extension agent		
8. NGO/ Development Agent		
9. Veterinary Service provider		
10. Agricultural researcher		
11. Agricultural/Micro Finance Representative		
12. Animal Traction owner		
13. Leader of farmer organizations		
14. Leader of women's organization		

SECTION 2 Code Sheet Kapchorwa

Over the past two weeks, with whom did you interact in order to obtain foods?	How do you know this person ?	In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? What portion of your food from this food group came from this interaction?	In the past 2 weeks, How did you obtain food from this person?	Location and events: In the past 2 weeks, Where did you interact?	Distance: How long did you have to travel in order to see this person?	In general, Do you discuss important matters with this person?	In general, do you exchange other resources?	In general, How often do you interact with this person?	Gender
(List Name, first name only is okay)	0. N/A 1. Kinship 2. Farm org 3. Credit org 4. Women's group 5. Youth group 6. Church 7. School 8. Group labor exchange 9. Neighbor 10. Other ____	0.None 1.Staples and Grains 2.Pulses/Legumes 3.Vegetables 4.Fruits 5.Meat, fish, and eggs 6.Dairy products 7.Sugar 8.Oil 9. Beverages _____	Record as a fraction of 10, i.e if 10 is their total amount of product consumed in the past 2 weeks, what portion between 1 and 10 (signifying very little to all) came from this interaction	0.N/A 1. Gift 2. Food donation 3.Barter or trade 4.Exchange for individual labor 5.Exchange for group labor 6.Purchase on credit 7.Purchase with cash	0. N/A 1. Your farm 2. Neighbor's farm 3. Community center 4. Weekly Market 5. More distant market 6. Butcher 5. NGO Office 7. Farmer field day/event _____ 8. Other _____	0.Less than 5 minutes 1.5-30 minutes 2.30-1 hour minutes 3.1 hour or more	5.Never 6.Rarely 7.At times 8.Often 9.Always	0.N/A 1.Cash 2.Land 3.Plowing/ digging 4.Fertilizer 5.Seeds 6.Information 7.Advice 8. Pesticide, Herbicide/ Weedicide 9.Crop finance/ loans 10. Vet services AI 11. Other _____	0.Daily 1.2-3 x weekly 2.Once weekly 3.Once monthly 4.Seasonally 5. New relationship	0.Female 1. Male

HH Ref Number: _____

Baseline Survey Supplement for Kitale, Kenya
Conservation Agriculture Production System for Food Security

0.1 Date of Interview: ___/____/____ 0.2 Enumerator: _____ _____

Location: 0.3 Province/District _____ 0.4 Subcounty/Location _____
0.5 Parish/Sublocation: _____ 0.6 Village_____

Household Identification: 0.7 Name of Head of Household: _____
0.8 Name of Person Interviewed: _____
(Should be person primarily responsible for food preparation in the household—I.E. Spouse or Female HH Only Women should be interviewed.)

Section 1: Consumption Module

Was yesterday a 'normal' day regarding what you consumed? YES _____ NO_____

If "No", please explain what was abnormal and why: _____

_____

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did <u>YOU</u> consume in the past 24 hours?	4. How many **days** did the <u>HOUSEHOLD</u> consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
Staples and Grains				
179.Ugali (Maize)				
180.Roasted Maize				
181.Ugali (Sorghum)				
182.Matooke				
183.Irish Potatoes (boiled)				
184.Irish Potatoes (fried)				
185.Sweet Potatoes				
186.Yams				
187.Cassava				
188.Millet Ugali				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
189. Millet porridge				
190. Chapatti				
191. Bread				
192. Mandazi				
193. Matooke				
194. Rice				
195. Maize/Millet porridge				
196. Gidheri (Maize & beans)			Other Ingredients: _____	
197. Other staples or grains _____				
Pulses				
198. Green grams (ndengu)				
199. Peas				
200. Cowpeas				
201. Groundnuts			Prepared how: _____	
202. Red Beans				
203. Soya (boiled)				
204. Soya (fried)				
205. Bambara nuts				
206. Other pulses_____				
Vegetables				
207. *Sukumawiki* (kale)				
208. Dodo Amaranthas				
209. Carrots				
210. Cabbage				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
211. Tomatoes				
212. Peppers				
213. Sucha				
214. Sagaa				
215. Spinach				
216. Murenda				
217. Cowpea leaves				
218. Pumpkin leaves				
219. Bean leaves				
220. Dania				
221. Garlic				
222. Beet roots				
223. Other Local greens (prepared with oil)				
224. Other local greens (prepared with milk)				
225. Other local greens (prepared with milk and oil)				
226. Other vegetables _____				
Fruits and Fruit Juices				
227. Passion				
228. Passion juice				
229. Guavas				
230. Guava juice				
231. Mango				
232. Mango juice				
233. Pineapple				
234. Pineapple juice				
235. Paw paw				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
236. Oranges				
237. Orange juice				
238. Avocado small				
239. Avacado large				
240. Avacado juice				
241. Ripe bananas small				
242. Ripe bananas large				
243. Banana shake				
244. Apples				
245. Watermelon				
246. White supporter				
247. Strawberries				
248. Stawberry juice				
249. Other Fruits: _____				
Meat, Fish, Eggs and Dairy				
250. Beef boiled				
251. Beef fried				
252. Beef roasted				
253. Goat boiled				
254. Goat fried				
255. Goat roasted				
256. Sheep boiled				
257. Sheep fried				
258. Sheep roasted				
259. Tilapia				
260. Omena				
261. Pork fried				
262. Kuku boiled				
263. Kuku fried				
264. Kuku roasted				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did <u>YOU</u> consume in the past 24 hours?	4. How many **days** did the <u>HOUSEHOLD</u> consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
265. Turkeys				
266. Rabbits				
267. Doves				
268. Ducks				
269. Eggs fried				
270. Eggs boiled				
271. Eggs Spanish (omellete)				
272. Milk cow plain				
273. Milk goat plain				
274. Yoghurt				
275. Other Meat or Dairy _____				
Beverages				
276. Milk tea				
277. Strong tea				
278. Chocolate (milk)				
279. Chocolate (maji)				
280. Soya beverage (milk)				
281. Soya beverage (maji)				
282. Coffee (milk)				
283. Coffee (maji)				
284. Herbal tea				
285. Sorghum beverage				
286. Sodas			What kind? _____	
287. Changaa				
288. Banana wine				
289. Busa				
290. Honey beverage				
291. Other Beverages _____				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	4. No 5. Yes	10. All from the farm 11. Mostly from farm 12. About half from the farm and half other sources 13. Mostly from other sources 14. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
Processed Fats and Oils				
292. Blue band or other margarine				
293. Peanut butter				
294. Jam				
295. Butter				
296. Ghee				
297. Honey				
298. Other processed fats or oils_____				

Section 2: Identification of the quality of relations within the food acquisition network (Use Section 2 Code Sheet)

1.Over the past two weeks, with whom did you interact in order to obtain foods?	2.How do you know this person ?	3.In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? How much of that food did you get from this person in the past two weeks? (Calculate the percentage)	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7.Distance: How long did you have to travel in order to see this person?	8.In general, Do you discuss important matters with this person?	9.In general, do you exchange other resources?	10.In general, How often do you interact with this person?	11. Gender
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										

Section 3: Friendship Networks

1.What persons, other than those you listed above, do you discuss important matters with?	2.How do you know this person ?	3. Frequency: How often do you interact with this person?	4.Gender
(Please list names below)	20. Kinship 21. Farm org 22. Credit org 23. Women's group 24. Youth group 25. Church 26. School 27. Group labor exchange 28. Friend 29. Neighbor 30. Other ____	1. Daily 2. 2-3 x weekly 3. Once weekly 3. Once monthly 4. Seasonally 5. Yearly	0. Female 1. Male
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Relative to those that you know, how healthy would you say that you are? Poor Average Better than average

Section 4: Most commonly Reported Agriculture support sector contacts

Position	Name	Location or Contact : (mobile preferred)
23.37. Village/Subcounty chief		
23.38. Vendor in local market		
23.39. Vendor in a shop in urban center		
23.40. Vendor in a agro-vet shop		
23.41. Teacher in village		
23.42. Minister/Priest in village		
23.43. Government Extension agent		
23.44. NGO/ Development Agent		
23.45. Veterinary Service provider		
23.46. Agricultural researcher		
23.47. Agricultural/Micro Finance Representative		
23.48. Animal Traction owner		
23.49. Leader of farmer organizations		
23.50. Leader of women's organization		
23.51. Leader of youth organization		

SECTION 2 Code Sheet: Kitale

Ask each female HH to talk about her networks for acquiring food, listing the names of the persons. (These persons could be neighbors, friends, church members, relatives, an extension agent, market vendors, school teachers, etc). Reassure respondent that information will not be shared and is totally confidential

Over the past two weeks, with whom did you interact in order to obtain foods?	How do you know this person ?	In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? How much of that food did you get from this person in the past two weeks? (Calculate the percentage)	In the past 2 weeks, How did you obtain food from this person?	Location and events: In the past 2 weeks, Where did you interact?	Distance: How long did you have to travel in order to see this person?	In general, Do you discuss important matters with this person?	In general, do you exchange other resources?	In general, How often do you interact with this person?	Gender
(List Name)	0.N/A 1.Kinship 2.Farm org 3.Credit org 4.Women's group 5.Youth group 6.Church 7.School 8.Group labor exchange 9. Neighbor 10.Other _____	0.None 1.Staples and Grains 2.Pulses 3.Vegetables 4.Fruits 5.Meat, fish, and eggs 6.Dairy products 7.Sugar 8.Oil 9. Beverages	Record percentage	0.N/A 1. Gift 2. Food donation 3.Barter or trade 4.Exchange for individual labor 5.Exchange for group labor 6.Purchase on credit 7.Purchase with cash	1. Your home/farm 2. Neighbor's farm 3. Community center 4. Kitale market 5.. Local butcher 6. Kitale butcher 7. Farmer field day/event _____ 8. Other _____	0.Less than 5 minutes 1.5-30 minutes 2.30-1 hour minutes 3.1 hour or more	0.Never 1.Rarely 2.At times 3.Often 4.Always	0.N/A 1.Cash 2.Land 3.Plowing/ digging 4.Fertilizer 5.Seeds 6.Information 7.Advice 8. Pesticide, Herbicide/ Weedicide 9.Crop finance/ loans 10. Vet services AI 11. Other	0.Daily 1.2-3 x weekly 2.Once weekly 3.Once monthly 4.Seasonally 5. New relationship	0.Female 1. Male

HH Ref Number: _____

Baseline Survey Supplement for Bungoma, Kenya
Conservation Agriculture Production System for Food Security

0.1 Date of Interview: ___/____/____ 0.2 Enumerator: _____

Location: 0.3 Province/District _____ 0.4 Subcounty/Location _____
0.5 Parish/Sublocation: _____ 0.6 Village_____

Household Identification: 0.7 Name of Head of Household: _____
0.8 Name of Person Interviewed: _____
(Should be person primarily responsible for food preparation in the household—I.E. Spouse or Female HH Only Women should be interviewed.)

Section 1: Consumption Module

Was yesterday a 'normal' day regarding what you consumed? YES _____ NO_____

If "No", please explain what was abnormal and why: _____

_____

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did <u>YOU</u> consume in the past 24 hours?	4. How many **days** did the <u>HOUSEHOLD</u> consume in the past week?
	6. No 7. Yes	15. All from the farm 16. Mostly from farm 17. About half from the farm and half other sources 18. Mostly from other sources 19. All from other sources	Record number of *servings* (0- etc)	Record number of *days* in past week (0-7)
Staples and Grains				
299. Ugali (Maize)				
300. Ugali (Sorghum)				
301. Matooke				
302. Irish Potatoes				
303. Sweet Potatoes				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	6. No 7. Yes	15. All from the farm 16. Mostly from farm 17. About half from the farm and half other sources 18. Mostly from other sources 19. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
304. Cassava				
305. Millet Ugali				
306. Millet porridge				
307. Chapatti				
308. Bread				
309. Mandazi				
310. Rice				
311. Maize porridge				
312. Sorghum porridge				
313. Other staples or grains _____				
Pulses				
314. Lentils				
315. Cowpeas				
316. Groundnuts			Prepared how: _____	
317. Red Beans				
318. Soya				
319. Bambara nuts				
320. Other pulses_____				
Vegetables				
321. *Sukumawiki* (kale)				
322. Amaranthas				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	6. No 7. Yes	15. All from the farm 16. Mostly from farm 17. About half from the farm and half other sources 18. Mostly from other sources 19. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
323. Carrots				
324. Cabbage				
325. Tomatoes				
326. Peppers				
327. Black jack				
328. Cowpea leaves				
329. Pumpkin leaves				
330. Black night shade				
331. Crotalaria				
332. Other Local greens (prepared with oil)				
333. Other local greens (prepared with milk)				
334. Other local greens (prepared with milk and oil)				
335. Other vegetables _____				
Fruits and Fruit Juices				
336. Passion				
337. Guavas				
338. Mango				
339. Pineapple				
340. Paw paw				
341. Oranges				
342. Avocado small				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	6. No 7. Yes	15. All from the farm 16. Mostly from farm 17. About half from the farm and half other sources 18. Mostly from other sources 19. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
343. Avacado large				
344. Ripe bananas small				
345. Ripe bananas large				
346. Java plums				
347. Other Fruits: _____				
Meat, Fish, Eggs and Dairy				
348. Beef stew				
349. Beef dry				
350. Goat stew				
351. Goat dry				
352. Sheep stew				
353. Sheep Dry				
354. Fish_____ ___				
355. Pork Stew				
356. Pork Dry				
357. Birds				
358. Eggs fried				
359. Eggs boiled				
360. Eggs Spanish				
361. Milk cow				
362. Milk goat				
363. Yoghurt				
364. Other Meat or Dairy				

Food:	1. Does your family consume this product?	2. When product is consumed, where does it come from?	3. How many **servings** did YOU consume in the past 24 hours?	4. How many **days** did the HOUSEHOLD consume in the past week?
	6. No 7. Yes	15. All from the farm 16. Mostly from farm 17. About half from the farm and half other sources 18. Mostly from other sources 19. All from other sources	Record number of *servings* (0-etc)	Record number of *days* in past week (0-7)
_____				
Beverages				
365. African Tea				
366. Strong tea				
367. Chocolate (milk)				
368. Chocolate (milk)				
369. Soya beverage (milk)				
370. Soya beverage (milk)				
371. Sodas			What kind? _____	
372. Other Beverages _____ __				
Processed Fats and Oils				
373. Blue band or other margarine				
374. Peanut butter				
375. Other processed fats or oils_____				

Section 2: Identification of the quality of relations within the food acquisition network (Use Section 2 Code Sheet)

Ask each female HH to talk about her networks for acquiring food, listing the names of the persons. (These persons could be neighbors, friends, church members, relatives, an extension agent, market vendors, school teachers, etc). Reassure respondent that information will not be shared and is totally confidential

1.Over the past two weeks, with whom did you interact in order to obtain foods?	2.How do you know this person ?	3.In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? 4. What portion of your food from this food group came from this interaction? (Use 10 beans)	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7.Distance: How long did you have to travel in order to see this person?	8.In general, Do you discuss important matters with this person?	9.In general, do you exchange other resources?	10.In general, How often do you interact with this person?	11. Gender
1.										
2.										
3.										
4.										
5.										

1.Over the past two weeks, with whom did you interact in order to obtain foods?	2.How do you know this person ?	3.In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? 4. What portion of your food from this food group came from this interaction? (Use 10 beans)	5. In the past 2 weeks, How did you obtain food from this person?	6. Location and events: In the past 2 weeks, Where did you interact?	7.Distance: How long did you have to travel in order to see this person?	8.In general, Do you discuss important matters with this person?	9.In general, do you exchange other resources?	10.In general, How often do you interact with this person?	11. Gender
6.										
7.										
8.										
9.										
10.										
11.										
12.										

Section 3: Friendship Networks

1.What persons, other than those you listed above, do you discuss important matters with?	2.How do you know this person ?	3. Frequency: How often do you interact with this person?	4.Gender
(Please list names below)	31. Kinship 32. Farm org 33. Credit org 34. Women's group 35. Youth group 36. Church 37. School 38. Group labor exchange 39. Other ____	1. Daily 2. 2-3 x weekly 3. Once weekly 3. Once monthly 4. Seasonally 5. Yearly	3.Female 4.Male
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Relative to those that you know, how healthy would you say that you are? Poor Average Better than average

Section 4: Most commonly Reported Agriculture support sector contacts (for Ndengelwa residents only)

Position	Name	Location or Contact : (mobile preferred)
23.52. Village/Subcounty chief		
23.53. Vendor in local market		
23.54. Vendor in a shop in urban center		
23.55. Vendor in a agro-vet shop		
23.56. Teacher in village		
23.57. Minister/Priest in village		
23.58. Government Extension agent		
23.59. NGO/ Development Agent		
23.60. Veterinary Service provider		
23.61. Agricultural researcher		
23.62. Agricultural/Micro Finance Representative		
23.63. Animal Traction owner		
23.64. Leader of farmer organizations		
23.65. Leader of women's organization		
23.66. Leader of youth organization		

SECTION 2 Code Sheet: Bungoma

Over the past two weeks, with whom did you interact in order to obtain foods?	How do you know this person ?	In the past 2 weeks, What kind of food products were accessed through the interaction?	In the past 2 weeks, How much food did you get from this person? What portion of your food from this food group came from this interaction? (Use 10 beans)	In the past 2 weeks, How did you obtain food from this person?	Location and events: In the past 2 weeks, Where did you interact?	Distance: How long did you have to travel in order to see this person?	In general, Do you discuss important matters with this person?	In general, do you exchange other resources?	In general, How often do you interact with this person?	Gender
(List Name)	0.N/A 1.Kinship 2.Farm org 3.Credit org 4.Women's group 5.Youth group 6.Church 7.School 8.Group labor exchange 9.Other ____	0.None 1.Staples and Grains 2.Pulses 3.Vegetables 4.Fruits 5.Meat, fish, and eggs 6.Dairy products 7.Sugar 8.Oil 9. Beverages _____	Record number of beans	0.N/A 1. Gift 2. Food donation 3.Barter or trade 4.Exchange for individual labor 5.Exchange for group labor 6.Purchase on credit 7.Purchase with cash	0. N/A 1. Your farm 2. Neighbor's farm 3. Community center 4. Bungoma market 5. More distant market 6. Butcher 5. NGO Office 7. Farmer field day/event _____ 8. Other _____	0.Less than 5 minutes 1.5-30 minutes 2.30-1 hour minutes 3.1 hour or more	0.Never 1.Rarely 2.At times 3.Often 4.Always	0.N/A 1.Cash 2.Land 3.Plowing/ digging 4.Fertilizer 5.Seeds 6.Information 7.Advice 8. Pesticide, Herbicide/ Weedicide 9.Crop finance/ loans 10. Vet services AI 11. Other	0.Daily 1.2-3 x weekly 2.Once weekly 3.Once monthly 4.Seasonally 5. New relationship	0.Female 1. Male

Appendix B: Food Composition Tables, Total Calories, and WFP FCS Calculation

The following pages present the compiled food composition tables for the four sites in which the field work was conducted: Tororo and Kapchorwa Uganda and Bungoma and Kitale, Kenya. The nutritional values reported in the tables are compiled from a number of sources, including the Tanzania Food Composition Tables (Lukmanji, et al 2008), a nutrient data base compiled by Murphy et al (1991), an article from South Africa recording nutritional composition of a number of indigenous African leafy vegetables (Oldhav et al 2007) and several online resources where these sources could not identify a particular food. Serving sizes, as described in the main text, were developed in focus groups of 15-30 women from each of the survey locations and were recorded based off of a locally familiar ½ kilogram mug used by women in serving and cooking. Women decribed what portion of the cup they would serve to themselves of a prepared product, or how many people they would serve from one cup of a prepared food. The food composition tables on the following pages document the foods, food group classification given for the calculation of the WFP FCS and serving sizes reported to be consumed by the different focus groups, and their matched calories and protein content according to the source of the nutritional value and serving size. The legend below documents abbreviations for the main sources used by the food composition tables as well as some additional notation to signify when serving sizes were substituted for those reported by the Tanzania Food Composition Tables (Lukmanji et al 2008). The second section of this appendix includes the MATLAB Code utilized to calculate the WFP FCS and total calories.

Legend for Reading Food Composition Tables:

Abbreviation or Symbol	Description
TZ	Tanzania Food Composition Tables
TZ-food	Indicates a food that was matched using a close substitute in the Tanzania Food Composition Tables
Murphy	Research Nutrient Database using Foods from Rural Kenya
2007 SA	Preliminary Assessment of nutritional value of traditional leafy vegetables from KwaZulu Natal South Africa
.com	Online source for food/recipe. Detailed separately in the Bibliography
*	Substitution made for the Tanzania food composition table serving size

Tororo

Food:Tororo	Food Group	Source, Comments	Serving Size (g)	Cal/Serving	Protein (g)/Serving
1. Maize Posho	staple	TZ	500	**619**	**13.5**
2. Sorghum Posho	staple	TZ	500	**551.5**	**15**
3. Matooke	staple	TZ	500	**580**	**4**
4. Irish Potatoes	staple	TZ*	150	**139.5**	**3**
5. Sweet Potatoes	staple	TZ*	150	**145.5**	**3.15**
6. Cassava Plain	staple	TZ*	200	**262**	**2.2**
7. Cassava w/ Sorghum	staple	TZ	500	**630.25**	**15.25**
8. Cassava w/Millet	staple	TZ	500	**630.25**	**15.25**
9. Millet Posho	staple	TZ	500	**560.5**	**17**
10. Chapatti	staple	TZ	100	**372.6**	**5.9**
11. Bread	staple	TZ	100	**274**	**8.8**
12. Mandazi	staple	TZ	100	**316.6**	**5.2**
13. Rice	staple	TZ	500	**795**	**13**
14. Maize porridge	staple	TZ	500	**470**	**4**
15. Millet porridge	staple	TZ	500	**455**	**3.5**
16. Sorghum porridge	staple	TZ	500	**455**	**5**
17. Cassava porridge	staple	TZ	500	**427.5**	**2**
19. Green Grams	legume	TZ-Lentils	167	**193.72**	**15.03**
20. Cowpeas boiled	legume	TZ	62.5	**96.6875**	**4.5625**
21. Cowpeas sauce	legume	TZ	62.5	**96.6875**	**4.5625**
22. Groundnuts sauce	legume	food.com	167	**250**	**9.23**
23. Groundnuts roasted	legume	TZ-groundnuts	167	**946.89**	**43.086**
24. Groundnuts raw	legume	TZ-groundnuts	167	**946.89**	**43.086**
25. Groundnuts boiled	legume	TZ-groundnuts	84	**265.9944**	**11.34**

Food:Tororo	Food Group	Source, Comments	Serving Size (g)	Cal/Serving	Protein (g)/Serving
26. Grounduts fried in shell	legume	TZ-groundnuts	42	**238.14**	**10.836**
27. Groundnuts pasted	legume	food.com	167	**250.5**	**9.2518**
28. Red Beans	legume	TZ-Kidney	62.5	**81.625**	**3.0625**
29. Soya (pounded into sauce)	legume	TZ-Yellow variety	62.5	**259.375**	**22.8125**
30. Pigeon pea mixed with potatoes	legume	TZ-Calculated as pigeon pea/potato (25/75)	250	**257.5**	**8.125**
31. Pigeon pea as sauce	legume	TZ-Pigeon pea cooked	125	**151.25**	**8.375**
32. Bambara nuts	legume	TZ	500	**705**	**62**
33. Fried Soya	legume	TZ	250	**513.15**	**40.35**
34. *Sukumawiki* (kale)	vegetable	Murphy	125	**62.5**	**0.875**
35. Dodo (Amaranthas)	vegetable	Murphy	125	**28.75**	**10.625**
36. Carrots	vegetable	TZ	50	**20.5**	**0.45**
37. Cabbage	vegetable	TZ	250	**85.25**	**1.75**
38. Tomatoes (fresh)	vegetable	TZ	50	**9.5**	**0.45**
39. Tomatoes (cooked)	vegetable	TZ	125	**26.25**	**1.13**
40. Onions	vegetable	TZ	125	**50**	**1.63**
41. Cowpea leaves	vegetable	TZ	125	**46.25**	**11.63**
42. Pumpkin leaves	vegetable	TZ	83	**53.17**	**0.58**
43. Bean leaves	vegetable	TZ	125	**52.5**	**3.38**
45. Black night shade	vegetable	2007 SA	167	**91.85**	**5.01**
46. Eggplant prepared with groundnuts	vegetable	TZ	125	**96.625**	**1.5**
47. pumpkin	vegetable	TZ	250	**50**	**1.25**
48. Garden eggs	vegetable	Murphy	83	**18.26**	**0.83**
49. Other Local greens (prepared with oil)	vegetable	Murphy	125	**62.5**	**0.875**
53. Passion	fruit	TZ*	150	**64.5**	**1.05**
54. Guavas	fruit	TZ*	100	**68**	**2.6**
55. Mango	fruit	TZ*	200	**130**	**1**

Food:Tororo	Food Group	Source, Comments	Serving Size (g)	Cal/Serving	Protein (g)/Serving
56. Pineapple	fruit	TZ*	400	**192**	**2**
57. Paw paw	fruit	TZ*	400	**156**	**2.4**
58. Oranges	fruit	TZ*	160	**75.2**	**1.44**
59. Avocado small	fruit	TZ*	150	**240**	**3**
60. Avocado large	fruit	TZ*	150	**240**	**3**
61. Ripe bananas small	fruit	TZ*	100	**111**	**1.2**
62. Ripe bananas large	fruit	TZ*	100	**88**	**1.5**
63. Apples	fruit	TZ*	125	**65**	**0.25**
64. Jackfruit	fruit	TZ*	150	**141**	**2.25**
66. Tangerines	fruit	TZ*	70	**37.1**	**0.56**
67. Lemon Juice	fruit	TZ*	200	**58**	**2.2**
68. Tamarind	fruit	TZ*	60	**35.4**	**0.12**
70. Beef boiled	meat	TZ	125	**263.375**	**15.5**
71. Beef roasted	meat	TZ*	30	**243.96**	**7.53**
72. Beef fried	meat	TZ*	30	**243.96**	**7.53**
73. Goat boiled	meat	TZ	125	**336.25**	**31.125**
74. Goat roasted	meat	TZ	125	**336.25**	**31.125**
75. Goat fried	meat	TZ	125	**336.25**	**31.125**
76. Sheep boiled	meat	TZ	125	**336.25**	**31.125**
77. Sheep roasted	meat	TZ	125	**336.25**	**31.125**
78. Sheep fried	meat	TZ	125	**336.25**	**31.125**
79. Fish Omena	meat	TZ	125	**125.125**	**9.625**
80. Fish Tilapia	meat	TZ	125	**317**	**26.5**
81. Pork fried	meat	TZ	125	**301.25**	**41.125**
82. Chicken boiled	meat	TZ	125	**356.25**	**33.625**
83. Chicken fried	meat	TZ	125	**393.625**	**23.5**
84. Birds	meat	gunnersden.com	125	**181.25**	**28.625**
85. Turkey	meat	gunnersden.com	125	**203.75**	**32.125**
86. Rabbit	meat	livestrong.com	125	**243.75**	**36.25**

Food:Tororo	Food Group	Source, Comments	Serving Size (g)	Cal/Serving	Protein (g)/Serving
87. Eggs fried	meat	TZ	70	**171.64**	**8.26**
88. Eggs boiled	meat	TZ	70	**108.5**	**8.82**
89. Eggs Spanish	meat	TZ	100	**274.7**	**8**
90. Milk cow fresh	dairy	TZ	500	**300**	**16**
91. Milk cow sour	dairy	livestrong.com	500	**300**	**16**
93. African Tea (milk tea)	beverage	TZ	500	**155**	**6.5**
94. Strong tea (black tea)	beverage	TZ	500	**177**	**0**
95. Sodas	beverage	TZ	300	**111**	**0.3**
96. Local grain alcohol	beverage	TZ	500	**205**	**1.5**
97. Local beer	beverage	TZ	500	**205**	**1.5**
98. Bottled beers	beverage	TZ	500	**205**	**1.5**
100.Blue band or other margarine	fats	Murphy	15	**88.06**	**0**
101.Peanut butter	fats	TZ	15	**72.8**	**3.626**

Kapchorwa

Food Kapchorwa	Food Groups	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
1. Posho (corn meal)	staple	TZ	500	619	13.5
2. Mingoling (wheat)	staple	TZ	500	551.5	15
3. Matooke	staple	TZ	500	580	4
4. Irish Potatoes	staple	TZ	500	465	10
5. Sweet Potatoes	staple	TZ	500	485	10.5
6. Yams	staple	TZ	500	485	10.5
7. Millet	staple	TZ	500	560.5	17
8. Chapatti	staple	TZ	500	372.6	5.9
9. Bread	staple	TZ	100	274	8.8
10. Mandazi	staple	TZ*	100	316.6	5.2
11. Rice	staple	TZ	100	870	13
12. Millet/maize Porridge	staple	TZ	500	455	3.5
13. Other staples or grains	staple	TZ	500	0	0
14. Lentils	legume	TZ	250	290	22.5
15. Cowpeas	legume	TZ	250	386.75	18.25
16. Groundnut raw or roast	legume	TZ-groundnuts	125	708.75	32.25
17. Groundnuts fried	legume	TZ-groundnuts	125	238.14	10.84
18. Groundnuts boiled	legume	TZ-groundnuts	125	266	11.34
19. TZ (Tanzania)	legume	TZ-Kidney	250	326.5	12.25
20. Red Beans	legume	TZ-Kidney	250	326.5	12.25
21. Natawa	legume	TZ-Kidney	250	326.5	12.25

Food Kapchorwa	Food Groups	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
22. Taso	legume	TZ-Kidney	250	326.5	12.25
24. *Sukumawiki* (kale)	vegetable	Murphy	250	125	1.75
25. Local greens (prepared with oil)	vegetable	Murphy	250	125	1.75
26. Local greens (prepared with milk)	vegetable	TZ-potato leaf relish	250	169.25	16.25
27. Dodo	vegetable	Murphy	250	57.5	21.25
28. Carrots	vegetable	TZ	125	51.25	1.125
29. Cabbage	vegetable	TZ	125	42.625	0.875
30. Eggplant boiled	vegetable	TZ	250	60	2.5
31. Eggplant prepared	vegetable	TZ	250	193.25	3
32. Bamboo	vegetable	TZ	125	0	0
33. Tomatoes	vegetable	TZ	125	26.25	1.125
34. Peppers	vegetable	TZ	68	12.92	0
36. Passion	fruit	TZ*	150	64.5	1.05
37. Passion juice	fruit	TZ*	200	220.2	0.6
38. Oranges	fruit	TZ*	160	75.2	1.44
39. Orange juice	fruit	TZ*	200	84	1.2
40. Lemon	fruit	TZ*	200	58	2.2
41. Lemon juice	fruit	TZ*	200	58	2.2
42. Avocado small	fruit	TZ*	150	240	3
43. Avacado large	fruit	TZ*	150	240	3
44. Nasharundu	fruit	Murphy	100	49	0.9
45. Kumolick	fruit	Murphy	100	49	0.9
46. Ripe bananas	fruit	Murphy	100	89	1.1
47. Mutongulak	fruit	Murphy	100	49	0.9
49. Beef stew	meat	TZ	125	263.375	15.5
50. Beef dry	meat	TZ	125	243.96	7.53
51. Goat stew	meat	TZ	125	336.25	31.125

Food Kapchorwa	Food Groups	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
52. Goat dry	meat	TZ	125	336.25	31.125
53. Sheep stew	meat	TZ	125	336.25	31.125
54. Sheep Dry	meat	TZ	125	336.25	31.125
55. Tilapia	meat	TZ	125	317	26.5
56. Omena	meat	TZ	125	125.125	9.625
57. Pork Stew	meat	TZ	125	301.25	41.125
58. Pork Dry	meat	TZ	125	301.25	41.125
59. Birds	meat	gunnersden.com	125	181.25	28.625
60. Eggs fried	meat	TZ	70	171.64	8.26
61. Eggs boiled	meat	TZ	70	108.5	8.82
62. Eggs Spanish	meat	TZ	100	274.7	8
63. Milk cow	dairy	TZ	500	300	16
64. Milk goat	dairy	Murphy	500	345	18
65. Yoghurt	dairy	TZ	100	61	3.5
67. African Tea	beverage	TZ	500	155	6.5
68. Strong tea	beverage	TZ	500	177	0
69. Chocolate (milk)	beverage	TZ	500	0	0
70. Chocolate (milk)	beverage	TZ	500	0	0
71. Soya beverage (milk)	beverage	TZ	14	110.6	9.66
72. Soya beverage (milk)	beverage	TZ	14	110.6	9.66
73. Local brew	beverage	TZ	500	205	1.5
74. Local brew (honey)	beverage	TZ	500	205	1.5
75. Sodas	beverage	TZ	300	111	0.3
77. Blue band or other margarine	fats	Murphy	15	88.06	0
78. Peanut butter	fats	TZ	15	72.8	3.626

Bungoma

Food:Bungoma	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
1. Ugali (Maize)	staple	TZ	500	619	13.5
2.Ugali (Sorghum)	staple	TZ-maize/sorghum mix	500	551.5	15
3. Matooke	staple	TZ	500	580	4
4. Irish Potatoes	staple	TZ	500	465	10
5. Sweet Potatoes	staple	TZ	500	485	10.5
6.Cassava	staple	TZ	500	655	5.5
7. Millet Ugali	staple	TZ-sorghum/millet mix	500	560.5	17
8.Millet porridge	staple	TZ	500	455	3.5
9.Chapatti	staple	TZ*	100	372.6	5.9
10.Bread	staple	TZ*	100	274	8.8
11.Mandazi	staple	TZ*	100	316.6	5.2
12.Rice	staple	TZ	500	995	14.5
13.Maize porridge	staple	TZ	500	470	4
14. Sorghum porridge	staple	TZ	500	455	5
16. Green Grams	legume	TZ-Lentils	500	580	45
17. Cowpeas	legume	TZ	500	773.5	36.5
18a. Groundnuts roasted	legume	TZ-groundnut	100	567	25.8
18b. Groundnut pasted	legume	TZ-groundnut	500	**250.5**	**9.2518**

Food:Bungoma	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
18c. Groundnut boiled	legume	TZ-groundnut	100	265.9944	11.34
19. Red Beans	legume	TZ-Kidney	500	653	24.5
20. Soya	legume	TZ-Yellow variety	500	2075	182.5
21. Bambara nuts	legume	TZ	500	705	62
23. *Sukumawiki* (kale)	vegetable	Murphy	250	175	2.5
24.Amaranthas	vegetable	Murphy	167	38.41	14.195
25.Carrots	vegetable	TZ	50	20.5	0.45
26. Cabbage	vegetable	TZ	250	85.25	1.75
27. Tomatoes	vegetable	TZ	250	52.5	2.25
28. Peppers	vegetable	TZ	50	9.5	0
29. Black jack	vegetable	SA 2007	167	65.13	8.35
30. Cowpea leaves	vegetable	TZ	167	61.79	15.531
31. Pumpkin leaves	vegetable	TZ	250	159.5	1.75
32. Black night shade	vegetable	SA 2007	167	91.85	5.01
33. Crotalaria	vegetable	SA 2007	167	91.85	5.01
34. Other Local greens (prepared with oil)	vegetable	Murphy	167	125	1.75
35. Other local greens (prepared with milk)	vegetable	TZ-potato leaf relish with milk	250	113.059	10.855
36. Other local greens (prepared with milk and oil)	vegetable	TZ-potato leaf relish with milk	167	113.059	10.855

Food:Bungoma	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
38. Passion	fruit	*	150	64.5	1.05
39. Guavas	fruit	*	100	68	2.6
40. Mango	fruit	*	200	130	1
41. Pineapple	fruit	*	400	192	2
42. Paw paw	fruit	*	400	156	2.4
43. Oranges	fruit	*	160	75.2	1.44
44. Avocado small	fruit	*	150	240	3
45. Avacado large	fruit	*	150	240	3
46. Ripe bananas small	fruit	*	100	89	1.1
47. Ripe bananas large	fruit	*	100	89	1.1
48. Java plums	fruit	*	125	57.5	0.875
50. Beef stew	meat		225	474.075	27.9
51. Beef dry	meat		225	1829.7	56.475
52. Goat stew	meat		167	449.23	41.583
53. Goat dry	meat	Murphy	250	672.5	62.25
54. Sheep stew	meat		167	449.23	41.583
55. Sheep Dry	meat		250	672.5	62.25
56. Tilapia	meat		250	575.25	44.5
57. Pork Stew	meat		167	896.79	32.732
58. Pork Dry	meat		250	1342.5	49
59. Chicken	meat		167	475.95	44.923
60. Eggs fried	meat		70	171.64	8.26
61. Eggs boiled	meat		70	108.5	8.82
62. Eggs	meat		100	274.7	8

Food:Bungoma	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
Spanish					
63. Milk cow	dairy		500	300	16
64. Milk goat	dairy	Murphy	500	345	18
65. Yoghurt	dairy		100	61	3.5
66. Sour milk	dairy	livestrong.com	500	300	16
67. African Tea	beverage		500	155	6.5
68. Strong tea	beverage		500	177	0
69. Chocolate (milk)	beverage		500	160	8
70. Chocolate (H20)	beverage		500	114	2
71. Soya beverage (milk)	beverage		300	110.6	9.66
72. Soya beverage (H20)	beverage		300	110.6	9.66
73. Sodas	beverage		300	111	0.3
75. Blue band or other margarine	fats	*	15	88.06	0
76. Peanut butter	fats	*	15	72.8	3.626

Kitale

Food: Kitale	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
1. Ugali (Maize)	staple	TZ	500	619	13.5
2. Roasted Maize	staple	TZ	200	238	5.4
3. Ugali (Sorghum)	staple	TZ	500	551.5	15
4. Matooke	staple	TZ	500	580	4
5. Irish Potatoes (boiled)	staple	TZ	500	465	10
6. Irish Potatoes (fried)	staple	TZ	250	622.5	4.25
7. Sweet Potatoes	staple	TZ	500	485	10.5
8. Yams	staple	TZ	500	485	10.5
9. Cassava	staple	TZ	500	655	6.55
10. Millet Ugali	staple	TZ	500	560.5	17
11. Millet porridge	staple	TZ	500	455	3.5
12. Chapatti	staple	TZ	100	372.6	5.9
13. Bread	staple	TZ	100	274	8.8
14. Mandazi	staple	TZ	100	316.6	5.2
16. Rice	staple	TZ	500	870	13
17. Maize/Millet porridge	staple	TZ	500	651.5	11
18. Gidheri (Maize & beans)	staple	TZ	500	782.5	18
Githeri w/potato banana	staple	TZ	500	630	21.5
Githeri w/vegetable	staple	TZ	500	550	18
20. Green grams (ndengu)	legume	TZ	125	145	11.25
21. Peas	legume	TZ	250	302.5	16.75

Food: Kitale	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
22. Cowpeas	legume	TZ	500	773.5	36.5
23a. Groundnuts roast	legume	TZ	125	708.75	32.25
23b gnuts paste	legume	TZ	250	**250.5**	**9.2518**
23c gnut boil	legume	TZ	250	**265.9944**	**11.34**
24. Red Beans	legume	TZ	250	326.5	12.25
25. Soya (boiled)	legume	TZ	250	1037.5	91.25
26. Soya (fried)	legume	TZ	250	513.15	40.35
27. Bambara nuts	legume	TZ	125	176.25	15.5
29. *Sukumawiki* (kale)	vegetable	TZ	250	215.25	2.5
30. Dodo Amaranthas	vegetable	TZ	250	57.5	21.25
31. Carrots	vegetable	TZ	250	102.5	2.25
32. Cabbage	vegetable	TZ	250	85.25	1.75
33. Tomatoes	vegetable	TZ	250	47.5	2.25
34. Peppers	vegetable	TZ	125	23.75	0
35. Sucha (nightshade)	vegetable	TZ	250	137.5	7.5
36. Sagaa(Spider Plant)	vegetable	TZ	250	137.5	7.5
37. Spinach	vegetable	TZ	250	270	6.75
38. Murenda	vegetable	TZ-potato leaf with milk	250	169.25	16.25
39. Cowpea leaves	vegetable	TZ	250	92.5	23.25
40. Pumpkin leaves	vegetable	TZ	250	159.5	1.75
41. Bean leaves	vegetable	TZ	250	105	6.75
42. Dania (coriander)	vegetable	TZ	250	0	0
43. Garlic	vegetable	TZ	14	20.86	0.896

Food: Kitale	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
44. Beet roots	vegetable	nutritiondata.com	125	70	1.25
45. Other Local greens (prepared with oil)	vegetable	Murphy	250	215.25	2.5
46. Other local greens (prepared with milk)	vegetable	TZ-potato leaf with milk	250	169.25	16.25
47. Other local greens (prepared with milk and oil)	vegetable	TZ-potato leaf with milk	250	169.25	16.25
49. Passion	fruit	TZ*	150	64.5	1.05
50. Passion juice	fruit	TZ*	200	220.2	0.6
51. Guavas	fruit	TZ*	100	68	2.6
52. Guava juice	fruit	TZ*	200	136	5.2
53. Mango	fruit	TZ*	200	130	1
54. Mango juice	fruit	TZ*	200	108	0.4
55. Pineapple	fruit	TZ*	400	192	2
56. Pineapple juice	fruit	TZ*	200	98	0.8
57. Paw paw	fruit	TZ*	400	156	2.4
58. Oranges	fruit	TZ*	160	75.2	1.44
59. Orange juice	fruit	TZ*	200	84	1.2
60. Avocado small	fruit	TZ*	150	240	3
61. Avacado large	fruit	TZ*	150	240	3
62. Avacado juice	fruit	TZ*	200	209	1.2
63. Ripe bananas small	fruit	TZ*	100	111	1.2
64. Ripe bananas large	fruit	TZ*	100	88	1.5
banana shake		TZ*	125		
66. Apples	fruit	TZ*	230	117.5	1.875

Food: Kitale	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
67. Watermelon	fruit	TZ*	100	69	1.38
68. White supporter	fruit	TZ*	100	49	0.9
69. Strawberries	fruit	TZ*	100	32	1
70. Stawberry juice	fruit	TZ*	100	32	1
71. Loquats	fruit	Murphy	100	47	0.4
72. Beef boiled	meat	TZ	250	526.75	31
73. Beef fried	meat	TZ	250	2033	62.75
74. Beef roasted	meat	TZ	250	526.75	31
75. Goat boiled	meat	TZ	250	672.5	62.25
76. Goat fried	meat	TZ	250	672.5	62.25
77. Goat roasted	meat	TZ	250	672.5	62.25
78. Sheep boiled	meat	TZ	250	672.5	62.25
79. Sheep fried	meat	TZ	250	672.5	62.25
80. Sheep roasted	meat	TZ	250	672.5	62.25
81. Tilapia	meat	TZ	250	575.25	44.5
82. Omena	meat	TZ	250	250.25	19.25
83. Pork fried	meat	TZ	250	1342.5	49
84. Kuku boiled	meat	TZ	250	712.5	67.25
85. Kuku fried	meat	TZ	250	787.25	47
86. Kuku roasted	meat	TZ	250	712.5	67.25
87. Turkeys	meat	TZ	250	312.5	64.25
88. Rabbits	meat	TZ	250	487.5	72.5
89. Doves	meat	TZ	250	312.5	57.25
90. Ducks	meat	TZ	250	312.5	57.25
91. Eggs fried	meat	TZ	70	171.64	8.26
92. Eggs boiled	meat	TZ	70	108.5	8.82
93. Eggs Spanish (omellete)	meat	TZ	100	274.7	8
94. Milk cow plain	dairy	TZ	250	150	8

Food: Kitale	Food Group	Source, Comments	Serving Size (g)	Cals/Serving	Protein (g)/Serving
95. Milk goat plain	dairy	Murphy	250	172.5	9
96. Yoghurt	dairy	TZ	250	152.5	8.75
98. Milk tea	beverage	TZ	500	155	6.5
99. Strong tea	beverage	TZ	500	177	0
100.Chocolate (milk)	beverage	TZ	500	160	8
101.Chocolate (maji)	beverage	TZ	500	114	2
102.Soya beverage (milk)	beverage	TZ	14	110.6	9.66
103.Soya beverage (maji)	beverage	TZ	14	110.6	9.66
104.Coffee (milk)	beverage	TZ	500	160	6
105.Coffee (maji)	beverage	TZ	250	78.75	3.25
106.Herbal tea	beverage	TZ	500	177	0
107. Sorghum beverage	beverage	TZ	500	455	5
108.Sodas	beverage	TZ	300	111	0.3
109.Changaa	beverage	TZ	125	51.25	0.375
110.Banana wine	beverage	TZ	125	51.25	0.375
111.Busa	beverage	TZ	125	51.25	0.375
112.Honey beverage	beverage	TZ	125	51.25	0.375
114.Blue band or other margarine	fats	Murphy	15	88.06	0
115.Peanut butter	fats	TZ	15	72.8	3.626
116.Jam	fats	TZ	15	36.54	0.056
117.Butter	fats	TZ	15	100.38	0.126
118. Ghee	fats	TZ	15	122.64	0.042
119.Honey	fats	TZ	15	42.56	0.042

Online Sources and Full Citations for Food Composition Tables:

Gray, Christine 14 June 2011. Calories in Rabbit Meat. Livestrong.com Available: http://www.livestrong.com/article/305440-calories-in-rabbit-meat/. Accessed 4 October 2011.

East Africa Peanut Sauce Recipe. 21 March 2008. East African Peanut Sauce Recipe. Available: http://www.food.com/recipe/east-african-peanut-sauce-293440. Accessed 4 October 2011.

Mili Sour Milk Nutrition. Livestrong.com Online Food Composition Database. Available: http://www.livestrong.com/thedailyplate/nutrition-calories/food/mili/sour-milk/.Accessed 4 October 2011

Nutrient Content of Wild Game Meat v. Domesticated Meat. Dove and Wild Turkey. Available: http://www.gunnersden.com/index.htm.hunting-game-nutrition-value.html Accessed 4 October 2011.

Murphy, S.P., S. Weinberg-Andersson, C. Neumann, K. Mulligan and D.H. Calloway. 1991. Development of research nutrient data bases: An example using foods from rural Kenya. *Journal of Food Composition and Analysis* 4: 2-17.

Lukmanji, Z., E. Hertzmark, N. Mlingi, V. Assey, G. Ndossi and W. Fawzi. 2008. Tanzania Food Composition Tables. Muhimibili University of Health and Allied Sciences (MUHAS)and Tanzania Food and Nutrition Center (TFNC) and Harvard School of Public Health (HSPH). Dar es Salaam, Tanzania and Boston, MA, USA.

Oldhav, B., S. Beekrum, Us. Akula and H. Baijnath. (2007). Preliminary assessment of nutritional value of traditional leafy vegetables in KwaZulu-Natal, South Africa. *Journal of Food Composition and Analysis* 20 (2007): 430-43

MatLAB Code for the Calculation of Total Calories and the WFP FCS

```
%% initialize
clear; close all; clc;

%% read in data

% - user input file from gui
[fn,dn,~] = uigetfile('*.xlsx');
filename = fullfile(dn,fn);

% - user input data
prompt = {'Enter the location exactly as it is in the Excel File: ','Enter
Top Left Cell of the Data in the Spreadsheet: (ex: A1)','Enter the Bottom
Right Cell of the Data in the Spreadsheet: (ex: OE94)'};
numlines = 3;
defaultanswer = {'Tororo','A1','OF94'};
name = 'Input Data Cell Location in Sheet';
options.Resize = 'on'; options.WindowStyle = 'normal'; options.Interpreter =
'tex';
answer = inputdlg(prompt,name,numlines,defaultanswer,options);
tic % - start runtime clock
sheet = deblank(answer{1}); % - excel sheet

food_groups = { 'staple'
                'legume'
                'vegetable'
                'fruit'
                'meat'
                'dairy'
                'beverage'
                'fats'};
num_food_groups = length(food_groups);


% - create data range from user data
range = strcat(answer{2},':',answer{3});

% - read in raw data
[num, txt]= xlsread(filename,sheet,range);
firstrow = txt(1,:);

% - data for calorie and protein matrix
specifier = '_3';
index = strfinder(firstrow,specifier);
data1 = num(:,index);
num_people = size(data1,1);

% - data for FCS
specifier2 = '_4';
index2 = strfinder(firstrow,specifier2);
```

```
data_score = num(:,index2);
test = firstrow(index2);

% - read in conversion tables
[num2, txt2]= xlsread(filename,sprintf('Nutrition_%s_Raw',sheet));

cal_serv = 2;
pro_serv = 3;

%% total calories and protein for each person

% - obtain calorie and protein matrices
for i = 1:length(num2(:,cal_serv))
   cal_matrix(:,i) = data1(:,i).*num2(i,cal_serv);
   pro_matrix(:,i) = data1(:,i).*num2(i,pro_serv);
end

food_type = txt2(2:end,2); % - obtain the various food types

% - initialize cell variables
calsums_Cell = cell(num_people+1,num_food_groups+1);
calmatrix_Cell = cell(num_people+1,length(food_type)+1);
prosums_Cell = cell(num_people+1,num_food_groups+1);
promatrix_Cell = cell(num_people+1,length(food_type)+1);
maxes_Cell = cell(num_people+1,num_food_groups+2);


% - insert specific food types for matrices.
calmatrix_Cell(1,:) = txt2(:,1)';
promatrix_Cell(1,:) = txt2(:,1)';

% - insert 1st row to be food groups for sums data
calsums_Cell(1,2:(length(food_groups)+1)) = food_groups';
prosums_Cell(1,2:(length(food_groups)+1)) = food_groups';
  maxes_Cell(1,2:(length(food_groups)+1)) = food_groups';
  maxes_Cell{1,end} = 'Score';


% - insert 1st column to be person ID #
calsums_Cell(2:(num_people+1),1) = num2cell(num(:,1));
calmatrix_Cell(2:(num_people+1),1) = num2cell(num(:,1));
prosums_Cell(2:(num_people+1),1) = num2cell(num(:,1));
maxes_Cell(2:(num_people+1),1) = num2cell(num(:,1));
promatrix_Cell(2:(num_people+1),1) = num2cell(num(:,1));

% - calculate calorie and protein sums for each individual sorted by food
%   group
for i = 1:num_food_groups
    currentfood = food_groups{i}; % - current food group
    indices.(currentfood) = strfinder(food_type,currentfood); % - find data
column location corresponding to the current food group
    currentindices = indices.(currentfood);
    calsums.(currentfood) = sum(cal_matrix(:,currentindices),2); % -
calculate calorie sum
```

```
    calsums_Cell(2:(num_people+1),i+1) = num2cell(calsums.(currentfood)); % -
save data to cell
    prosums.(currentfood) = sum(pro_matrix(:,currentindices),2); % -
calculate protein sum
    prosums_Cell(2:(num_people+1),i+1) = num2cell(prosums.(currentfood)); % -
save data to cell
    % - calculate max value for each person on current food group
    maxes_Cell(2:(num_people+1),i+1) =
num2cell(max(data_score(:,currentindices),[],2));


end

% - save calorie and protein matrices to cells
calmatrix_Cell(2:(num_people+1),2:(length(food_type)+1)) =
num2cell(cal_matrix);
promatrix_Cell(2:(num_people+1),2:(length(food_type)+1)) =
num2cell(pro_matrix);

% - make NaN's 0 in the maxes_Cell
FCS_data =  cell2mat(maxes_Cell(2:end,2:(end-1)));
FCS_data(isnan(FCS_data)) = 0;
maxes_Cell(2:end,2:(end-1)) = num2cell(FCS_data);

% - calculate FCS
% - FCS = staples*2 + legumes*3 + vegetables*1 + fruits*1 + meats*4 +
beverages*0.5 + fats*0.5
FCS = FCS_data(:,1)*2 + FCS_data(:,2)*3 + ...
                  FCS_data(:,3)*1 + FCS_data(:,4)*1 + ...
                  FCS_data(:,5)*4 + FCS_data(:,6)*4+ FCS_data(:,7)*0.5 +
FCS_data(:,8)*0.5;


maxes_Cell(2:end,end) = num2cell(FCS);

%% print results in excel spreadsheet
% - turn warning off
warning off MATLAB:xlswrite:AddSheet

% - write calories and proteins sums sheets as well as protein and calorie
%   matrices
timestamp = datestr(now); % - file written timestamp
calsums_Cell(1,1) = {sprintf('Data Written: %s',timestamp)};
prosums_Cell(1,1) = {sprintf('Data Written: %s',timestamp)};
maxes_Cell(1,1) = {sprintf('Data Written: %s',timestamp)};
try
    xlswrite(filename,calmatrix_Cell, ['Calorie Matrix ',answer{1}]); % -
write cal matrix
    xlswrite(filename,calsums_Cell,['Calorie Sums ', answer{1}]);     % -
write cal sum
    xlswrite(filename,promatrix_Cell, ['Protein Matrix ',answer{1}]); % -
write pro matrix
    xlswrite(filename,prosums_Cell,['Protein Sums ', answer{1}]);     % -
write pro sum
    xlswrite(filename,maxes_Cell,['FCS ', answer{1}]); % - write FCS sheet
```

```
    runtime = toc; % - calculates the amount of time it took to read the data
files
    % - print program statistics.
    fprintf('%s\n Read data, calculated sums, and wrote in file in %f
seconds.\n Thank you for using the program :)\n',datestr(now),runtime);
catch exception
    question = questdlg(sprintf('Your excel data file %s is still open. It
needs to be closed to proceed with writing the results. Would you like to
close it now?',fn));
    switch lower(question)
        case 'yes'
             h = actxGetRunningServer('Excel.Application');
             h.Workbooks.Item(fn).Close;
             xlswrite(filename,calmatrix_Cell, ['Calorie Matrix
',answer{1}]); % - write cal matrix
             xlswrite(filename,calsums_Cell,['Calorie Sums ', answer{1}]);
% - write cal sum
             xlswrite(filename,promatrix_Cell, ['Protein Matrix
',answer{1}]); % - write pro matrix
             xlswrite(filename,prosums_Cell,['Protein Sums ', answer{1}]);
% - write pro sum
             xlswrite(filename,maxes_Cell,['FCS ', answer{1}]); % - write FCS
sheet
             runtime = toc;% - calculates the amount of time it took to read
the data files
             % - print program statistics.
             fprintf('%s\n Read data, calculated sums, and wrote in file in
%f seconds.\n Thank you for using the program :)\n',datestr(now),runtime);
        otherwise
            errordlg(sprintf('Please close your data file, %s, then rerun
this program to produce the results.',fn));
    end
end
```