The Impact of Groundnut Production and Marketing Decisions upon Household Food Security Among Smallholder Farmers in Sub-Saharan Africa: Does Gender Matter?

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ABSTRACT

This thesis investigates the relationship between groundnut cash cropping decisions and household food security in two regions of sub-Saharan Africa. Particular attention is paid to how the gender of groundnut growers influences this relationship. Additionally, the thesis examines how gender influences household marketing decisions. Household groundnut production and marketing data was obtained using surveys administered in eastern Uganda and central Ghana. A food consumption score developed by the World Food Program is used as a quantitative measure of food security. Measures of household groundnut cultivation intensity are specified using data on household groundnut production and marketing levels. An OLS regression estimates the relationship between the food consumption score and measures of cash cropping intensity and other cash crop production decisions. Apart from the OLS regression, a tobit model is employed to estimate the gender effects on household marketing decisions, examining both the decision to participate in a market and the decision concerning the amount to market. Cash cropping decisions are found to play no role in the determination of food security. While the presence of female groundnut growers in a household has a small positive effect on the food consumption score, there is no identifiable gender influence upon the cash cropping and food security relationship. The tobit model results indicate no gender effect upon household marketing decisions.

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CHAPTER 1: INTRODUCTION

PROBLEM STATEMENT:

Acquiring an adequate supply of nutritious food is an enduring and pressing problem for many people across the globe. The Food and Agriculture Organization of the United Nations (FAO) estimates that globally there were almost one billion hungry people in 2011, approximately 1 out of every 7 people worldwide. This widespread issue of hunger is an outcome of food insecurity, or a lack of food security. Food security being when an individual, "at all times, [has] physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (FAO, 2009). Naturally, food insecurity implies that an individual does not have access to enough food for an active and healthy lifestyle. Food insecurity leads to numerous problems that impede social and economic development. Hunger and malnutrition stemming from food insecurity lead to reductions in work output, reduced life expectancy, higher rates of infant mortality, and mental impairment that diminishes human capital and the effectiveness of educational programs (Schofield, 1979). For these reasons, the issue of food insecurity is seen as a crucial problem that the global community must address. To that end, the United Nations named halving global hunger and malnutrition before 2015 as one of their Millennium Development Goals. Furthermore, the United States government recently implemented a 3.5 billion dollar initiative, Feed the Future, aimed at reducing global hunger and increasing food security among twenty targeted countries.

The vast majority of world's food insecure individuals live in developing countries (FAO, 2012). Within this population, food insecurity is especially prevalent among poor farmers, owning little or no land. As of 2012, the FAO estimates that half of the developing world's

hungry population are low income smallholder farming households. These households depend heavily on what they can produce on their own small plots for both their income and their nutritional needs. Thus, to effectively assist small holder farming households improve their livelihoods and their food security, it is crucial to understand how household and community characteristics along with household production decisions impact food security.

One prominent factor of household food security among the low income agrarian population of the developing world is the production of cash crops. A cash crop is defined as any crop that is sold instead of consumed by the farmer, whether it is a surplus or it was grown specifically to be sold (von Braun and Kennedy, 1994). The commercialization of agriculture, or the process by which agricultural systems move from subsistence production to one in which production is sold on the market, has been a prominent force of change among small scale farmers throughout the 20th century. As infrastructure improved and more and more farmers gained access to ever increasingly integrated markets, they began selling their output instead of consuming it themselves. Presently, the commercialization process has penetrated nearly all farming communities in the developing world.

It is generally agreed that poor farmers that rely on subsistence agriculture act rationally and use the resources at their disposal as efficiently as possible (Shultz, 1975). However, because of their limited resource base, the productivity of these farmers is low compared to their commercialized counterparts. This low productivity is becoming increasingly problematic as the world's growing population demands more from increasingly scarce resources (von Braun and Kennedy, 94). Basic economic theory tells us that agricultural commercialization is inherently more productive because it utilizes the economic concept of comparative advantage (Maxwell and Fernando, 1989). Farmers that sell some of their crops can specialize in the production of a crop that is particularly well suited to their land, abilities, or climate and in turn

trade for needed foods and goods that they would otherwise have to less efficiently produce themselves. It seems intuitive that agricultural commercialization would lead to improved standards of living, and thus improved food security among the farmers that grow cash crops; however, the empirical reality is not that clear cut[1].

There are a multitude of household, farm, and community factors that determine how cash crop production influences household food security. For instance, the crop itself and its role in the agricultural system factor into the relationship between cash cropping and food security. Household factors such as the education and abilities of members affect the impacts of cash cropping. Community factors such as access to infrastructure and food markets play a role, along with the scope and accessibility of agricultural research. The sheer number and variety of influencing factors means the relationship between cash cropping and food security may depend on the unique characteristics of the situation. Thus the impact of cash cropping upon household food security is an empirical question that must be examined within a specific community and cultural context.

An important objective of the thesis is to investigate how gender in particular affects the relationship between cash cropping and food security. The gender composition of a household is seen to influence this relationship in numerous ways. Who participates in agricultural production influences which crops are grown and if the crops are to be sold or consumed. Which gender controls the marketing decisions also affects how income is spent and which household members receive available resources, including food. How much time and effort each gender dedicates to tasks determines what foods are procured and how they are prepared. These numerous pathways both alter and complicate the cash cropping and food security relationship and reinforce the need for an empirical study to fully examine the complex relationship.

1 This paradigm assume both complete markets and efficient allocation of resources within households

The thesis will examine the impact that one cash crop, groundnuts, has on the household food security of farmers residing in two countries in sub-Saharan Africa, Uganda and Ghana. Groundnuts have long been seen as an important food and cash crop for low income countries. Richard Longhurst (1985) describes the many nutritional and economic benefits attributed to groundnut cultivation. He states that they are a nutritious food, dense in protein rich calories, and are readily sold in local markets. Beyond that, the groundnut plant grows quickly and does not rob the soil of nutrients, it actually fixes nitrogen in the soil, and groundnut byproducts can be used as animal feed. Because of these reasons, Longhurst contends that groundnuts are a "good" cash crop and he promotes it as a crop that provides households with both nutrition and income.

Groundnut are an important cash crop across much of Africa, especially throughout West and Central Africa where the arid, warm climate and sandy, loose soils suit the groundnut plant. In the areas where groundnuts are grown, this annual legume is an important source of oil and protein. Two thirds of the global crop is crushed for oil while the remaining third is consumed as food (ICRISAT, 2012). In 2010, 11.6 million hectares of land in Africa was dedicated to groundnut production, approximately 48% of the worldwide production area (FAOSTAT, 2012). Ghana produced 530,887 metric tons and Uganda produced 172,000 metric tons in 2010, sizable harvests once the relatively small size of both countries is taken into consideration (FAOSTAT, 2012). In the same year, groundnuts were the largest pulse crop grown in Ghana by both volume and value, and the seventh most produced crop overall in the country (FAOSTAT, 2012). In Uganda in 2010, the groundnut was the second most produced pulse crop behind beans (FAOSTAT, 2012).

Despite its importance as a crop, groundnut yields per hectare are relatively low across Africa. While Africa contains nearly half of the global land area under groundnut cultivation,

only 28% of the global production comes from the continent (FAOSTAT, 2012). This is mainly because African groundnut producers tend to be smallholder farmers that use limited inputs and face undependable rainfall. Ghana's average yield was approximately 15 metric tons per hectare in 2010, which is slightly below the global average. Uganda's average yield for that year was only 7.3 metric tons per hectare, which is even below the average African yield of 8.9 metric tons per hectare (FAOSTAT, 2012).

The regions within Ghana and Uganda examined in this thesis are typical of sub-Saharan low-income farming communities. The farmers in these communities grow a mixture of crops along with groundnuts. Their land holdings are small and they produce crops both for their own consumption and for market. With this in mind, the thesis will attempt to empirically model two important relationships to gain a greater understanding of the role of groundnut cash cropping in the well being of smallholder farmers in the sub-Saharan region as a whole. The first relationship is the role that groundnut grower gender plays in the impact that groundnut cash crop production has on household food security. The second relationship is how gender affects household groundnut marketing. Two components of the marketing decisions will be explored, the decision to market groundnuts and the amount of groundnut marketed.

GOAL AND OBJECTIVES:

Goal: Generate an understanding of the impact that groundnut cash cropping has on household food security in rural sub-Saharan African households.

In order to achieve this goal, several research objectives must be addressed:

1. Demarcate cash cropping and food security levels of rural, groundnut producing households in sub-Saharan Africa.
2. Empirically estimate the relationship between groundnut production and marketing and household food security applying regression analysis to household survey data on

groundnut producers in the Eastern region of Uganda and the Brong Ahafo, Ashanti, and Eastern regions of central Ghana

3. Use the regression findings:

    a. to determine how groundnut cash cropping dependency and gender control of production and marketing influences household food security

    b. to determine how household characteristics and gender influence the marketing habits of households

4. Distill the implications of the findings for government policy, agricultural research, extension services, and community development aimed at improving household food security.

CHAPTER 2: CONCEPTUAL FRAMEWORK

This chapter includes a discussion of the conceptual framework forming the basis of both models estimated in the thesis. The first part of this section describes the concept of food security and the various methods employed to quantitatively measure the concept. There is also a discussion of the concept of cash-cropping and how the intensity of cash cropping influences food security. Furthermore, gender roles in agriculture are described in relation to their impact on both cash-cropping and food security. Finally there is a brief synopsis of previous empirical studies examining the relationship between cash-cropping and food security. The second part of the chapter describes household marketing. There is a discussion of the importance of trade and markets in household productivity and of the factors that influence market participation.

FOOD SECURITY AS A CONCEPT:

As previously stated, food security describes when an individual or household has access to the food required to sustain a healthy and productive lifestyle and food insecurity represents the converse. While food insecurity is often seen as synonymous with hunger and malnutrition, it is vital to understand that these concepts differ in subtle, but important ways. Barrett (1990) separates hunger and food insecurity by describing food insecurity as a status that describes a condition. On the other hand, he states that hunger and malnutrition can be, but do not have to be, outcomes of food insecurity. This means an individual that is considered hungry is also food insecure, but an food insecure individual is not necessarily hungry. For example, an individual could eat a diet that is satiating, yet eat nutrient poor foods that leaves him or her vitamin deficient and therefore, food insecure. This shows that food insecurity is a sufficient, but not a necessary condition for hunger.

In the case of malnutrition, an individual that is malnourished is not necessarily food

insecure, and a food insecure person is not necessarily malnourished. An individual that is food secure, yet malnourished may be unable to absorb nutrients, possibly due to a disease, leading to deficiencies in nutrient levels even if food intake is adequate. An individual that is food insecure, yet not malnourished, may eat foods that provide all the needed nutrients, yet does not eat enough to meet the daily calorie requirement. In the case of malnutrition, food security is neither necessary nor sufficient for its elimination.

To be clear, this thesis is concerned with food security status and not the possible outcomes (i.e. hunger and malnutrition) that the status might entail. While the households that this thesis examines may have hungry or malnourished members, this thesis makes no attempt to classify or predict the outcomes of household members. This thesis is only concerned with how certain actions, such as cash cropping, affect a household's ability to provide itself with enough food of adequate nutrition to maintain a healthy lifestyle as described by the food security definition.

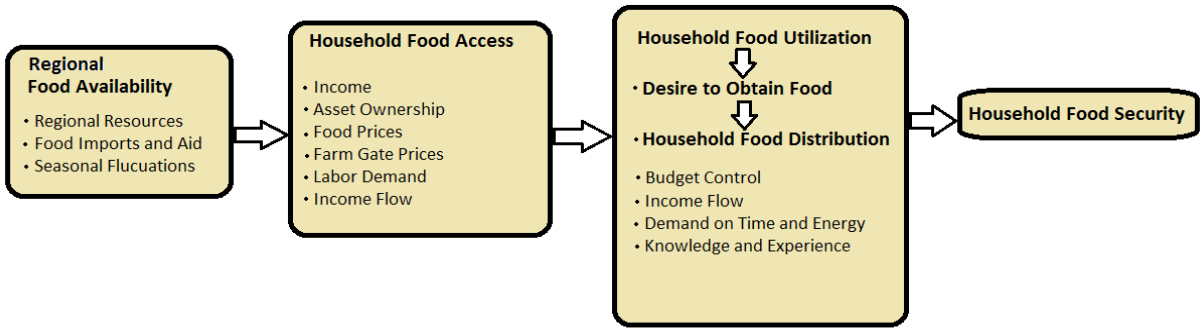
How food security has been assessed has changed greatly over the past decades. Barrett (2002) discusses how food security was first seen as a supply issue. It was assumed that food insecurity arose when there was insufficient food supplies available to a population. The focus then changed to the aggregate demand side. Research on food security focused on a population's ability to access the available food supply. These assessments would latter be replaced by methods that focused food security on a more disaggregated individual or household scale.

Amartya Sen (1979) revolutionized the conceptual approach of food security by introducing food security as an individual phenomenon. Instead of examining food insecurity on a national or regional scale, Sen argues that food insecurity originates at the household level and bases his analysis of food security on what he calls an entitlement approach. Sen maintains that

a household is food insecure, or as he says starves, if the household is not able to command enough food. The ability of an individual to command food is derived from his set of endowments. Endowments can be land, labor, and any other resource available to the individual. Sen states that the individual can use, consume, or exchange any combination of these endowments for food. Starvation or food insecurity occurs when all options available through the household's endowments are unable to provide enough food.

Combining the ideas of the previous models, Pinstrup-Anderson (1985) breaks down the concept of food security into hierarchical, yet overlapping dimensions of availability, access, and utilization. Availability describes the supply of food within a community or region. Access describes potential demand for food by describing the resources available to an individual or household that they could use to acquire food. Utilization describes how an individual or household uses their available resources to obtain food and also how a household decides to distribute the acquired food among the household members. These dimensions are hierarchical in nature because each of the outcomes of the dimensions are dependent of the previous. Food must be available within a community for an household to have access to it, and an individual must have resources available to access food before they can utilize it.

Figure 2.1: Dimensions of Food Security[2]



2 Adapted from: Pinstrup-Anderson, 1983

Figure 2.1 shows the three hierarchical dimensions along with factors that determine its effect on food security. Food availability, or the food supply of a region, is influenced by the resources of the region, both natural and man-made. These resources determine what foods can be produced in the region and what can be brought into the region. Soil type and condition, water availability, and climate all influence what food can be produced and when it can be produced. Man-made resources such as roads and rails affect what food can be brought to a region, either through imports or though aid deliveries.

An individual's or household's access to the available food supply depends on the resources available to them. Resources include financial and physical capital. Financial capital can be used to buy food for the household. Physical capital includes household assets such as land or livestock. Additionally, the household possesses human capital in the form of household members that can provide labor. These resources can either be used to produce food or be exchanged for food. Furthermore, the value of the financial, physical, and human capital resources, and thus how they can be used to obtain food are influenced by numerous factors. Prices for crops, food, and labor affect both how much income is earned from producing crops and how much must be spent to obtain food or hired labor. The form in which income is received can also affect how a household can use it to obtain food. Whether income is received as a lump sum or as spread out payments, whether it is received as cash or in-kind payments all influence if financial capital is available to an individual or household to exchange for food.

Utilization is associated with two concepts. The first is how individuals or household members decide to use available resources to acquire food and what resources they use. They can of course use their resources to acquire other things besides food, thus it is up to the household to decide what resources they dedicate to food acquisition. Second, the household decides how the acquired food is distributed among household members. These two decisions

can be affected by who controls the budget. For example, men have been shown to make different decisions than women when it comes to how they spend income (von Braun and Kennedy, 1986). How income is spent can also be affected by the form in which income is received. The previously mentioned forms of capital not only affect if assets are available to be exchanged for food, but also if an individual or household chooses to use the assets to procure food. The form of capital influences what foods the household chooses to procure and possibly how food is distributed within the household. The knowledge and experience of household decision makers are also very important. Factors like the skill of a farmer and how an individual utilizes local trade networks oftentimes affect their success in obtaining food. Also how much time and energy household members expend to acquire food will affect both household need for food and the type of food they obtained. These influencing factors, and specially how they relate to the relationship between food security and cash crop production, will be examined in greater detail later in the thesis.

MEAUSRING FOOD SECURITY:

The food security status of an individual or household is notoriously hard to quantify. This is because a food security status is unobservable by its nature. Despite this difficultly, numerous and varied methods have been developed in order to quantify it by measuring the physical, mental, or emotional outcomes of a food security status or by measuring the perceived determinants of food security. Migotto et al. (2005) categorize the different measures of food security into five basic approaches.

One approach is nutritional status. Here food security is measured by any number of outcomes of food consumption or a lack thereof, such as weight or vitamin deficiencies, and relating these outcomes to the subject's food security status. The downside of this method is that these measured outcomes are what Migotto et al. calls “non-specific indicators”. They are non-

specific because many food security outcomes, such as malnutrition, can be caused by subject's food security status, but it can also be caused by such things as sanitation or child care practices. This means that this method must rely on a potentially strong assumption that the cause of the measured outcome is the subject's food security status.

A second approach incorporates a dynamic approach to food security measurement. This approach attempts to measure an individual's or household's "vulnerability" to food insecurity across a given time period. Migotto et al. describes vulnerability as a dynamic expression of the future state of the world. In other words, the approach focuses on the likelihood that a target group will fall into food insecurity. Because vulnerability is difficult to isolate using traditional quantitative measures, this approach often relies on self-assessment. The weakness of this method is inherit in all self assessment methods. The type of information collected is highly subjective and difficult to assess on an objective basis.

Another food security measurement approach relies on examining the food supply available to a targeted study group. This measurement type estimates how much food is available to the study group and how this food supply is distributed among the members based on determinants such as household income and market access. This information is combined with data on the estimated per capita food energy needs of the study group to calculate which segments of the study group are able to meet their food energy needs and which segments cannot.

A fourth approach focuses on individual household characteristics instead of broad estimations of group characteristics like the previous method (Sen, 1981). This measurement type examines an individual's or household's ability to access food based on their wealth status. This wealth status can be measured through income, consumption, or expenditures on various goods. Based on the estimated wealth status, a determination is made of which individuals or

households can meet their dietary needs to be food secure. One downside of this measure is that is does not take food supply into account. If there are food market failures that prohibit people from accessing food who otherwise could, then this method will not accurately measure food security.

The final food security measurement type uses survey data to determine the actual consumption habits of individuals or households. This measurement type either can use indirect or direct methods. The indirect method uses surveys to assess the ability of a household or individual to acquire foods by examining their expenditure habits. This information can then be used to estimate the quantity and quality of food obtained by the participant. The direct approach uses data reported by the survey participant about their food consumption habits using a variety of methods. Food consumption can be measured through the weighing of consumed food or through chemical analysis. Additionally, self reported survey methods such as diaries or food frequency questionnaires can be used to discover the types and quantities of food consumed over a given period or time. Regardless if an indirect or direct approach is used, the final step of this type is to determine how each food consumed contributes to food security.

Relying on calculations of how diet affects food security status to create a measure of food security is an issue with this survey of consumption habits approach, an issue that is also present in the former two measurement approaches. The calculation is usually done by assessing the caloric and nutritional value of foods to determine how different foods contribute to an adequate diet, and thus food security. However, no preferred method for this assessment method has emerged.

Despite this weakness, this consumption habits approach has important strengths. First, it relies on actual food consumption. This means that it incorporates both food availability and food access. Furthermore, it is does not rely on measures of indirect outcomes of food

consumption and thus does not contain the weakness of a non-specific indicator. Finally, while this is a static approach that does not incorporate an aspect of time, it also does not suffer from the weakness of subjectivity that are found in dynamic approaches that measures vulnerability.

AGRICULTURAL COMMERCIALIZATION AND CASH CROPPING:

The term cash crop has been used to define a variety of crops. Maxwell and Fernando (1989) explain the term cash crop has meant a surplus crop that is marketed, a crop that is considered a non-staple crop or one not traditionally grown in the region, a non-food crop such as cotton or rubber, or a crop that is specifically produced for the export market. In an effort to standardize and generalize the term, von Braun and Kennedy (1994) state that a cash crop is any crop that is sold by the farmer on the domestic or export market, no matter if it was initially intended to be sold or consumed when planted. This thesis relies on this more generic definition of a cash crop and concludes that groundnuts are a cash crop in Uganda and Ghana as they are sold or could be potentially sold by the household.

The production of cash crops or cash cropping, and agricultural commercialization are in some ways synonymous. In essence, agricultural commercialization occurs when an agricultural system shifts from producing crops destined to be consumed by the producer to producing crops destined for the marketplace. In other words, agricultural commercialization is the process of moving from food cropping to cash cropping. Agricultural commercialization is formally defined by Hinderink and Sterkenburg (1987) as a "deliberate action on the part of agricultural producers, of their own free will or by means of coercion, to use the land, labor, implements and annual inputs in such a way that a greater or smaller part of the crops produced or animals raised is for exchange or sale."

Farmers choose to commercialize or engage in cash cropping for a variety of reasons. von Braun (1995) states that population change, access to new technology, the creation of

infrastructure or markets, and trade policy changes can all induce commercialization. However, farmers can also be forced to commercialize. In fact, Africa has a long history of forced commercialization, usually at the hands of colonial powers. However, there is no evidence to suggest that the surveyed farmers in Uganda and Ghana engage in cash cropping for any other reason than their own free will. Additionally, for the purposes of this thesis, the focus will be on the outcomes of cash cropping, not why the farmer pursues the strategy.

One of the necessary outcomes of agricultural commercialization is that the agricultural system becomes increasingly integrated into the wider economy. Integration occurs on both the input and output side of production. Not only do farmers sell their products in a market, but they buy inputs, such as fertilizer, instead of relying on their own production of inputs, like manure (von Braun, 1995). This integration into the wider economy means that farmers shift their goals from self sufficiency towards profit and income generation (Pingali and Rosegrant, 1995). Agricultural commercialization is generally assumed to be economically beneficial. This is because of the ability of commercialization to motivate specialization, diversification and integration; all drivers of economic growth (Maxwell and Fernando, 1989).

Increasing incomes and economic growth through agricultural commercialization implies that households will have access to new and more assets to contribute to food security. However, there is considerable evidence that the economic benefits of commercialization do not automatically translate to improved food security. For example, a study conducted by the FAO in 1984 shows that while Kenyan farmers that grew tea had higher incomes and owned more livestock and land than their subsistence farming counterparts, the nutritional status of their children was not measurably better than their counterparts. Another study in Kenya examining sugar producers, again showed that while the sugar producers' income was higher than the income of maize farmers in the same area, the nutritional statuses of sugar producers' children

was no different than the children of maize farmers (Kennedy and Cogill, 1987). Both studies indicate that higher levels of wealth do not necessarily translate into better food security, or more specifically, childhood nutritional statuses.

If an increase in income or wealth is to improve food security then it must allow household members access to more and better food. This can only happen if regional, community and household conditions allow it. How exactly these conditions determine food security is a crucial part of this thesis and a complex matter that will be discussed next.

CASH CROPPING'S IMPACT ON FOOD SECURITY:

A good way to examine how cash crop production influences food security is to examine it through the dimensions of availability, access, and utilization described by Pinstrup-Anderson. It must be noted, however, that while it is helpful to demarcate how cash cropping influences food security through these dimensions, each linkage cannot be neatly placed in one category. Oftentimes linkages may belong to two categories, blending the separation between each dimension. For example income is a financial resource that affects household food access. However, as previously explained the type of income also affects how a household utilizes it to obtain food.

In terms of availability, cash cropping can affect the amount of household produced food available to households. Cash crops that compete directly with traditional food crops may lead to food shortages as food crop production decreases. However, shortages need not occur if cash crops can be grown alongside food crops or in different seasons, thus not directly competing with food crops. Further, if there exists a viable exchange network to bring food into the region to offset these decreases in food supply due to cash cropping, shortages should not occur.

Cash cropping can also affect food access in a number of ways. Cash cropping potentially provides a resource through income that can be used to obtain food. This rise in income from

selling cash crops should increase capacity to obtain food. However, there are a number of factors that influence this relationship between income and food procurement. Increases in income may be partially offset if food prices rise because staple food supply decreases due to cash crop replacement of food crop production. Income gains can also be offset if cash cropping increases a farmer's demand for purchased inputs, such as fertilizer or machinery. Finally, the form of the income from cash cropping influences what food a farmer can access. Income may be received primarily during a time of the year when foods are unavailable to purchase. Conversely, increased real income can grant a farmer access to food sources that can normally only be bought, that he himself would be unable to produce. In the developing world, these foods can be nutritious meats and fruits, but also less nutritious processed foods, such as sodas.

The utilization component encompasses the most varied set of effects of cash-cropping on food security. Cash cropping affects both what foods are bought and how they are distributed. First, and perhaps most importantly, cash cropping effects the distribution of income within a household. For example, in many parts of Africa, men produce cash crops, while women produce food crops and manage gardens. This means that a household that shifts to more cash crop production, also shifts the control of household resources to the man. This could actually reduce household food security, because it has been shown that income generated by women has a greater positive impact on household food security (von Braun and Kennedy, 1986). Second, income composition can be effected depending on the type of crop. Some crops are harvested and sold all at one time, meaning that the farmers produce a single lump sum payment instead of receiving smaller payments spread throughout the year. It has been shown that households tend to use lump sum payments to buy expensive, durable goods such as bicycles or livestock and not to buy food that would naturally lead to improved food security (von Braun and Kennedy, 1986). How much time or energy an individual uses to produce a cash crop can also influence how its

production affects food security. The more labor intensive a cash crop is, the greater the possibility that the household substitutes labor away from food crop production. If cash crop production takes enough time away from food acquisition and preparation, than it can have an negative effect on food security. This is especially true if women are involved in the cultivation of labor intensive cash crops, because they are responsible for the procurement and preparing of food for a household (von Braun and Kennedy, 1986) Finally knowledge and experience are important aspects of utilization. How a cash crop affects food security through the linkages described above, can greatly depend on the decisions of household heads. The decisions of what crops to grow, how much land to dedicate to each crop, how to grow crops, and how to spend the income gained from selling of cash crops all greatly influence how cash cropping affects food security.

These examples illustrate that not only are there many varied linkages between food security and cash crop production, but also that the direction and magnitude of these linkages can greatly differ with the circumstances of the household. This suggests there can be no definitive or generic conclusion on how cash cropping relates to food security. Empirical studies reveal this through their widely differing, and often contradictory conclusions on how the production of individual cash crops influence food security. For every study that shows a positive relationship there is another that shows a negative relationship. This is not to imply that any of these studies are flawed, only that the unique characteristics of the crop, the households, and the region significantly change the relationship of food security and cash-cropping.

Figure 2.2 illustrates the complexity associated with both how households divide their production capabilities between cash and food crops, and how these production choices in turn affect household food security through different pathways and linkages. From the chart, it can be seen that the amount of cash crop production a household maintains, depends on how much time

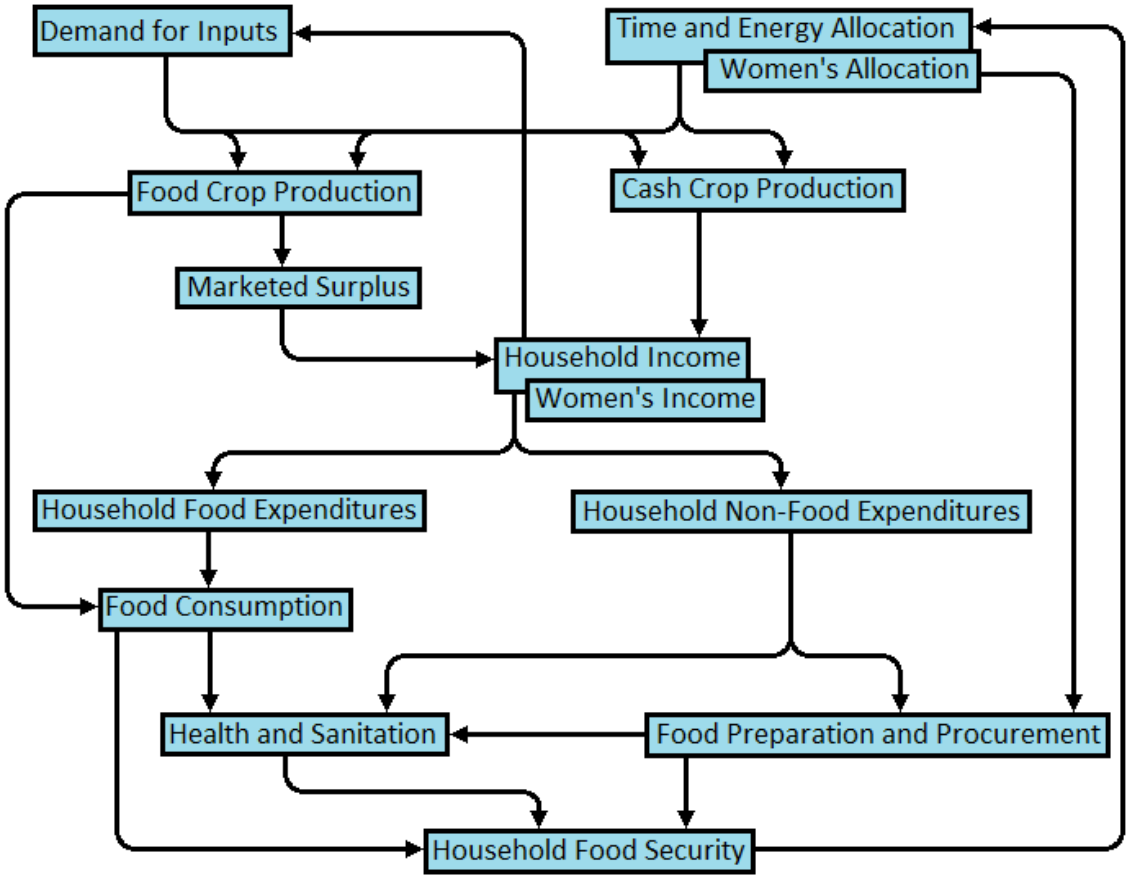
and energy, along with the amount of inputs, the household decides to dedicate to cash crop production. Each household has a finite amount of land, labor, and capital resources and must decide how to divide them among their production activities. The income of a household is in turn affected by the division of these activities. More resources dedicated to income generating activities will likely increase household income.

Food consumption is both directly and indirectly affected by this division of activities. There is a direct pathway between food production and food consumption, and also an indirect pathway though income. Income in generated through production activities, like cash crop production, and then this income must be spent on food to eventually link to food consumption.

Finally these pathways converge on household food security. As the chart indicates, food security status is not solely dependent on household food consumption. Time and energy spent on food procurement and preparation along with the health status of the household members also affect the food security status.

The multiple choices and pathways reflected in the flow chart demonstrates an important aspect of this thesis. The relationship between cash crop production and food security status is complicated by the many linkages and decision making points. The pathway from food crop production to food consumption to food security status is relatively simple and direct. However when cash crop production decisions are included, the relationship between production and food security become far more complex and context specific. Thus it is vital to have a clear understanding of the cash-cropping and food security relationship and how it is mediated by family and community factors to accurately model and analyze observed outcomes of each situation.

Figure 2.2: Flow Chart of the Linkages Between Cropping Decisions and Food Security[3]



WOMEN'S ROLE IN CASH CROPPING:

This thesis will focus on how women's participation in cash crop production and household decision making affect household food security. This impact will likely depend on the role that women play in the agricultural society. Katona-Apte (1983) classifies the three dominant agricultural societies in the developing world and the role that women play in agricultural production in these societies. Type 1 societies are ones where women do not participate in agriculture in any significant way. Arabic societies would be an example of a type

3 Adapted from: von Braun and Kennedy, 1986; von Braun, Puetz, and Webb, 1989

1 society. The traditional Arabic societal roles for women are confined almost entirely to the home. In type 2 societies, women participate in agricultural production by working along side men in the same fields. An example of this society would come from southeast Asia. Men and women work together, cultivating the same rice paddies. Finally, type 3 societies are ones where women and men cultivate separate fields. Many West African regions are characterized by type 3 societies. Men often produce a cash crop or care for livestock, while women maintain vegetable gardens or grow other food crops.

Katona-Apte argues how women engage in agricultural production in these different societal types influences how cash cropping affects household outcomes. Three prominent issues are dependent on the society type; the control of income within a household, the perception of food needs within the household, the time and energy that is available to men and women members within the household.

If a household increases cash crop production and successfully sells the crop, then it will likely see an increase in income. However, who controls this income and how it is ultimately spent depend on the societal type. In type 1 societies, there will most likely be no change in the income controlled by women because of their lack of participation in cash cropping. In type 2 societies, where men and women cultivate the same fields, there is a chance the income of women could rise due to cash cropping if the income is shared among the producers. However it is often the case that men control the income earned from cash crops, despite the fact that women assist in its production. Finally in type 3 societies, the most likely outcome of cash cropping is a decrease in proportion of income controlled by women because men usually dominate cash crop production in these societies, and thus control the income earned from it.

The perception of food within a household primarily depend on which members are the most active. If a household increases their production of cash crops this means that those

participating in cash cropping will be seen to need more food due to their greater energy expenditures. Therefore, only men will be seen as needing more food in type 1 and 3 societies because they are the only ones active in cash cropping. However, in type 2 societies where both genders participate in cash cropping, both genders will likely see a need to increase their food intake.

If a household is to increase their production of cash crops or possibly begin to grow a labor intensive cash crop, then those participating in the production must dedicate more time and energy to its production. Again, this means that the time and energy available to women in type 1 and 3 societies will not change because they play no or little role in cash cropping. However, in type 2 societies the time and energy available to women may decrease. This is because they must dedicate more time and energy to the cultivation of the cash crop, yet they still are responsible for all other chores typically done by women in these societies, such as child care and food procurement and preparation.

There is one important caveat to the conclusions of the type 3 society. These outcomes depend on men dominating cash crop production, leaving women to grow food crops on their own fields. However, if women do cultivate cash crops on their own fields, then the outcomes to those three issues would be very different. Firstly, women would likely earn and thus control income and they too would have greater food needs due to the increased energy expenditures. They would likely have the same outcome as women in type 2 societies concerning the amount of time and energy available to them. Like type 2 societies, women would still be responsible for the procurement and preparation of food, a traditional obligation of women, despite extra effort and time spent cultivating a cash crop.

Table 2.1: Effect of Women's Participation Upon Agricultural Societal Types[4]

	Type 1	Type 2	Type 3	
			Men only involved in cash cropping	**Women involved in cash cropping**
Income Control for Women	No change	No Change, Possible Increase	Decrease	No Change, Possible Increase
Perception of Food Needs	Increase for Males	Increase for both	Increase for Males	Increase for both
Time and Energy Available for Women	No change	Decrease	No change	Decrease

The role of women in cash crop production and the outcomes to the women ultimately also affects household food security, not just the woman's own food security. As noted by von Braun and Kennedy (1986) women tend to spend the income under their control differently than men. There is a stronger positive relationship between income controlled by women and food consumption than between income controlled by men, implying that women tend to spend income on food for the household rather than on other expenditures such as durable investments or possibly alcohol and tobacco. On the other hand, if a woman must dedicate a great deal of time and energy in cash cropping, than they may have to sacrifice time and energy used to procure and prepare food. This may cause women to buy less nutritious foods that are easier and quicker to prepare (Senauer, 1990). This decrease in food preparation time could lead to decreased food security for the household with increased participation of women in cash cropping.

WOMEN'S AGRICULTURAL ROLE IN GHANA AND UGANDA;

According to the questionnaire data conducted for this thesis, in both the Ghanaian and

4 Adapted from Katona-Apte, 1983

Ugandan regions that will be investigated women tend plots that are independent of the plots of men, typical of a type 3 society. However, the data also show that a significant number of women participate in groundnut production and marketing. Women participation in groundnut cash cropping suggests that the outcomes may be more similar to type 2 societies than type 3 societies. However, the outcomes do not just depend on participation, but also who in the household is making decisions. It may be that men make the growing and financial decisions for all members of the household, or its possible that men and women jointly make the decisions. In these cases where the societal arrangement cannot be neatly classified, the nature of the outcomes become more complicated to decipher and impacts of cash cropping on food security are even less predictable.

AN OVERVIEW OF CASH CROPPING IMPACT STUDIES:

Numerous studies over the past decades have been conducted to examine how cash cropping affects household food security. Table 2.2 lists many of these studies and their conclusions dating from the 1960's. The table is adapted and expanded from previous summaries created by Longhurst (1988) and Dewalt (1994). All of these studies examine cash cropping's effect on either household food consumption or the nutritional status of primarily children or women family members.

Table 2.2: Overview of Cash Cropping Impact Case Studies

Author(s), Date Published	Country	Crop	Household Food Consumption	Nutritional Status
Collis, 1962	Nigeria	Cocoa		Negative
Keller, Muscat, and Valder, 1969	Kenya	Coffee, Pyrethrum	Positive	Positive
Gross and Underwood, 1971	Brazil	Sisal	Negative	
Hernandez et al., 1974	Mexico	Cocoa, Sugarcane		Negative
Lambert, 1978	Guinea	Coffee	Negative	
Dewey, 1979	Mexico	Cocoa		Negative

Lev, 1981	Tanzania	Coffee, Bananas	Positive	
Hitchings, 1982	Kenya	Tea		Positive
		Coffee		Postive
		Cotton		Negative
		Pyrethrum		Negative
		Sugarcane		Negative
Rabeneck, 1982	Kenya	Coffee, Staples		Positive
Fleurat and Fleuret, 1983	Kenya	Coffee, Vegetables		Neutral
Harvey and Fleywood, 1983	Papua New Guinea	Coffee	Positive	Positive
FAO, 1984	Kenya	Tea		Neutral*
FAO, 1984	Zambia	Cotton		Neutral
Eide et al., 1986	Sri Lanka	Rice	Neutral	Postive*
Haaga et al., 1986	Kenya	Coffee		Negative
Kennedy and Cogill, 1987	Kenya	Sugar		Neutral**
Dewalt et al., 1988	Mexico	Sorghum	Neutral	Neutral
Neimeijer et al., 1988	Kenya	Rice	Neutral	Neutral
von Braun, 1988	The Gambia	Rice	Postive	Postive*
Huss-Ashmore and Curry, 1989	Swaziland	Corn		Negative*
Kurth, 1989	Malawi			Neutral
von Braun et al., 1989	Guatamala	Vegetables		Postive*
Bouis and Haddad, 1990	Phillipines	Sugar		Neutral
Peters, 1990	Malawi	Tobacco		Negative
Shack et al., 1990	Papua New Guinea	Rubber		Postive*
Immick and Alcaron, 1991	Guatamala	Wheat, Potatoes, Vegetables		Neutral*

* Nutritional Status measured solely among children
** Nutritional Status measured among only women and children

Among these studies, nutritional status is the primary measure used to determine food security status. As previously explained nutritional status does not directly measure food security, it essentially measures the physical outcome of food consumption, usually by examining weight compared to height, but also through morbidity rates and certain nutritional related diseases. When many of these studies were conducted it was common to measure

nutritional status instead of food security, because it is assumed that these chosen measures are easily identifiable outcomes of chronic food insecurity. Furthermore, the data needed to calculate a nutritional status, such as height and weight, is relatively easy to collect and was thought to be generally more accurate because it did not rely on reported data, as is the case with many food security measurements. While most studies employed a nutritional status measure, many others used a food consumption score or both.

It is clear from the results of these past case studies is that there is no definite conclusion on the effects of cash cropping upon the measures of food security status. The studies have concluded cash cropping to have both negative and positive impacts. The results also show no trend in time since these types of studies began in the 1960's. Furthermore no continent or region shows either a consistently positive or negative relationships. For example, for studies conducted just in Kenya, there are listed five studies showing positive impacts, four studies showing negative impacts, and two studies showing neutral or ambiguous impacts.

However, there are some commonalities between studies that demonstrate either negative or positive relationships. Among those studies concluding a negative relationship between cash cropping and food security, oftentimes the cash crop is a non-edible crop. A study by Peters (1990) examining tobacco growers in Malawi and one by Bouis and Haddard (1990) examining sugar producers in the Phillipines show a negative and neutral relationship, respectively, between the cash cropping activities and nutritional status, despite an increase in household income due to the cash cropping. Both authors conclude that this increase in income could not overcome the loss of subsistence food crop production and therefore led to lower household food security.

Conversely, studies that examine how the marketing of edible cash crops affect food security tend to conclude a positive relationship. The study conducted by Immick and Alcaron (1991) in Guatemala examining wheat, potato, and vegetable growers finds there is a positive

relationship between childhood nutrition and increased cash cropping of food crops among both large and small land holdings farmers. Another study, conducted by von Braun, Rueben and Webb (1988) in The Gambia, finds increased rice cash cropping to be positively correlated with both household food consumption and the nutritional status of children. Finally a study implemented by Eide et al. (1986) finds a positive correlation between childhood nutritional status and a families participation in the Kirama Oya rice commercialization project in Sri Lanka.

Two studies that appear to be exceptions to this rule offer telling information. The first study shows a positive relationship between a non-food crops and food security. Shack et al. (1990) demonstrate a positive relationship between producing rubber and the nutritional status of the children of producers. However, the majority of the food consumed in the household is from their own production, and the income households earned from rubber production only contributes a small amount to the households total income. Another study by Neimeijer et al. (1988) investigates rice farmers that entered into a irrigated rice growing scheme in Kenya concludes that there is a negative relationship between rice production and household food security. However the study noted that rice production is strictly controlled by the scheme's managers, meaning participating farmers are not allowed to keep any production for their own consumption and have little opportunity to grow other food crops.

These examples suggest that flexibility may benefit farmers. When farmers grow a non-edible crop that must be sold in order to benefit the household, it limits how the farmer can use the crop as they are subject to the will of the market. However, if a farmer grows an edible crop that can be sold on the market then he or she has more choices and thus more opportunities to benefit the household by choosing to sell or consume the crop. If prices are high than the crop can be sold and the income used to buy food, while if prices are low, then the crop can be

consumed directly by the household. The latter is obviously not an option for the farmer of a non-edible crop. In the case of the counter examples, again flexibility seems to be key. Rubber production benefited food security when it was merely a supplement to income, not something that the household depended on for survival. With the case of rice production, the strict control of project managers limited what farmers could do with their rice. All these examples point to the fact that a diversity of options benefit agricultural producers. If a farmer has alternatives then he or she is less susceptible to individual shocks or disturbances that could otherwise hurt the food security status of a farmer with less options. The other underlying conclusion drawn from these studies is that the relationship between cash cropping and food security is context specific and no generalized conclusions can safely be made about the relationship.

THE BENEFITS OF TRADE:

An integral component of the cash cropping discussion is the degree of trade-ability, alternatively called the degree of market participation. Obviously trade must occur in order for a household to exchange their cash crop for other goods and services, therefore cash cropping does not exist without trade or participation in markets. The motivation to trade is present because it provides multiple benefits. Most importantly, trade allows households to capture the welfare gains of comparative advantages of production (Romer, 1994). Households that trade can take advantage of specialization and economies of scale, thereby acquiring a diversified consumption bundle (Barrett, 2006). Additionally, household interactions induced by trade encourage the flow of knowledge and ideas (Romer, 1993). This in turn, can produce gains in total factor productivity as households utilize improved technologies and practices (Edwards, 1998). Finally, wide scale trade and commercialization encourages economies to grow and diversify (Timmer, 1988). Despite these benefits, trade is not always an available option. There are a multitude of factors that determine if trade occurs and the degree to which it occurs.

AGRICULTURAL SUPPLY AND MARKETED SURPLUS:

For agricultural households to be able to participate in a market or trade, they must be produce a crop surplus, or harvest an amount above their own consumption needs. As described by Barrett (2006), a number of factors must be in place for a household to be able to produce a crop surplus. Household land access is vital. Households with larger land holdings tend to produce proportionally more cash crops because they must dedicate proportionally less land to meet their own consumption needs (Fafchamps, 1992). Households must often have access to inputs, such as labor, machinery, fertilizer, and improved plant cultivars in order to produce yields that offer surpluses. Barrett also mentions public institutions, such as publicly funded research organizations, as a factor that plays a role in the ability of households to enhance productivity and boost yields. Utilization of and access to these private inputs and public infrastructure allow households to produce surpluses that can be marketed.

AN AGRICULTURAL HOUSEHOLD SURPLUS MODEL:

Strauss (1984) sets out the private and public determinants of market crop surplus within a household context to describe market participation. He does this through a system of equations describing the production of a crop j (x_{jp}) and its consumption (x_{jc}) for a household through Equations (2.2) and (2.3),

(2.2) $$x_{jp}=x_{jp}(p, \varphi)$$

(2.3) $$x_{jc}=x_{jc}[p, \eta, \alpha + p_n T(\mu) + f(p,\varphi)]$$

where p is the price of crop j, η is a vector for household characteristics, α is exogenous household income, p_n is the price of labor, T is a function for work and leisure time determined by a vector of household characteristics (μ), f is a profit function determined by price of crop j (p) and φ, a vector a farm characteristics. Thus marketed surplus (q_j) is Equation (2.2) minus

Equation (2.3), as described in Equation (2.4). If marketed surplus is positive, this means that the household is a net seller of crop j, if q_j is negative they are a net buyer, and if it is zero than the household is autarkic. Strauss solves the reduced form of Equation (2.4) to arrive at Equation (2.5), a function describing marketed surplus.

(2.4) $q_j = x_{jp}(\cdot) - x_{jc}(\cdot)$

(2.5) $q_j(p, \eta, \alpha, \mu, \varphi)$

Thus q_j is a function of the crop price, household and farm characteristics and exogenous household income. For example, high prices signal households to produce and sell, while low prices discourages production. Households with greater exogenous income tend to consume more and are therefore more likely to be buyers. Together these factors determine if a household is a net buyer, seller or is autarkic.

MARKET ACCESS AND TRANSACTIONS COSTS:

Not only must a household produce a surplus to engage in trade, but it must have access to a market that can facilitate trade. There are a multitude of barriers to trade that are collectively known as transactions costs. These costs inhibit trade and if they are severe enough, they can prohibit trade altogether. In fact, transactions costs are often seen as the primary cause of market failure among rural developing markets (De Janvry, Fafschamps, Saudolet, 1991).

Key, Sadoulet and De Janvry (2000) categorize transaction costs as either fixed transaction costs (FTC) or proportional transaction costs (PTC). PTC's include such costs as the monetary and time costs of transportation. As the distance a farmer must travel to market increases, the incurred costs also rise along with the time taken to reach the market. FTC's include the vast majority of transaction costs. North (1987) divides FTC's costs into four basic categories. First, there is the cost of measurement, or the costs of developing and maintaining a

widely accepted system of measures that market participants can use to obtain information about traded products. Second is the cost of the exchange process. Market participants must take time and use resources to negotiate transactions and develop contracts in an effort to maximize their benefits of market exchanges. Third, is the costs of enforcement. Again, resources must be used to ensure that market participants behave justly, contracts are enforced, and legal rights are respected. Finally, North mentions a cost of ideological attitudes. These costs involve the creation of a society that has a vested interest in upholding and following the laws that govern trade. Both the FTC's and PTC's act as inhibitors to trade and market participation.

While transactions costs are a constant presence in market activities there are also numerous methods, both private and public, used to lessen these costs and promote market participation. Households use trucks and carts to efficiently bring their crop surpluses to markets. They also rely on public infrastructure, such as roads and rails to reduce transportation costs. Households depend on their own market experience and community relationships to find and keep trading partners. They utilize radio and increasingly use cell phones and the Internet to access publicly provided information on crop prices and markets to inform their search. Law enforcement and judicial institutions create and uphold rights and laws put in place to reduce risks and encourage trade and market participation.

These numerous private and public assets facilitate trade and allow households to take advantage of the benefits of trade. However, households do not always own or live in areas that provide the goods and services that reduce transactions costs. This is especially true in the developing regions of rural sub-Saharan Africa where households have limited resources and inefficient,under-funded, and oftentimes corrupt government institutions provide few public services that lower the transactions costs of trade. In these rural regions where transaction costs are high and many agricultural household are excluded from trading, the agricultural markets are

thin and prices are unstable. Thus it stands to reason that agricultural households in these regions often rely on subsistence farming to meet their own consumption needs (Fafchamps, 1992).

THE DECISION TO MARKET:

Over the past two decades many studies have investigated how agricultural supply and transactions costs affect the decision to trade or not to trade among agricultural households (Goetz, 1992; Omamo, 1998; Key, Sadoulet, de Janvry, 2000; Renkow, Hallstrom, Karanja, 2004). These studies conclude that when faced with a marketing decision concerning an agricultural commodity, households decide to either become a buyer or a seller of that commodity, or they decide not to participate in the market as an autarkic household. Thus the decision to trade or market an agricultural commodity is divided into two separate decisions. The first decision concerns if the household will buy or sell or not participate at all. The second decision concerns the amount that a household buys or sells, conditioned on the premise that they first decided to trade. It is evident that supply conditions and transactions cost affect the two marketing decisions. A household with a small harvest would most likely not have a surplus to sell and may need to become a buyer in order to meet its consumption needs. A remote household facing a long and expensive trip to a market may chose to not sell at all. This is especially true if the household is unaware of the market price or if ready buyers exists, dampening the household's response to price incentives (Omamo, 1998). Thus it is apparent, that both agricultural supply and transaction costs play a large and obvious role in the determination of household marketing decisions.

GENDER'S ROLE IN HOUSEHOLD MARKETING DECISIONS:

Women have traditionally encountered many hurdles to wider participation and relevance in the economies of the developing world. Collier (1988) describes four main causes of women's diminished economic status. First, women face discrimination by men. They are often excluded

from certain activities and afforded little respect. Second, women are subject to asymmetric rights and burdened with asymmetric obligations. Women often cannot own land or independently apply for credit. Furthermore, they are often completely responsible for child care and household food security. Third, women in the developing world have few women role models that rise above their traditional roles. Because they know no alternative, women often do not expect or demand better treatment or additional rights. Fourth, women must take on the responsibility of reproduction. In the developing world where large families are common, women are often pregnant numerous times, binding them to the household and away from other economic activities. Collier argues that all of these dimensions combine to relegate women to a lower economic status. This low status in turn reinforces discrimination against women and continues a trend of women failing to break from the traditional roles.

The situation described by Collier is indeed bleak, however it would be incorrect to state that this description holds true for all women in all regions of the developing world. There is in fact ample evidence that women in sub-Saharan African in particular, are doing much better than the previous description would suggest. A World Bank study found poverty rates were no higher among women headed households in four of the six countries studied (Blackden, 1999). A study conducted in Uganda reinforces this finding. Using national household survey data, it found that women headed households are no poorer than similar households lead by males (Appleton, 1996). While it is true that women in sub-Saharan Africa usually do most of the domestic household chores like food processing and storage, they also do up to 60% of the household marketing, a more economically prominent activity (Blackden, 1999). In regions like central Ghana, they actually make up approximately the majority of market traders and often organize and lead trading organizations (Clark, 1994). Clearly, while women certainly still face gender specific hardships, they are also finding ways to successfully participate in the market economy.

UGANDAN AGRICULTURAL MARKETS AND GENDER CONDITIONS:

Regarding household marketing decisions, this thesis will focus on Uganda. Therefore it is important to assess the current Ugandan situation. Kasante et al. (1999) provides a thorough description of the Ugandan agricultural and social conditions. The nation's economy is dominated by agriculture, but its agricultural markets are underdeveloped. Ugandan farmers are often unable to market crops because they cannot produce an adequate surplus due to low yields. These low yields are often blamed on low utilization of technology and inputs and also diminished soil quality. Additionally, farmers that do have surpluses to market find it difficult to participate in markets because of poor access to information, high costs of transportation due to poor roads, and a lack of storage options. Thus, 90% of Uganda's population is dependent on subsistence farming to some degree due to the widespread poverty of rural areas and the lack of access to agricultural markets.

Like many regions in sub-Saharan Africa, women in Uganda have traditionally been afforded few right or privileges in Ugandan society. The patriarchal society treated adult women as minors, not allowing them to own or sell land, independently control income, or even plant perennial crops like coffee or tea (Kasante et al., 1999). The Ugandan constitution, adopted in 1995, granted women rights and prohibited many of the traditional practices. However, many women are still unaware of their rights or are unable to practice them.

Thus, it appears that trading options are limited for Ugandan farmers. Women especially appear to face many economic and social barriers reducing their ability to trade. There has been little research conducted on how women's statuses influences household marketing decisions. A focus of this thesis is to empirically examine the determinants of market participation among Ugandan groundnut farming households, focusing on the role gender plays in marketing.

CHAPTER 3: STATISTICAL MODELS

Two statistical models are presented in this thesis. The first model estimates the impact that household groundnut cash cropping decisions, along with gender, have on household food security. The second model estimates how gender and other household characteristics influence household decisions to market groundnuts.

THE FOOD SECURITY MODEL:

As Pinstrup-Anderson and others described, food security can be delineated by food availability, access to food, and the utilization of acquired food. The food security model used in this thesis estimates how household food security is determined using these dimensions in order to isolate how key household decisions and traits affect food security. The following equation describes this model.

(3.1) $$Y=v_i\alpha+x_i\beta+u_i\delta+z_i\eta+\varepsilon_i$$

Y is the measure of food security; v_i, x_i, and u_i are vectors of variables used to describe availability, access, and utilization respectively; and z_i represents the variables used to measure the influence of groundnut dependency and gender. The variables are all specified to have a linear impact in their parameters. This means that if variables are continuous they are assumed to have a constant level of change across their range. OLS regression models are estimated separately for Uganda and Ghana.

THE TWO-STEP MARKETING MODEL:

Statistical modeling of marketing presents a complication in that the measure of market participation is not normally distributed. Rather, the measure is clustered at zero because many of the households choose not to participate in the market. When used as a dependent variable, this non-normal distribution violates an assumption needed for a consistent OLS estimator.

A corner-solution model, such as a tobit model, overcomes this issue by treating the zero values of the dependent variable as censored observations, but not treating them as unobserved. This restricts the observable dependent variable to equaling the latent variable only when its value is greater than zero. The resulting statistical model generates consistent and unbiased parameter estimates (Amemiya, 1973).

An additional benefit of a tobit model is that it jointly estimates the implicit two-part decision of market participation. In the first part, a household decides to participate as a buyer or seller or is autarkic. In the second part, if a household participates then they decide the amount they buy or sell. The tobit model does this by jointly estimating the likelihood of market participation and the amount of participation.

A key assumption of the tobit model is that the determinants of the likelihood of market participation and the amount marketed are the same. However, this may not necessarily be the case with marketing decisions. There are factors that could influence only the likelihood of participation, but not necessarily the amount of participation. For example, the use of a cell phone to obtain market information greatly reduces the costs of obtaining market information and thus lowers the barriers to trade. Cell phone usage therefore influences if participation occurs, but may not influence the amount of participation. Access to a truck also influences market participation. Theoretically, it would seem that a truck would influence both aspects of participation, however empirical evidence suggests that truck ownership influences primarily likelihood (Alene et al., 2008). Taking these examples into consideration, models that can differentiate the decision making determinants may be more appropriate. For instance, Goetz (1992) estimated a bi-variate probit model to examine the coarse grain market participation in Senegal and Alene et al.. (2008) estimated a Heckman's sample selection model to study how input usage affects market participation among Kenyan maize farmers.

Alternatively, double-hurdle models have also been used to separately estimate the two marketing decisions. This corner-solution model is useful for modeling marketing behavior because the model treats zeros as an observed choice rather than a missing value as is the case in other selection approaches (Ricker-Gilbert, Jayne and Chirwa, 2011). Furthermore, it still allows for the differentiation of the determining factors for each marketing decision, unlike the more restrictive tobit model (Cragg, 1971). These models have primarily been used to estimate consumption or demand. Jones (1989) models cigarette consumption in the U.K. and Goa, Wailes, and Cramer (1995) models U.S. rice demand. Ricker-Gilbert, Jayne and Chirwa (2011) estimate the demand effect of subsidized fertilizer in Malawi using a double-hurdle model with panel data.

The validity of both the various selection models and the double-hurdle model depends on the identification of a variable or variables that uniquely affect the separate parts of the decision process. Naturally, variables that describe the previous examples would best serve as selection variables. For example, Alene et al. use two variables representing access to information and transportation as selection variables. However, this type of information was not available in the surveys used for this thesis. Fortunately, tobit models have also been successfully used to study marketing decisions. Halloway et al. (2000) estimated a tobit model to examine barriers to market among Ethopian highland dairy producers. Additionally, Barrett and Bellemore (2006) estimated an ordered tobit model to examine when Kenyan maize farmers make their decisions to participate in food markets.

This thesis will also use a tobit model to examine marketing decisions among the surveyed groundnut farmers. The respondents are all producers, therefore the buying side of market participation is not examined. Equation (3.2) describes the market participation tobit model.

(3.2) $Y_i^* = p_i\alpha + h_i\beta + n_i\delta + f_i\eta + x_i\mu + \varepsilon_i$

$Y_i = Y_i^* \text{ if } Y_i^* > 0$

$Y_i = 0 \text{ if } Y_i^* = 0$

Y_i is the dependent measure of groundnut marketing; p_i, h_i, n_i, f_i and x_i are vectors representing price, household characteristics, exogenous income, and farm characteristics respectively. The vector x_i represents the variables used to estimate the gender effect on market participation. As shown by Equation (3.2), Y_i only equals Y_i^* if Y_i^* is greater than zero, otherwise Y_i is restricted to equaling zero. The likelihood of Y_i being greater than zero, indicating household marketing, is estimated by a probit model.

CHAPTER 4: MODEL SPECIFICATIONS

CROSS SECTIONAL DATA AND THE FOOD SECURITY MODEL:

Food security as described by Sen and others is a dynamic process that incorporates temporal issues of risk assessment and forecasts. This suggests that panel data of households over a number of years would be the optimal choice to specify a model describing food security. However, this type of data is extremely expensive and time consuming to collect, meaning cross sectional household data is usually the only data available. Despite its drawbacks, cross-sectional data can be adequately employed to identify factors that influence food security. Therefore, this thesis will use cross sectional household data from one time period.

THE DEPENDENT FOOD SECURITY MEASURE:

A measure of household food security is the dependent variable in the model. This model employs the food consumption score (FCS) developed by the World Food Program (WFP) to represent household food security. The FCS is obtained through a questionnaire, also developed by the WFP as a quick and accurate summary of the quantity and variety of foods being consumed by a household.

The FCS is generated as follows. The cook of each household completes the questionnaire, in which he or she reports the number of days a particular food was consumed in the past week based on a list of food types commonly consumed by that regions' population. For example, in Uganda, foods such as maize, millet and bananas were commonly chosen. In Ghana groundnuts, fish and eggs were typical choices. All listed foods are categorized as either a starch, pulse, vegetable, fruit, sugar, oil, meat, or milk. These categories are then weighted by their nutritional and caloric values. Meats and milk have large weights because they are caloric dense foods, while vegetables and fruits have medium weights because they are rich in vitamins but not as rich in calories, and sugar has a low weight because it has little nutritional value. The number of days

each food category was consumed within the past week is then multiplied by their category weight and finally these values are summed together. For this survey, if a respondent ate every food group every day of the week, then the score would be 112, the highest score obtainable. In order to normalize the final food consumption score, the sum of each respondent's values is divided by 112. This creates a ratio in which all scores potentially range from zero to one, one being a household that ate all food groups on every day of the week, and zero being if the household ate nothing at all the entire week. These ratios are the values of the dependent variable in the food security model. An analysis of the descriptive statistics of this variable is presented in the Data Chapter.

THE FOOD SECURITY MODEL EXPLANATORY VARIABLES:

The food security model is specified by various control variables that describe food availability, access, and utilization; along with variables that are likely to influence groundnut cultivation. The independent variables in the model all come from respondent reported data with one exception. The agroecozone (AEZ) in which each household was located was assigned by the researchers that conducted the surveys. What follows is a description of each variable and the rationale for its inclusion.

Availability Variables:

Two variables describe food availability. The first variable represents access to markets. Market access allows households to trade by selling their cash crops and buying needed foods and materials that they do not produce on their own. As a household become more remote, it becomes increasingly costly in terms of time and money to access markets (Omamo, 1998). These costs in turn are detrimental to household food security. In the model, access to markets will be represented by a variable that measures the distance a household is from the nearest market.

In the case of Ghana, there are many missing values for market distance. The missing

values are replaced with the average distance reported by all other households in the same village. This calculation should be a reasonable estimation since Ghanaian households tend to be clustered together, meaning that road distances should not be substantially different among households in the same village.

The second variable addressing food availability indicates the AEZ in which each household is located. The United States Environmental Protection Agency describes an AEZ as a "dynamic association of crops, pastures, livestock, other flora and fauna, soils, water, and the atmosphere. [AEZ's are] contained within larger landscapes, which include uncultivated land, drainage networks, rural communities, and wildlife" (2010). The different characteristics of AEZ's determine what crops farmers can grow and the productivity and reliability of crops. Naturally, AEZ's play a large role in food production and thus food availability in a region.

The Ugandan respondents all farm in three AEZ's present in Eastern Uganda. Mwebaze describes these zones in a 1999 FAO report. The first AEZ, the Teso Zone, is characterized by bimodal rainfall. The rainy season occurs from December to March, while the rest of of the year is primarily dry. Annual crops like millet, maize, sorghum and groundnuts are grown in this zone. The second AEZ is the Banana-Cotton-Millet Zone. This zone is somewhat drier than other AEZ's where bananas are typically grown . Because rain occurs in this zone less often, farmers also depend on annual crops that are more drought resistant. The final zone is the Montane Zone. This AEZ occurs in higher elevations between 1500m and 1750m above sea level. Rainfall is abundant here and the climate is more temperate than in the surrounding areas lower in elevation. Bananas are commonly grown here along with root crops live cassava, sweet potatoes and Irish potatoes.

The Ghanaian respondents farm in three AEZ's typical of southern and central Ghana. One AEZ is the Forest Zone. This AEZ receives more rain than the surrounding savannah zones

and can support perennial and tree crops. Kola and coffee, along with oil and coconut palms are commonly grown in this zone (E.M. Aregheore, 2009). A second AEZ is the Coastal Savannah Zone. This zone receives less rainfall than the Forest Zone (K. Oppong-Anane, 2001). As with other dry AEZ's, annuals like sorghum and millet are commonly cultivated in this zone. The final AEZ in the Transition Zone. This AEZ separates the forest and coastal savannah zones. As the name suggests, the zone is characterized by a mixture of Forest and Coastal Savannah Zone attributes. This AEZ is wetter than the savannah zone, yet farmers still depend mainly on annual crops.

All of the Ghanaian AEZ's have two periods of rainfall. This means that there are two growing seasons each year in these zones, a major and minor season. The major season occurs from March to July during the first rainy period and the minor growing season occurs in September and October, the second rainy period (K. Oppong-Anane, 2001).

Discrete variables are used to assign each Ugandan and Ghanaian household an AEZ. Because there are three AEZ in each country case, one is randomly assigned as the base variable, and left out of the model specification. For Uganda, the Teso AEZ is the base variable and for Ghana, the Transition AEZ is the base.

Access Variables:

As previously stated, food access refers to the resources households have available to use in order to acquire food. In this model, household resources are measured by the acreage farmed by each household. Other measures of household wealth and resources such as income, expenditures, or an account of household assets like livestock or farm machinery, could also be used. In fact, many of these measures would be better suited as measures of access, however, information on household assets was not collected in the survey. While total acreage is not the most precise or comprehensive measure, it is correlated with household wealth and thus used to

specify the household resource access.

This household acreage variable represents the total number of acres all the respondents of each household reported cultivating in the 2010 growing season[5]. This is the acreage for all crops grown by the household, including perennial crops such as bananas and coffee that were maintained or harvested in 2010, but not necessarily planted in that year. Where there are major and minor growing seasons, the reported cultivated acreage for both seasons was summed to obtain the total household acreage.

Utilization Variables:

The food utilization dimension tends to have the most determining factors and thus has the most variables specified in the model. The number of family members within each household is one variable. Family size obviously is a primary determinant of how much food a household demands and therefore is included in the model. Many studies also add variables that state how many children and working age adults live in a household. These have shown to be important factors in household food security. However, respondent reported data on family member characteristics are not reliable and therefore can not be used for this model. This variable represents a count of all members that participated in the survey as groundnut growers and all others living in the household.

Farming experience obviously plays a role in the outcome of a farming household. However, this influence can go both ways. Experienced farmers draw upon a wealth of accumulated knowledge to aid production, but may also be resistant to new and possibly beneficial change. Furthermore, experience and age are highly correlated and in regions like sub-Saharan Africa where farming is a physically demanding occupation, more experienced and therefore older farmers may not be as physically productive as their younger counterparts. For

5 A model using an alternate measure of household acreage is included in Appendix A

this model, farming experience is measured as the number of years the most experienced farmer within a household has been cultivating groundnuts.

Education is often used as an explanatory variable when modeling food security. As previously discussed, there are many reasons why education could play a role in food security. Assessing the level of education at the household level can be difficult when there are often multiple adults with varying levels of education within one household. For the sake of simplicity, the adult with the highest level of education is used as the measure for each household. Additionally, the variable is a discrete measure indicating if that adult has a secondary level of education or not. A household receives a one if any adult member has received nine or more years of education. For this study, any person over the age of 18 is considered an adult.

Agricultural extension services exists throughout sub-Saharan Africa. In theory, they disseminate knowledge and technology for the benefit of farmers. Naturally, utilization of extension services could influence a farmer's productivity and yield and in turn, the farmer's food security. Respondents reported if they visited an extension service office and also if an extension agent visited their household. The first measure was chosen to specify extension service use, because it can be assumed that farmers that make a proactive effort to visit an extension office would have more motivation to learn and adopt the knowledge and methods offered by the extension service. As a result, the contribution of the extension service would have a greater influence over the outcome of the household. A discrete variable measures if any groundnut growing members of a household visited an extension service. The variable is recorded as a one if there is a respondent within the household reporting that they contacted a extension service agent in the past two years.

Grower Gender Indicator and Cash Cropping Measures:

This model aims to describe the influence that groundnut cash cropping has on food security and how gender influences these effects. In order to do this, the model specifies five variables to establish the relationship between groundnut cash cropping intensity and food security. Gender interaction terms are then included to see if and how this relationship varies by gender.

The first of the two groundnut cash cropping measures examines how much of the household's farming efforts are concentrated on groundnuts. The ratio of land that each household dedicated to groundnut cultivation out of their total cultivated acreage in the 2010 growing season is used as the measure of groundnut dependency. The variable is the sum of cultivated acreage, across the minor and major growing seasons when applicable.

This ratio measure was chosen for several reasons. First, it was one of the most reliably reported measures. For many other possible measures, is was apparent that the farmers were giving their best, but not necessarily accurate guesses. Additionally, the use of a ratio is important for two reasons. First, it demonstrates the intensity of groundnut cultivation, rather than just the amount. This allows the estimation of how varying levels of dependence on groundnut cultivation affects food security. Second, it will not correlate with the measure of total acreage.

The second variable measures how much a household sells of its production. The variable is a ratio of how much a household reported selling out of how much they reported producing. This measure indicates the degree to which a household depends on groundnuts as a cash crop.

A discrete gender variable is included. This variable reports if the household has a female member that responded as a groundnut grower. The gender indicator variable is also multiplied

with the measures of groundnut cash cropping to create two interaction variables. The two interaction variables allow the model to disentangle the gender specific effects upon the relationship between food security and cash cropping.

These five variables allow for the examination of four questions about the interaction of groundnut cultivation, gender, and food security. First, how the level of household groundnut production affects food security? Second, how does the level of household groundnut marketing affect food security? Third, how does the gender of household groundnut growers affect household food security? Fourth, is the effect of groundnut cultivation or marketing upon food security dependent on gender? In other words, the interaction terms will isolate if there is different groundnut cash cropping effect upon food security for households with women growers and than for households with only men growers.

SPECIFYING THE MARKETING MODEL:

This thesis only estimates the tobit model using the Uganda household data . A tobit model using the Ghana household data is not estimated because nearly all households reported some degree of market participation. Because of this lack of variation, the Ghanaian data are not employed to examine marketing decisions.

THE DEPENDENT MARKETING MEASURE:

The censored dependent variable of the tobit model is the amount of unshelled groundnuts sold by each household. If a household has multiple groundnut growers that reported selling groundnuts, the individual totals are aggregated together into a total household sum. Respondents usually report the amount sold in various volume measurement units, the most common of which are gunny sacks, basins and tins. These volumetric units are converted into kilograms taking into account the density of unshelled groundnuts. The calculated aggregate mass of all unshelled groundnuts reported as sold by each groundnut grower in a household is the

final value of the dependent variable.

Households actually sold both unshelled or shelled groundnuts. Like unshelled groundnuts, respondents reported both the amount of shelled groundnuts and the price they received. The price per kilogram for shelled groundnuts is much higher than unshelled groundnuts because the density is greater and the labor intensive shelling process adds value to the product. The amount of shelled groundnuts is not included in the value of the dependent variable because there is no feasible way to combine the different prices and amounts of sold shelled and unshelled groundnuts into one relevant variable. However, a discrete variable is included in the model to indicate those households that sold any amount of shelled groundnuts to incorporate any potential influence this has on the model.

THEMARKETING MODEL EXPLANATORY VARIABLES:

The market participation model is specified by various control variables that describe the determinants of market participation set out by Strauss's model. The independent variables in the model again come from respondent reported data with the exception of the AEZ classification. As with the previous section, there is a description and rationale for the inclusion of each variable included in the model.

Price:

The price of unshelled groundnuts represents the price variable. Every respondent reported the price they received for selling their groundnuts. They reported the values in terms of Ugandan shillings per a given volumetric unit. The various units were converted to a uniform unit of Ugandan shilling (000's) per kilogram. Many of the households that did not sell any groundnuts also did not report the prices. Because price values for every household are needed for a proper model estimation the missing values are replaced with the average price reported by all other households that reported a price in the same village.

Household Characteristics:

Several variables are included in the household characteristics vector. Family size is included to represent the consumption of a household. As was previously stated, family size influences household consumption and therefore marketed surplus. Many studies also include variables that describe the composition of household members. Models developed by Geotz (1992) include the number of dependencies and Alene et al. (2000) include the number of adults in the household. These studies show that this type of information is useful in describing household consumption. Despite the relevance of information on family composition, it was not reliably reported and therefore is not included in this model.

The distance a household is to a market is a measure used to specify one aspect of transportation costs (Key (2000), Alene et al. (2000)). Households that are closer to a market spend less time and money getting their crops to market. Thus distance would tend to correlate with higher transportation costs and create barriers to market participation. This effect is specified as a discrete variable, adapted from Alene et al. (2000). Any household within 5km of a market is assigned a value of one.

Experience in marketing is specified with a variable indicating age of the household head (Geotz 1992, Barrett and Bellemore 2006). The age of the household is calculated in much the same as the household experience in the previous model. The age of the oldest responding groundnut grower is used as the household age.

Education level is used to measure the ability of a household to utilize available information. More educated people tend to be able to comprehend and utilize information that is helpful in making marketing decisions. This capability may make more educated people more likely to participate in markets. Additionally, access to information has been empirically shown to play a role in market participation since Geotz initiated these studies. Various indicators have

been used such as market membership (Key et al. 2000) or cell phone usage (Alene et al., 2000). This thesis will use information on households' utilization of extension services to measure this effect. The model uses the discrete variable described in the food security model section.

Exogenous Income:

Exogenous income is the household income that does not come from the selling of groundnuts. The non-groundnut income is a summation of all reported household income withholding the income from the selling of unshelled groundnuts. Household income is reported by each respondent. If there is a difference between respondents under the same household, the value stated by the household head is used. If the household head did not report the income, and there is a discrepancy among respondents, the highest value was used. Groundnut income was calculated by multiplying the amount sold by the price received. The non-groundnut income is simply the difference between total reported income and groundnut generated income. As with prices, the value is reported in Ugandan shillings (000's). In some cases the groundnut generated income is actually higher than the reported total household income. This only occurs in 4% of households, and is most likely due to inaccuracies on the part of the respondent. In these cases the value of this variable is reported as zero.

Farm Characteristic:

There are two variables that influence crop production that are included in the farm characteristic vector. One variable indicates the land dedicated to cultivatin
g the marketed crop. This variable is obviously important and incorporated in most models (Geotz 1992, Key 2000, Barrett and Bellemore 2006). In this model, the variable is specified as land dedicated to groundnut cultivation. Household groundnut acreage is calculated in the same fashion as total acreage in the previous model. Additionally, AEZ's influence the productivity of groundnuts and thus marketed surpluses. The AEZ's are the same ones included in the food

security model and are again specified as discrete variables. Also, the same AEZ's are left out of the model specification as base variables.

Gender Role Indicators:

This model aims to describe the influence that gender has on market participation. Two discrete variables are specified to examine this effect. One is a discrete variable that indicates if there are female groundnut growers within a household. This variable is multiplied by another discrete variable that indicates if the respondent participates in marketing decisions within the household. Thus, this interaction variable indicates which households have female groundnut growers contributing to marketing decisions. These variables indicate if gender affects market participation, concerning both the likelihood and amount of participation. Furthermore, the interaction variable disentangles differences in market participation among women growers participating in marketing decision making and those that are not.

CHAPTER 5: DATA

This chapter presents an analysis of the data used used to estimate the models in this thesis. A brief explanation is provided about the survey from which the data originates. Descriptive statistics of the variables used in both models are then presented.

THE SURVEY DATA:

The data used in this thesis comes from survey data collected in the summer of 2011 in Ghana and Uganda. The information was collected by local, trained enumerators that personally interviewed each member that grew groundnuts of selected households. Information on growing practices for the last (2010) agricultural season, household and farm characteristics, market access and prices, and availability and use of extension services was collected from all household members who reported growing groundnuts. Additionally, a survey was completed by the main household cook on weekly diet of the household, occurrence of food shortages, and consumption differences between household members.

The surveys were conducted in 40 villages in the Eastern region of Uganda and 12 villages in central Ghana. The method of selecting the surveyed villages and survey participants differed between Uganda and Ghana. To select the villages in Uganda, a 1.5 mile buffer was created around the road network of the Eastern Region using GIS software. Twenty villages within the buffer were selected along with twenty villages outside the buffer. The village leader of each selected village provided a list of all groundnut growing households in the village and ten households were randomly selected from the list. In Ghana, the survey also sought to address effectiveness of farmer field schools (FFS). Thus six village containing FFS's were selected , along with six nearby villages without farmer field schools. Within each village, thirty household were randomly selected to complete the survey.

Most of the variables used in this thesis are based on recall of respondents' past activities. Recall data by farmers contains inherent errors due to intentional strategic behavior or simple approximations or guesses.

THE FOOD SECURITY MEASURE:

The dependent variable for the food security model is the FCS described in the Model Specification Chapter. Along with the scoring system, the WPF developed country specific classifications of food security based on the FCS's. These categories are unique to each country survey. Tables 5.1 and 5.2 show the results from the FCS survey used in this thesis compared with the results of WPF Surveys in Uganda and Ghana, respectively. The WFP developed the categories to represent both the quantity and quality of food that a household is consuming. For example, a Ugandan household that receives a “poor” score tends to not consume enough calories, and the calories they do consume tend to come from a few, starchy sources such as sorghum or millet. On the other side, a household that is scored as “good” consumes an adequate amount of calories and consumes a variety of foods, regularly eating different vegetables and meats. The middle two scores fall in between those two descriptions. While the WFP create different labels for Ghana, the Ghanaian categories are described in much the same way. In both country cases, households receiving the bottom two scores are considered food insecure while those scoring in the top two categories are considered food secure.

The survey data used in this thesis closely matches the WFP national survey figures. Among the Ugandan respondents, the scores range from .0625 to 1, and from .254 to 1 among the Ghanaian respondents. In Uganda slightly over half the respondents scored as food insecure. In Ghana the share is much lower. Less than 6% of respondents reported a score that classified them as food insecure. However, the FCS scores should be taken with a grain of salt. There is a evidence that the FCS scores can underestimate the true food insecurity present in a region.

However, the cutoff point for food consumption scores will not be a factor in this thesis as the analysis is conducted on the scores and not the discrete food security classifications. This thesis is only concerned with how household decisions impact household food security. This means that only the relative change of the score due to the impact of household decision and other various factors will be important, not the score itself.

Table 5.1: Uganda Food Consumption Score Statistics

Food Consumption Category	Food Consumption Score	% of Households, (Survey Data)	% of Households, (WFP National Survey 2005)
Very Poor	0<FCS≤.3	11.5%	15%
Poor	.3<FCS≤.56	44.4%	37%
Fairly Good	.56<FCS≤..74	24.9%	26%
Good	.74<FCS≤1	19.2%	22%

Table 5.2: Ghana Food Consumption Score Statistics

Food Consumption Category	Food Consumption Score	% of Households (Survey Data)	% of Households, (WFP National Survey 2009)
Poor	0<FCS≤.25	0.0%	2%
Borderline	.25<FCS≤.375	6.1%	4%
Acceptable-Low	.375<FCS≤.465	8.7%	9%
Acceptable-High	.465<FCS≤1	85.2%	86%

THE FOOD SECURITY MODEL EXPLANATORY VARIABLE STATISTICS:

Descriptive statistics for model independent variables are reported in Tables 5.3 for Uganda and Table 5.4 for Ghana. Notable characteristics of the statistics are described in this section. When the variable statistics between countries are compared, it is clear they are remarkably similar. The statistics for household acreage, market proximity, households with a member attaining a secondary level of education, and household groundnut growing experience

are all close in value across the two countries. There are, however, some notably differences. Ugandan households tend to have larger families than their Ghanaian counterparts. Additionally, Ghanaian household contacted extension services more frequently than the Ugandan households.

With respect to groundnut cultivation, the two countries differ quite a bit. Ugandan households only dedicate on average 28.6% of their cultivated acreage to groundnuts, while Ghanaian household dedicate approximately 50% of their available acreage to groundnuts. This may be a result of preferences. Groundnuts are a much more significant part of the Ghanaian diet than the Ugandan diet. It may be that Ghanaian farmers prefer to grow groundnuts for their own consumption and to sell in a market with greater local demand. Only 36.3% of Ugandan households report a women groundnut grower, while the figure is 50.6% in Ghana. This fact suggests that groundnut cultivation is more dominated by males in Uganda, while there is not a great deal of gender dominance in cultivation in Ghana.

Table 5.3: Uganda Food Security Model Overall Statistics

Variables	Mean	Std. Deviation	Minimum	Maximum
400 Household Observations				
FCS Score	0.547	0.198	0.0625	1
Total Household Acreage (Ac)	5.670	4.089	0.5	28
No. of Family Members	8.185	3.639	1	26
Years of G. Nut Growing Exp.	12.481	11.366	1	65
Adult w/ Secondary Edu.*	0.303			
Distance from market (km)	6.122	6.260	0.01	60.992
Teso Zone*	0.512			
Montane Zone*	0.103			
BMC Zone*	0.385			
If Contacted Ext. Service*	0.278			
If women G. Nut Growers*	0.363			
G. Nut Acreage Ratio	0.286			
G. Nut Sold Ratio	0.351	0.323	0	1
Interaction: G. Nut Ac. Ratio	0.103	0.173	0	1
Interaction: G. Sold Ratio	0.106	0.235	0	1

*Discrete Variables

Table 5.4: Ghana Food Security Model Overall Statistics

Variables	Mean	Std. Deviation	Minimum	Maximum
310 Household Observations				
FCS Score	0.576	0.135	0.25446	1
Total Household Acreage (Ac)	5.701	5.233	0.5	31
No. of Family Members	6.272	3.171	1	24
Years of G. Nut Growing Exp.	12.979	10.624	1	50
Adult w/ Secondary Edu.*	0.285			
Distance from market (km)	5.201	4.068	0	16
Transition Zone*	0.644			
Forest Zone*	0.201			
Coastal Savannah Zone*	0.155			
If Contacted Ext. Service*	0.417			
If women G. Nut Growers*	0.508			
G. Nut Acreage Ratio	0.510			
G. Nut Sold Ratio	0.562	0.387	0	1
Interaction: G. Nut Ac. Ratio	0.313	0.397	0	1
Interaction: G. Sold Ratio	0.335	0.419	0	1

*Discrete Variables

Tables 5.5 and 5.6 display the average acreage farmed by respondent households and the average percentage of cultivated land each household dedicated to groundnut cultivation, separated by their AEZ. As one would expect, farmers in zones that are preferable for groundnut cultivation like the Teso and B-C-M Zones dedicate more of their land to groundnuts. Interestingly, surveyed farms in the Montane Zone's tend to be somewhat larger than farms in the other two zones. However, farms in the Montane Zone are usually smaller than farms elsewhere, because of the favorable climate for agriculture. The reported average farm size in this zone is 1.5 hectares, while farms in the Teso and the B-M-C Zones average 3 hectares (Mwebaze, 1999). This is probably because groundnuts are not typically grown in the Montane Zone, as the plant prefers warmer and drier climates zone. This oddity of the data may be because only farmers

with more available land would grow groundnuts in the Montane zone and thus be included in the survey.

Table 5.5: Ugandan AEZ Farm Characteristics

	Observations	Total Acreage	G. Nut Share
Teso Zone	205	5.72	.275
B-C-M Zone	154	5.34	.260
Montane	41	6.28	.161

Table 5.6: Ghanaian AEZ Farm Characteristics

	Observations	Total Acreage	G. Nut Share
Transition Zone	200	6.55	.445
Forest Zone	62	4.50	.710
Coastal Sav. Zone	48	3.74	.517

Table 5.6 shows that among Ghanaian households, farmers in the Forest Zone dedicate the highest percentage of their land to groundnut cultivation, followed by those in the Coastal Savannah Zone and then the Transition Zone. However, one would expect that this would not be the case. Groundnuts prefer the drier climates of the transition zone and the coastal Savannah zone. This unexpected result may be explained by the fact that the forest zone is more densely populated than the surrounding arid regions. Households near population centers may desire to grow groundnuts to sell at nearby markets, while farmers in the more remote savannah regions face higher costs to reaching a market and may choose to dedicate less land to groundnut cash cropping.

GROWER GENDER SPECIFIED HOUSEHOLD CHARACTERISTICS:

Table 5.7 and 5.8 divide the Ugandan and Ghanaian household between those that have women groundnut growers and those that do not. For Uganda there are 145 households with at

least one women groundnut grower, compared to 255 households with no women growers. The FCS is very similar among the Ugandan respondents, along with the age and groundnut growing experience. However solely male grower households reported cultivating both more total acreage and more acreage dedicated to groundnuts. As a result, both household types dedicate approximately 25% of their land to groundnut cultivation. In terms of education and training, the most educated member of a solely male household on average attended approximately two more years of school than the most educated member of households with women growers. Furthermore, households with solely males were more likely to have member with a secondary education and more likely to contact an extension service.

In Ghana, 157 have women groundnut growers while 152 household are composed of solely male growers. As in Ugandan households, the FCS, age, and experience of both household types are very similar. However, the average solely male household reported cultivating significantly more total land and dedicating more land to groundnuts. While households with women growers did dedicate less land to groundnut cultivation, they dedicated much more of their total land to groundnuts as a percentage of total acreage than their solely male counterparts. Households with women growers dedicated 40% of the land they cultivated to groundnuts, while solely male households only dedicated 27%. Solely male grower households reported receiving an average of 4.4 years of education, while households with women growers reported receiving only 2.9 years on average. Like Uganda, solely male households tend to be more educated. However, unlike Uganda, both household types tend to have the same likelihood of contacting an extension service.

Table 5.7: Uganda Food Security Model Statistics Divided by Grower Gender

	Mean	Std. Deviation	Minimum	Maximum
Households with Women Growers				
No. of Households: 145				
FCS	0.559	0.211	0.0625	1
Total Acreage (Ac)	5.305	4.345	0.5	28
Total G. Nut Acreage (Ac)	1.314	1.212	0	7
Age	44.131	13.123	20	88
Education	5.593	4.006	0	16
If Secondary Educated	0.207			
Experience	11.224	9.950	1	40
If Contacted Ext. Service	0.241			
Households with only Men Growers				
No. of Households:.255				
FCS	0.539	0.191	0.103	1
Total Acreage (Ac)	5.878	3.930	1	27.5
Total G. Nut Acreage (Ac)	1.501	1.123	0	8
Age	46.610	14.121	18	96
Education	7.176	3.951	0	17
If Secondary Educated	0.357			
Experience	13.196	12.058	1	65
If Contacted Ext. Service	0.298			

Table 5.8: Ghana Food Security Model Statistics Divided by Grower Gender

	Mean	Std. Deviation	Minimum	Maximum
Households with Women Growers				
No. of Households: 157				
FCS	0.554	0.139	0.254	1
Total Acreage (Ac)	4.146	4.555	0.5	30
Total G. Nut Acreage (Ac)	1.613	1.085	0.25	7
Age	43.244	14.541	20	90
Education	2.911	4.390	0	15
If Secondary Edu.	0.229			
Experience	13.312	11.111	1	50
If Contacted Ext. Service	0.401			
Households with only Men Growers				
No. of Households: 152				
FCS	0.599	0.128	0.326	0.973
Total Acreage (Ac)	7.306	5.414	0.5	31
Total G. Nut Acreage (Ac)	1.954	1.505	0	12
Age	45.566	14.653	19	80
Education	4.651	5.368	0	17
If Secondary Edu.	0.342			
Experience	12.635	10.121	2	50
If Contacted Ext. Service	0.434			

THE MARKETING MODEL VARIABLE STATISTICS:

There are 378 Ugandan households used in the marketing model sample. There are slightly fewer in this model, than in the food security model because some variables in this model have more missing observations. Table 5.9 reports the descriptive statistics for the variables used in the the marketing model.

The variables concerning secondary education, household size, extension service contact, AEZ's, and women growers within the household are all calculated the same way as the previous

model. Any differences in the statistics occur because of the difference in the households sample used in the model

The exchange rate for a Ugandan shilling in 2010 was approximately 2,000 shillings for one USD (oanda.com, 2013). This means that the groundnut prices ranged from just a few pennies per kilogram to 1.80 USD per kilogram. However, the average was 1322 shillings or .67 USD. These values vary quite substantially ranging from household reporting no income outside of groundnut production to a household income of 30,000,000 shilling or approximately 15,000 USD. The average exogenous household income of 1,383,218, or 680 USD, is more on par with what one would expect to see in the Eastern region of Uganda with the Ugandan Bureau of Statistics reporting a mean household income of 2,058,000 shillings (UNHS, 2010).

Table 5.9: Marketing Model Overall Statistics

	Mean	Std. Deviation	Minimum	Maximum
Amount of G. Nuts Sold	90.925	164.689	0	1150
Price received (per kg)	1317.846	532.051	90	3200
If Secondary Education*	0.298			
Age of Household Head	46.280	13.405	18	96
No. of Family Members	8.188	3.576	1	21
If Shelled G. Nuts Sold*	0.131			
Total G. Nut Acreage	1.429	1.174	0	8
Non G. Nut Income	1383218	2432613	0	30000000
If market is with 5km*	0.560			
If Contacted Ext. Service*	0.414			
Montane Zone*	0.107			
BMC Zone*	0.372			
Market Decision Maker*	0.348			
If women grower *	0.220			

*Discrete Variable

SELLER SPECIFIED HOUSEHOLD CHARACTERISTICS:

In table 5.10 the households are split between those that reported selling groundnuts and those that did not. Approximately 60% of households reported selling some amount of groundnuts. Descriptive statistics for many variables between the two groups are similar. The values for groundnut price, if a household member attained a secondary education level, the age of household, if they are within five km of a market, and the AEZ in which the household is located are all very close.

There are also some notable differences. On average there is almost one more member for households that did not sell than for households that did sell groundnut. Households that sold groundnuts dedicate more than one half acre more to groundnut cultivation than their non-selling counterparts, equivalent to 50% more land dedicated to groundnut cultivation. Furthermore, groundnut selling households reported almost 300,000 shillings (150 USD) more in non-groundnut generated income than non-selling households. Households selling groundnuts are also more likely to contact an extension service agent and have solely male groundnut growers. Just over 45% of groundnut selling households have a member contact a extension service office, while only 31% of non-selling households did so. While one third of groundnut selling households have a women grower, just under 40% of non-selling households have at least one women grower.

Table 5.10: Marketing Model Statistics Divided by Marketing Choice

	Mean	Std. Deviation	Minimum	Maximum
Households Where Groundnuts are Sold				
No. of Households: 243				
Amount of G. Nuts Sold	142.936	187.713	5	1150
Price received (per kg)	1303.030	561.099	90	3200
If Secondary Education*	0.305			
Age of grower	45.469	13.263	18	96
No. of Family Members	7.975	3.447	1	20
If Shelled G. Nuts Sold*	0.152			
Total G. Nut Acreage	1.653	1.244	0	8
Non G. Nut Income	1466586	2673222	0	30000000
If market is with 5km	0.547			
If Contacted Ext. Service	0.465			
Montane Agroecosystem*	0.115			
BMC Agroecosystem*	0.354			
If women grower *	0.325			
If women decision maker*	0.218			
Household Where No Groundnuts are Sold				
No. of Households: 139				
Price received (per kg)	1343.747	477.896	200	2600
If Secondary Education*	0.288			
Age of grower	47.698	13.580	22	91
No. of Family Members	8.561	3.775	1	21
If Shelled G. Nuts Sold	0.094			
Total G. Nut Acreage	1.038	0.922	0	6
Non G. Nut Income	1237474	1942296	38000	11000000
If market is with 5km	0.583			
If Contacted Ext. Service	0.324			
Montane Agroecosystem*	0.094			
BMC Agroecosystem*	0.403			
If women grower*	0.388			
If women decision maker*	0.223			

*Discrete Variable

CHAPTER 6: RESULTS

RESULTS OF THE FOOD SECURITY MODELS:

Heteroskedasticity:

Heteroskedasticity, or non-constant variance in the error term, is tested for in both models using a White test and a Breusch-Pagan test. The White test assumes a linear relationship between the error term and the independent variables, while the Breushc-Pagan test allows for a non-linear relationship. Table 6.1 shows that the null hypothesis of homoskedasticity is rejected in the Uganda model, but not in the Ghana model. In order to make valid inferences with t-statistics for hypothetical testing, the presence of heteroskedasticity is corrected for in the Uganda model by estimating robust standard errors.

Table 6.1: Error Consistency Tests

	Test	Null Hypothesis	X^2	p-value	Result
Uganda	White	Homoskedasticity	143.24	.0003	H_0: Rejected
	Breusch-Pagan	Constant Variance	25.24	.0214	H_0: Rejected
Ghana	White	Homoskedasticity	80.94	.9601	H_0: Cannot be Rejected
	Breusch-Pagan	Constant Variance	16.16	.2406	H_0: Cannot be Rejected

Interpretation of the Food Security Models:

Tables 6.2 presents the food security model estimation results for Uganda. The t-statistic values are tagged with asterisks to indicate the statistical significance at the conventional p=.01, p=.05, and p=.10 levels. The continuous variable coefficients are interpreted as the change in the FCS that corresponds to a one unit change in the independent variable. For example, in the Uganda model, an increase of one acre of total household farmland relates to a small FCS increase of .01, all else equal. Discrete variables represent a unit-intercept shift. Using household education as an example, Ugandan households with an adult member having attained

a secondary education have a FCS almost .06 higher than an otherwise similar household that does not have an adult with secondary education.

The R^2 value for this model is somewhat low. Both models explain less than 20% of the observed variation in the household FCS. The lack of overall explanatory power of the models contrasts with the fact that the majority of the independent variables in both models are statistically significant (p= .10). While statistically significant, some variable parameter estimates are associated with relatively small changes to the FCS that are economically insignificant. For instance, in the Uganda model, an extremely large increase in household acreage of five acres only relates to a FCS increase of slightly over .05, not even a 10% change from the average FCS. Despite the disappointing overall explanatory ability of the model, the results still shed light on the specific thesis questions. The parameter estimates for each model are now discussed separate.

Analysis of the Uganda Food Security Model:

Table 6.2: Uganda Food Security Model Parameter Estimations

Observations: 400			**R^2: .1524**
Variables	**Coefficient**	**Robust Std. Error**	**t-Statistic**
Total Household Acreage (Acre)	0.0100	0.0031	3.21***
Family Size	-0.0047	0.0028	-1.66*
Years of G. Nut Growing Exp.	-0.0016	0.0009	-1.72*
Adult w/ Secondary Edu.	0.0595	0.0224	2.66***
Distance from a Market	0.0018	0.0014	1.29
Montane Zone	0.0978	0.0311	3.15***
B-M-C Zone	0.0447	0.0198	2.25**
If Contacted Ext. Service	0.0396	0.0219	1.81*
If women G. Nut Growers	0.0643	0.0450	1.43
G. Nut Acreage Ratio	0.0145	0.0779	0.19
G. Nut Sold Ratio	0.0488	0.0353	1.38
Interaction: G. Nut Acreage Ratio	-0.0862	0.1389	-0.62
Interaction: G. Sold Ratio	-0.0184	0.0664	-0.28
Intercept	0.4478	0.0399	11.22***
*: p-value=.1, **: p-value=.05, ***: p-value=.01			

Table 6.3: Uganda Gender Specific Parameter Estimations

Variables	**Solely Men Grower Households**	**Men and Women Grower Households**
Acreage Ratio of G. Nuts	0.0145	-0.0717
Ratio of G. Nuts Sold	0.0488	0.0304
Intercept	0.4478	0.5121

Most of the variables in the Uganda Model have coefficient values that correspond to theory or past empirical findings. Total household acreage and secondary education variables are positively related to FCS scores, while family size shows a negative relationship (p=.10)[6]. The

6 Variables have a statistical significance level of p=.05 or less, unless otherwise noted in the text

sign for the years of household groundnut growing experience is also negative (p=.10). This suggests the detrimental effects of age upon the physically demands of groundnut production may outweigh the possible productivity gains from acquired skills and knowledge. The discrete variables representing the AEZ's indicate that households located in the less arid Montane and B-M-C Zones have significantly higher FCS's, suggesting that these AEZ's may be more favorable to agriculture. Furthermore, extension service contact has a significant and positive relationship to household FCS.

One variable that does seem to contradict assumptions is the measure of distance to market. The variable parameter estimate is not significant, which does not support the hypothesis that being closer to a market reduces barriers to trade and in turn benefits household FCS. The lack of an estimated relationship may be because the variable is a crude indicator of market transaction costs or the distances to markets are too small to significantly impact the FCS.

Turning now to the groundnut grower gender indicator, the Uganda model shows a positive relationship between this variable and household FCS's. The model parameter estimates indicate that the presence of women groundnut growers result in a 0.06 increase in the household FCS. For an average Ugandan household in this sample, this is equivalent to a 13% increase. However, the parameter estimate is just outside the bounds of conventionally accepted statistical significance. Despite the weak relationship, the result suggests that households with women growers may have higher FCS's.

Looking next at the two groundnut cash cropping measures, the groundnut acreage ratio and the ratio of sold groundnuts are not significantly related to household FCS. Additionally, the interaction variables used to allow the groundnut cash cropping decisions to impact household FCS's differently by gender are also not statistically significant. The lack of significance in the interaction terms is not entirely surprising because the variables used to generate the interaction

terms are themselves not significant.

Table 6.3 displays the gender specific parameter estimates of the groundnut cash cropping measures. The terms can be interpreted as two categories; households with solely men growers and those with growers of both genders. The parameter estimates of the interaction terms identify the differences between the two groups.

It may be noticed that the results of Table 6.3 appears to show that women growers negatively impact the relationship between the groundnut cash cropping measures and the household FCS. The parameter estimates for both groundnut measures are lower for households with women groundnut growers. This could be seen as evidence of women growers' negative impact, yet, it must be stressed that these relationships are not statistically significant and therefore this negative trend is suggestive at best.

Analysis of the Ghana Food Security Model:

Table 6.4: Ghana Food Security Model Parameter Estimations

Observations: 309			**R^2: .1637**
Variables	**Coefficient**	**Standard Error**	**t-Statistic**
Total Household Acreage (Acre)	-0.0018	0.0019	-0.94
Family Size	0.0068	0.0025	2.7***
Years of G. Nut Growing Exp.	-0.0016	0.0007	-2.22**
Adult w/ Secondary Edu.	0.0418	0.0173	2.42**
Distance from a Market	0.0039	0.0023	1.71*
Forest Zone	-0.0235	0.0241	-0.98
Coastal Savannah Zone	-0.0286	0.0224	-1.28
If Contacted Ext. Service	0.0364	0.0156	2.34**
If women G. Nut Growers	0.0513	0.0337	1.52
G. Nut Acreage Ratio	0.0241	0.0363	0.66
G. Nut Sold Ratio	-0.0466	0.0287	-1.62
Interaction: G. Nut Acreage Ratio	-0.0644	0.0439	-1.47
Interaction: G. Sold Ratio	-0.0360	0.0406	-0.89
Intercept	0.5470	0.0360	15.2
*: p-value=.1, **: p-value=.05, ***: p-value=.01			

Table 6.5: Ghana Gender Specific Parameter Estimations

Variables	**Solely Men Grower Households**	**Men and Women Grower Households**
Acreage Ratio of G. Nuts	-0.0644	-0.0403
Ratio of G. Nuts Sold	-0.0360	-0.0825
Intercept	0.5470	0.5983

Tables 6.4 presents the food security model estimation results for Ghana. The variable coefficients are interpreted in the same manner as the Uganda model. The results for many of the Ghana food security model variables do not conform to expectations. One of the most surprising

results is that the household acreage variable is not significantly related to the FCS's. This result suggests that household acreage may not be an accurate indicator of household resources and is also not strongly correlated with other factors that determine food security among the Ghanian households. Additionally, family size is positively related to the FCS's, meaning larger household generally have a higher household FCS . One explanation may be that many of the households have adult members that contribute to the household food security, thus more members results in higher FCS's. The model does not account for this possibility, because is does not control for household member composition and thus cannot disentangle the different influences of heterogeneous household members. On the other hand, the result may stem from Ghanaian culture. It is common for wealthier households to take in the dependents of less well off relations. This would mean that larger households would also tend to be wealthier households and, therefore, have higher FCS's. The sign of the distance to market indicator is positive in the Ghana model (p=.10), suggesting that households further from markets have higher FCS's. There is no credible suggestion of why farther distances to markets may actually be beneficial.

The remaining control variable coefficients have more straight forward and expected interpretations. The explanation for the negative sign of the experience variable coefficient in the Uganda model can be applied to this model. The discrete variables representing the AEZ's show that households located in either the Forest or Coastal Savannah Zones do not have any measurable differences in FCS's compared to households in the Transition Zone, the base AEZ. Finally, like with the Ugandan model, the extension service variable suggests that the service accessed by farmers increase household FCS's.

The Ghana model tells a similar story to the Uganda model regarding the gender indicator and the groundnut cash cropping measures and their interaction. As with the Uganda model, the

discrete gender indicator suggests that households with women growers have higher FCS's, but again the relationship is not significant at conventional levels. According to the model, the presence of women groundnut growers results in a 0.05 increase in the FCS.

The parameter estimates of the groundnut cash cropping measures along with the interaction terms show no statistical significance. Like with the Uganda model, this indicates that there is no measurable relationship between the household FCS and either the groundnut acreage ratio or the ratio of groundnuts sold. Furthermore, the insignificant parameter estimates of the interaction terms show that groundnut gender does not influence the groundnut cash cropping measures' effects on the FCS. Table 6.5 displays the gender specific parameter estimates of the groundnut cash cropping measures. The interpretation of the variable coefficients is the same as Table 6.3. Again, the parameter estimates for both groundnut measures are lower for households with women groundnut growers, but because of the statistical insignificance of the estimates, the result does not carry much weight.

RESULTS OF THE MARKETING MODEL:

Interpretation of the Marketing Model:

The aim of this model is to examine the two marketing decisions of Ugandan households; the decision to market groundnuts and the decision concerning the amount to market. Table 6.6 presents the parameter estimates for the amount of groundnuts marketed. The parameter values can be interpreted in the same way as the previous linear OLS regression model. In the case of continuous variable, the parameter coefficient is the estimated change to the amount marketed resulting from a one unit change in the variable, while the discrete variables represent a unit-intercept shift.

The other decision concerns the binary decision to market groundnuts or not. This is examined as the likelihood that a household markets any portion of their groundnut production.

In order to obtain the parameter estimates of impacts on the percent likelihood of participation, it is necessary to estimate the marginal effects of this model. Essentially, this entails isolating the results of the probit model used to censor the dependent observations in order to estimate the final tobit model. Table 6.7 presents the results of the underlying probit model.

Unlike the previous estimates for marketed amount, the probit model estimates are non-linear. This means that the estimated marginal effects depend on the values of the explanatory variables. Table 6.7 present the marginal effects of a household characterized by the mean values for all continuous variables and the most likely outcome for the discrete variables. This means that all discrete variables are zero except for the market proximity indicator, which is one. The marginal effects are interpreted as a percentage change in the likelihood of participation due to a one unit change in the explanatory variable. For example, a household with an additional year of age of the household head is .3% less likely to market their groundnut production.

Analysis of the Marketing Model:

Many of the explanatory variable parameter estimates have straight forward interpretations that conform to theoretical assumptions or empirical evidence. Family size is negatively related to market participation, the underlining theory being that larger families demand more food and thus the household has less marketable surplus. More acreage dedicated to groundnut cultivation relates to more market participation. In fact, there is quite a large effect associated with this relationship. One additional acre correlates with a 20% greater likelihood of participation and nearly 80kg more groundnuts sold. Like with the food security model, the extension service indicator is positively related to the dependent variable. Contacting an extension service leads to a 10% greater chance of marketing groundnuts and selling 50 additional kilograms. This indicates that households utilizing extension services are participating in markets to a higher degree. Interestingly, household education level does not significantly

affect market participation as households having members with a secondary education is not significant in either the participation or the amount marketed equations. Furthermore, household age has a negative impact on market decisions. Households headed by older members are less likely to sell groundnuts and they also sell less of them. But the parameter values are small, so the effect is minimal. Additionally, as with the Uganda food security model, both AEZ indicators show a positive relationship compared to the base Teso AEZ. In both cases households in the Montane and B-M-C Zones are nearly 20% more likely to market groundnuts and sell over 50kg more than otherwise similar households in the Teso Zone. One assumes this is because the climates more favorable to groundnut cultivation result in higher productivity and therefore more marketed surplus.

Surprisingly, the parameter estimate for price is insignificant. Standard theory states that as price goes up suppliers would respond by selling more to take advantage of the price increase. The lack of a significant relationship suggest that farmers see raising prices as a sign of scarcity and may hold back selling their stock in favor of consuming it. Related to this, the insignificance of the price parameter estimate may be due to transaction costs. High transactions costs tend to deaden the responsiveness of market participants (Omamo, 1998). If the costs of accessing price information is prohibitively high, the producer will not be able to effectively react to price signals.

The parameter estimate for exogenous income (total income excluding groundnut generated income) is not significant. This indicates that exogenous household income does not seem to play a significant role in market decision making, contrary to established theory (Strauss, 1984). However, the data supplied by surveyed farmers to calculate this statistic is somewhat suspect. It is evident that many farmers were merely hazarding guesses regarding their income. Because of this lack of accuracy, the income result should not be given much weight.

The parameter estimate of the discrete market proximity indicator is also not statistically significant. This weak relationship strengthens the argument previously proposed that market proximity is a crude indicator of transactions costs. In this case, it suggests that the farmers are selling their groundnuts using alternative methods. Perhaps they are selling to middle men that come to their farms or they are selling at specialized groundnut markets, the location of which was not indicated on the survey. Whatever the reason, the market indicator used in the model does not indicate any significant relationship between market distance and the market participation.

Turning now to the variables of interests, the model indicates no significant relationship between the gender indicators and household marketing decisions. There is no difference in the marketing decisions between households with women groundnut growers and those with only men growers. The same holds true for households where the women growers participate in marketing decisions. Essentially, household marketing decisions do not depend on the gender mix of groundnut growers or if the women growers participate in household marketing decisions.

Table 6.6: Marketed Amount Parameter Estimations

Variables	Coefficient	Standard Error	t-Statistic
Price received (in 0000's/ kg)	-0.012	0.0194	-0.64
If Secondary Education	8.572	23.8496	0.36
Age of Household Head	-1.784	0.7744	-2.30**
No. of Family Members	-7.254	2.9850	-2.43**
If Shelled G. Nuts Sold	29.285	29.6546	0.99
Total G. Nut Acreage	95.764	8.9175	10.74***
Non G. Nut Income (in 0000's)	5.49E-06	4.16E-06	1.32
If market is with 5km	-25.134	20.7367	-1.21
If Contacted Ext. Service	50.669	23.2377	2.18**
Montane Zone	78.367	34.5589	2.27**
BMC Zone	68.721	22.1935	3.10***
If women grower	-20.683	32.2457	-0.64
Market decision maker	10.268	28.3152	0.36
Intercept	9.789	51.2328	0.19
*: p-value=.1, **: p-value=.05, ***: p-value=.01*			

Table 6.7: Market Participation Likelihood Marginal Effects

Variables	Coefficient	Standard Error	t-Statistic
Price received (in 0000's/ kg)	-0.273	0.423	-0.64
If Secondary Education	0.0187436	0.0520193	0.36
Age of Household Head	-0.0039008	0.0017029	-2.29**
No. of Family Members	-0.0158605	0.0065367	-2.43**
If Shelled G. Nuts Sold	0.0640321	0.064679	0.99
Total G. Nut Acreage	0.2093872	0.0210819	9.93***
Non G. Nut Income (in 0000's)	1.20E-04	9.13E-05	1.32
If market is with 5km	-0.0549554	0.0447562	-1.23
If Contacted Ext. Service	0.1107872	0.050554	2.19**
Montane Zone	0.1713498	0.0745609	2.3**
BMC Zone	0.1502584	0.048148	3.12***
If women grower	0.0224501	0.0618231	0.36
Market decision maker	-0.0452233	0.0705989	-0.64
*: p-value=.1, **: p-value=.05, ***: p-value=.01*			

CHAPTER 7: DISCUSSION

DISCUSSION OF THE FOOD SECURITY MODELS:

The results of this thesis suggest a considerably more nuanced view of the impact of groundnut cash cropping than what has been previously put forth. Both the Uganda and Ghana models indicate no measurable relationship between groundnut cash cropping decisions and food security. However, the reasons behind this apparent lack of a relationship are not identified in the models. One explanation may be that groundnut cultivation is displacing food crop production, resulting in no net food gain for the household. On the other hand, the lack of a response could also be due to the relationship between groundnut cash cropping decisions and household income. It may be that groundnut cash cropping does not alter total household income. Any additional income from groundnut earnings could be offset by additional production costs or by income loss due to reduced production of another crop. It may also be the case that changes to groundnut production and marketing could lead to changes in household income, but the income change does not induce any change in the household food security status. For instance, increased groundnut cash cropping could lead to more income, but the additional income is used to purchase food that the household would otherwise have produced themselves. Households may also spend additional earned income on other goods and services that do not influence food security, such as bicycles or school fees. The numerous possible reasons why cash cropping decisions fail to influence food security once again illustrate the complexity of the relationship.

One might speculate that who in the household receiving the income from groundnuts influences food security impacts, but gender composition of household growers is found to not affect how groundnut production and marketing influence food security. The results of the

models support the conclusion that groundnut cash cropping decisions affect food security in households with women growers no differently than in households with only men growers, which is to say that there is no measurable cash cropping effect for either household type. So, while the models suggest that women groundnut growers do positively influence food security, this relationship breaks down once it is disaggregated through the groundnut cash cropping measures. This may be because women groundnut growers benefit household food security through other pathways than groundnut cash cropping. For instance, nearly all survey respondents grew other crops than groundnuts. It is possible that women are choosing to grow crops that are more beneficial to food security than their male counterparts, but because the model does not include this data, it cannot determine the validity of this theory and therefore it remains speculative. What the model does indicate is that gender does not influence how groundnut cash cropping affects food security.

The results of the other explanatory variables also offer insight into the determination of household food security. The parameter estimates for secondary education and the use of extension services are positive and significant in both the Uganda and Ghana models. The direct correlation between educated and knowledgeable households and improved household food security statuses, demonstrate the importance of human capital. It also attests to the effectiveness of extensive services in both countries Additionally, the AEZ parameter estimates reveal the importance of the surrounding ecosystem and climate in determining the agricultural potential of households and in turn the household food security status. Unlike groundnut cash cropping, both these measures appear to be significant determinants of household food security in the studies regions.

The results of the Uganda and Ghana models do support an important conclusion deduced from past studies. That being the relationship between cash cropping and food security is highly

dependent on situation specific determinants and attempts at generalizations are often undermined by numerous contradictory studies. If anything, these results underscore the continued need for empirical testing of gender impacts in location specific case studies.

DISCUSSION OF THE MARKETING MODEL:

The lack of any significant relationships between household marketing decisions and the gender indicators seems to indicate that there are no gender specific constraints to groundnut marketing in Uganda. Essentially, the model results show that households with women growers and women decision makers market their groundnut production no differently than households with only men growers and decision makers. The amount of land dedicated to groundnut production seems to be the important factor in household marketing decisions. Increased production leads to sizable increases in marketing. This supports the established conclusion that small holder households dependent on thin agricultural markets only sell their production once their household consumption needs are meant (Fafchamps, 1992). Therefore, households cultivating more land are more able produce beyond their own consumption needs and are more likely to sell their groundnuts and also sell greater quantities. Additionally, contacting an extension service seems to have a positive effect on household marketing. Along with benefiting household food security, Ugandan extension services appear to encourage households to market their groundnuts. While gender does not seem to play a significant role in marketing, the model indicates the former two variables do impact marketing decisions.

ISSUES AND FURTHER WORK OF THE FOOD SECURITY MODELS:

With food security models, there is always a concern of endogeneity. This particular model is assuming that household groundnut cash cropping affects food security, but the food security of the household does not affect the level of groundnut cash cropping. However, this assumption may not always hold. It could be argued that decisions concerning groundnut cash

cropping depend in part on household food security. For example, households with low food security may choose to concentrate on growing more dependable, yet less marketable food crops such as sorghum or millet. To accommodate for this possible endogenous relationship and reduce the possibility of biased estimators, instrument variables (IV) could be used to estimate the model.

It would be preferable to use an IV to correct for this possible source of endogeneity, but only if an effective instrument can be found. An effective IV is strongly correlated with the endogenous variable, but is also not directly correlated with the dependent variable. After an extensive search, the survey data was found not to contain any information that could be argued to affect food security only through its impact on groundnut cash cropping. It was theorized that a possible candidate could be the distance from a household to a groundnut market. This variable would obviously only affect food security through the groundnut cash cropping measures. However, after an unsuccessful endeavor to obtain this data, attempts to generate the variable were abandoned and only OLS regressions were employed. While not ideal, an OLS regression may actually generate less biased estimates than those from an IV model using a weak instrument.

The results of the food security models also suggest deficiencies in the statistical model. The primary weakness is low overall explanatory power. The use of additional variables not available from the surveys may boost the R^2 values and estimate a more predictive model. For example, climatic data for the 2010 growing season could better describe food availability through household production potential. It would also be useful to have variables that more accurately describe the household resources as crop producers, such as the use of fertilizer or access to tractors. More accurate information on family characteristics would help tease out the requirements and capabilities of family members and thus how the family utilizes food resources.

Also, results in both models suggest that the crude market distance variable may fail to measure the likely transaction costs incurred due to distance, indicating the need for a more refined measure. Having mentioned what would be ideal, the ideal is rarely available. Thus it must be stressed that these models, while not perfect, do provide valuable insight about food security and its determinants. The issues mentioned merely offer an opportunity to expand and improve what has been accomplished in this thesis and to inform the design of future questionnaires used to examine food security issues.

ISSUES AND FURTHER WORK OF THE MARKETING MODEL:

The major inhibiting factor for the marketing model is discussed in the Statistical Model Chapter. Many studies, starting with Geotz (1992), indicate the necessity of separating the decision to market and the decision concerning the amount to market. However, as previously mentioned, there were no feasible variables for identifying the two equations in such a selection model from the survey data or other sources. This naturally offers an opportunity for further investigation. Survey data on cellphone and vehicle usage would allow for the estimation of a selection model because these variables have been empirically shown to affect the binary market participation decision, but not the decision regarding the amount to market. Thus, these variables offer a process to separate the components of marketing, allowing for the estimation of an alternate model to describe how gender influences household marketing decisions.

CHAPTER 8: CONCLUSION

THESIS SUMMARY:

This thesis examines the impact of agricultural commercialization upon household nutrition and food security. In order to accomplish this, two research queries are posited. The first asks how does groundnut cash cropping impact household food security among small holder farmers in sub Saharan Africa, and particularly how does gender influence this relationship. The second question examines if and how gender influences groundnut market participation.

In order to answer the first query, the thesis develops an empirical food security model. Drawing from the work of Pinstrup-Anderson and others, the food security dimensions of availability, access, and utilization are used to identify potential underlying determinants of food security. Combining these dimensions with measures of household cash cropping decisions generates an empirical model that is used to estimate the relationships between household characteristics and decisions, and food security outcomes.

The model is specified with variables drawn from household survey data collected in 2011 in Uganda and Ghana. The dependent variable, a food consumption score, measures the level of household food security. Independent variables that influence the three dimensions of food security and variables that describe the level of household groundnut production and marketing are employed to estimate the relationship between groundnut cash cropping and household food security. Interaction terms generated by multiplying the cash cropping measures by a household grower gender indicator are used to estimate how gender influences the relationship between the food consumption score and the cash cropping measures.

Previously, four questions were poised about how groundnut cultivation influences household food security and what role gender plays in the relationship. The first two questions

asked how household decisions affecting groundnut cash cropping decisions relate to food security. Both models offered little evidence that there is any significant relationship between food security and household decisions regarding groundnut production or marketing. The third question sought to examine how the gender of growers influences household food security. The results of both Uganda and Ghana weakly suggest that women groundnut growers may positively affect household food security. The parameter estimates of the gender indicators are both positive, yet just outside the bounds of conventionally accepted significance levels. The final question concerns the pathway by which gender influences the relationship between groundnut production decisions and household food security. Both, the Ghana and Uganda models do not reveal any meaningful differences between households with women growers and those without, concerning the relationship between groundnut production and food security. The overall conclusion of these models is that there may be a positive effect on food security due to presence of women groundnut growers, but the pathway remains unclear.

The second query concerns the impact that gender has on household marketing decisions. The concept of market participation is divided into two decisions that determine the household marketing outcome. First a household makes a binary decision to participate in a market and sell a portion of its groundnut production. Second, the household decides the amount to sell, if any at all.

A tobit model is used to empirically model the two decisions. The tobit model is estimated to correct for the non-normal distribution of the dependent variable; the amount of groundnuts sold by each household. The model is specified using determinants drawn from past studies examining market participation including household and farm characteristics, prices, and household exogenous income. Two variables are used to represent the influence of gender. The first variable indicates if households have women groundnut growers and the second indicates if

these women growers participate in marketing decisions. Only Uganda survey data are used in this model, as Ghana does not have adequately variation in household market participation to estimate a tobit model.

The results indicate that the gender composition of household groundnut growers does not influence the marketing decisions of the household. Neither the decision to sell nor the decision regarding the amount to sell is impacted by the presence of women groundnut growers or by women participation in marketing decisions. This result indicates that households with women growers and those with women decision makers are no more or less likely to participate in the groundnut market.

IMPLICATIONS:

As previously described, the groundnut is widely viewed as an economically and biologically beneficial crop. Peanut CRSP, an agricultural research organization funded by USAID, echoes Longhurst's positive assessment of the contributions of groundnuts to nutrition and agricultural systems (PeannutCRSP.org, 2013). The organization goes on to state that groundnut cultivation plays an important role in economic development, gender equality, and the sustainability of small scale agriculture. Because millions of dollars fund the many research projects of Peanut CRSP and other agricultural research organizations, it is crucial to scrutinize these claims concerning the economic and social role of groundnut cultivation in the developing world.

The results of this thesis indicate that groundnut cash cropping may not benefit food security as much as previously suggested. These results, however, do not invalidate the previous claims of the importance of groundnuts, they merely more precisely specify its role in agricultural development. Agricultural development projects, like the ones conducted by Peanut CRSP, aim to develop groundnut cultivation in order to improve the quality of life of the farmers.

This thesis indicates that if increased food security is the desired outcome, then investing in groundnut development may not be the best option. At the very least, it demonstrates the need for empirically testing the role that groundnut cash cropping plays in household food security.

It must also be understood that there are important caveats to the general conclusion that cash cropping decisions do not affect household food security. First, it is important to note that this lack of evidence is itself evidence that groundnut cash cropping is not negatively impacting household food security. Past research is full of case studies demonstrating the negative effects of cash cropping upon food security and nutritional outcomes (Lambert, 1978; Haaga et al., 1986; Peters, 1990). This thesis, at least can state that groundnut cash cropping does not hurt household food security. Second, the conclusion that groundnut cash cropping is benefiting households in other ways is in no way excluded. This thesis focuses on food security, one aspect of a household's quality of life, therefore the entirety of the benefits stemming from groundnut cash cropping are not measured. As previously mentioned, additional income stemming from groundnut production may be spent on farming equipment or school fees that could improve living standards and productivity. Furthermore, cash cropping plays a role in economic integration and the diversification of household consumption bundles, both of which are widely viewed as positive. Third, this result is not meant to be extrapolated to other regions. It has been stressed multiple times that the manner in which cash cropping affects food security is dependent on numerous situational determinants. It is completely conceivable that different regions outside of the two studied in this thesis would yield different results.

How gender influences the relationship between cash cropping and food security is an important focus of this thesis. The result that households with women growers have slightly higher food security statuses reinforces the long held notion that productive women benefit household food security (von Braun and Kennedy, 1986). However, the statistical weakness of

this relationship suggests the benefits from women may be weak or heterogeneous. The food security models also present no evidence that women's participation in groundnut production or marketing impacts household food security. Additionally, the marketing model shows no indication that neither women growers nor women decision makers affect household marketing decisions.

The lack of significant gender impacts upon groundnut production and marketing decisions and outcomes suggest that these communities are fairly equitable, at least with respect to groundnut cash cropping. When viewed in the context of the traditional male dominated society of Uganda, this may demonstrate that groundnut cultivation has provided women with an opportunity to empower themselves in a patriarchal system. Women growers have nearly the same number of years of growing experience as their male counterparts, indicating women's involvement in groundnut cultivation is not a new development. Therefore, the resulting equitable household and farming characteristics could very well be the result a tradition of women cultivating groundnut providing them a source of income and domestic control.

Moreover, the mere fact that women growers and decision makers compose a significant portion of the survey respondents in both regions show that women are not minor players regarding groundnut cultivation. The old model of women's role in agricultural systems developed by Katona-Apte may be becoming less applicable. In both regions there are a considerable number of women independently growing and selling groundnuts, even within households with adult men, a modern type of agricultural society that Katona-Apte does not even present as an option. In light of women's significant role in groundnut production, continued monitoring and impact evaluation is needed to ensure that new groundnut technologies are accessible to women, and that technology benefits are equitably shared across genders.

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APPENDIX

Appendix A: Alternative Food Security Model Results

The total household acreage calculated using Ugandan survey question 31 and Ghanaian survey question 34 instead of question 4 from both surveys.

Table A.1: Alternate Uganda Food Security Model

Observations: 400			**R^2: .1539**
Variables	**Coefficient**	**Robust Std. Error**	**t-Statistic**
Total Household Acreage (Acre)	0.0076	0.0030	2.57**
Family Size	-0.0042	0.0029	-1.45
Years of G. Nut Growing Exp.	-0.0014	0.0010	-1.42
Adult w/ Secondary Edu.	0.0615	0.0222	2.76***
Distance from a Market	0.0019	0.0014	1.40
Montane Zone	0.0922	0.0305	3.02***
B-M-C Zone	0.0455	0.0199	2.29**
If Contacted Ext. Service	0.0391	0.0218	1.79*
If women G. Nut Growers	0.0707	0.0465	1.52
G. Nut Acreage Ratio	-0.0676	0.0725	-0.93
G. Nut Sold Ratio	0.0582	0.0357	1.63
Interaction: G. Nut Acreage Ratio	-0.1171	0.1370	-0.85
Interaction: G. Sold Ratio	0.0001	0.0653	0.00
Intercept	0.4723	0.0381	12.40
*: p-value=.1, **: p-value=.05, ***: p-value=.01			

Table A.2: Alternate Ghana Food Security Model

Observations: 309			**R^2: .1597**
Variables	**Coefficient**	**Standard Error**	**t-Statistic**
Total Household Acreage (Acre)	-0.0013	0.0016	-0.85
Family Size	0.0067	0.0025	2.66***
Years of G. Nut Growing Exp.	-0.0016	0.0007	-2.16**
Adult w/ Secondary Edu.	0.0410	0.0173	2.37**
Distance from a Market	0.0042	0.0023	1.83*
Forest Zone	-0.0260	0.0241	-1.08
Coastal Savannah Zone	-0.0271	0.0228	-1.19
If Contacted Ext. Service	0.0381	0.0156	2.45**
If women G. Nut Growers	0.0352	0.0353	1.00
G. Nut Acreage Ratio	0.0128	0.0353	0.36
G. Nut Sold Ratio	-0.0442	0.0289	-1.53
Interaction: G. Nut Acreage Ratio	-0.0161	0.0456	-0.35
Interaction: G. Sold Ratio	-0.0468	0.0415	-1.13
Intercept	0.5447	0.0355	15.36
*: p-value=.1, **: p-value=.05, ***: p-value=.01			

Appendix B: Uganda Peanut CRSP Questionnaire and FCS Questionnaire

Peanut CRSP IPM Practices of Farmers and their Impacts in Uganda

Questionnaire

Enumerator # ☐

Interview Date ☐

Household ID ☐

Region ☐

District ☐

Village ☐

Latitude of House ☐ **Longitude of House** ☐

Latitude of Farm ☐ **Longitude of Farm** ☐

Agro-Ecological System ☐

(1 =The Banana-coffee System, 2 = The Banana-millet-cotton System, 3 = The Montane System, 4 = The Teso System, 5 = The Northern System, 6 = The West Nile System, 7 = The Pastoral System)

Respondent's Name ☐

Respondent is Head of Household **YES** ☐ **NO** ☐

Counting yourself, how many people live in your household? _____

How far is your house from the nearest market? _____ miles

How far is your house from the nearest major road? _____ miles

How far is your house from the nearest extension agent? _____ miles

ROSTER OF ALL HOUSEHOLD MEMBERS

Name of Family Members	**Gender** 1=Male 2=Female	**Age**	**Years of Schooling**	**Relationship to the Head of the Household** 1=Head 2=Spouse 3=Son/Daughter 4=Grandchild 5=Step Child 6=Parent of Head or Spouse 7=Sister/Brother of Head or Spouse 8=Nephew/Niece 9=Other Relatives 10=Servant 11=Non-Relative 99=Other (specify)	**Number of Groundnut Fields for Which You are the Primary Cultivator or Manager**
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

PLEASE INTERVIEW **EACH MEMBER** OF THE HOUSEHOLD LISTED IN PAGE 2 THAT CULTIVATES/MANAGES THEIR PERSONAL GROUNDNUT FIELD(S). FOR EACH MEMBER YOU INTERVIEW, PLEASE FILL OUT **A SEPARATE SURVEY**.

Respondent's Name (from page 2) _____
Household ID _____

We are interested in learning about your groundnut production. We would therefore like to ask you a few questions about your groundnut production.

1. Did you grow groundnuts in 2010/2011?
    1. Yes
    2. No

2. How many years have you been cultivating groundnuts? _____

3. If you started cultivating groundnuts in **the last five years**, what is the main reason for doing so? Were you convinced by: (CIRCLE ALL THAT APPLY)
    1. Farmer Field School (FFS)
    2. Other Research/Extension Activities
    3. Fellow Farmers
    4. Relatives
    5. Media
    6. Income opportunities
    7. Nutritional values/Food
    8. Employment
    9. Other (Please Specify)_____
    10. N/A

4. Please provide the following information on all the crops you grew last year.

Crop	Number of Acres (if other than acres please specify unit)	Number of Seed Bowls Used to Plant the Field	Distance of Field From the Your House (miles)
1. Groundnut field 1			
2 Groundnut field 2			
3			
4			
5			
6			
7			
8			
9			
10			
Total			

*** Please specify units if different than listed**

A. SEED

5. What factors do you consider when choosing which groundnut seeds to plant? (CIRCLE ALL THAT APPLY)
    1. Availability
    2. Drought Resistance (resistant to lack of water or dry conditions)
    3. Duration
    4. Disease Resistance (Please Specify) _____
    5. Quality Characteristic (such as taste, oil content, etc)
    6. Yield
    7. Pest Resistance
    8. Seed Price
    9. Other (Please Specify) _____

6. Have you noticed any spots on the groundnut leaves before harvesting?
    1. Yes
    2. No

7. Please describe how the spots on the leaves look like in terms of color, size, and density (if possible, have farmer show any infected plants).

    _____

8. Have you changed the groundnut seeds in the last 5-10 years?
    1. Yes (Please specify the year(s)) _____
    2. No

9. Have you ever heard of Rosette Resistant groundnuts?
    1. Yes
    2. No

10. Who have you heard from about Rosette Resistant? (CIRCLE ALL THAT APPLY)
    1. Seed retail store/agro-dealer
    2. Fellow Farmers
    3. Open market (from traders)
    4. Extension/Research Station
    5. Other (Please Specify) _____
    6. Cannot Tell
    7. N/A

11. Have you ever used Rosette Resistant groundnuts?
    1. Yes
    2. No

12. Did your yields change after beginning to use the Rosette Resistant groundnut seeds?
    1. Yes (Please Specify Change)
       Increase by _____
       Decrease by_____
    2. No
    3. Do not know. Always used Rosette Resistant groundnut seeds
    4. N/A

13. Have you used Drought Resistant groundnuts?
    1. Yes
    2. No

14. Did your yields change after beginning to use the Drought Resistant groundnut seeds?
    1. Yes (Please Specify Change)
       Increase by _____
       Decrease by_____
    2. No
    3. Do not know. Always used Drought Resistant groundnut seeds
    4. N/A

15. Are resistant (improved) varieties groundnut seeds available for purchase?
    1. Yes
    2. No

16. What is your main source for resistant varieties groundnut seeds? (CIRCLE ALL THAT APPLY)
    1.
    2. Seed retail store/agro-dealer
    3. Seed company stores
    4. Own saved seeds
    5. Fellow Farmers
    6. Open market (from traders)
    7. Extension/research station
    8. Other (Please Specify) _____
    9. Cannot Tell
    10. N/A

17. Are regular (local) groundnut seeds available for purchase?
    1. Yes
    2. No

18. What is your main source for regular groundnut seeds? (CIRCLE ALL THAT APPLY)
    1.
    2. Seed retail store/agro-dealer
    3. Seed company stores
    4. Own saved seeds
    5. Fellow Farmers
    6. Open market (from traders)
    7. Extension/research station
    8. Other (Please Specify) _____
    9. Cannot Tell
    10. N/A

19. Do you test your seed before planting?
    1. Yes
    2. No

B. DISEASE AND PEST CONTROL

20. How did you manage your primary groundnut pests and diseases last year? (e.g. rosette virus, leaf spots, rust, termites, aphids, thrips, beetles, weeds, etc.)
    1.
    2. Fungicide Application
    3. Use of Resistant Varieties
    4. Field Monitoring
    5. Plant Extracts
    6. Hand Weeding
    7. Herbicide Application
    8. Soap Treatment
    9. Use of Treated Seeds
    10. Row Spacing
    11. Plowing
    12. Nothing
    13. Other (Please Specify) _____

Name/Type of Pest	Control Method (Use Pest Control Code Above)
1.	
2.	
3.	
4.	
5.	

21. What part of the annual production of groundnuts did you lose **because of drought/lack of water**?
    1. In 2010_____
    2. A Decade Ago_____

22. What part of the annual production of groundnuts did you lose **because of the Rosette virus**?
    1. In 2010_____
    2. A Decade Ago_____

C. VARIETIES

23. Please list your groundnut varieties planted in the **MAJOR SEASON** last year.

Name of Variety Planted in **Major Season**	Variety is: 1 = improved 2 = local	Acres of Variety Planted	Why did you use this variety? See codes below	Who Decided on the Choice of Variety?
1.				
2.				
3.				

1 = High Yield, 2 = Resistant to Disease, 3 = Seed Availability, 4 = Taste, 5 = Easily Marketable, 6 = Oil Content, 7 = Others (Please Specify)

24. Please list your groundnut varieties planted in the **MINOR SEASON** last year.

Name of Variety Planted in **Minor Season**	Variety is: 1 = improved 2 = local	Acres of Variety Planted	Why did you use this variety? See codes below	Who Decided on the Choice of Variety?
1.				
2.				
3.				

1 = High Yield, 2 = Resistant to Disease, 3 = Seed Availability, 4 = Taste, 5 = Easily Marketable, 6 = Oil Content, 7 = Others (Please Specify)

25. Where did you learn about these varieties? (CHECK ALL THAT APPLY)

	Variety 1	**Variety 2**	**Variety 3**
1. Farmer Field School	☐	☐	☐
2. Other Research/Extension Activities	☐	☐	☐
3. Fellow Farmers	☐	☐	☐
4. Relatives	☐	☐	☐
5. Media	☐	☐	☐
6. Other (Please Specify)_____	☐	☐	☐

D. PRODUCTION

26. What was the production of groundnuts in 2010 from **the fields for which you are the primary cultivator or manager**?

	Field 1	**Field 2**	**Field 3**
Major season - Acreage of groundnut (all varieties)			
Major season - Total production (unshelled, gunny bags)			
Minor season - Acreage of groundnut (all varieties)			
Minor season - Total production (unshelled gunny bags)			

***Please specify units if different than listed**

27. At the time of selling most of your groundnuts, what was the price of a gunny bag?

Price for Unshelled_____ Price for Shelled _____

28. What month did you sell most of your groundnut production?

_____

29. Of the cash crops you grew in 2010, which 3 provided you the most income?

1. Most income _____

2. Second most income _____

3. Third most income _____

30. Who makes the decisions (e.g. purchasing of inputs, hire of labor, harvesting and marketing) regarding farming activities for **your individual plot**?
    1. Myself
    2. Spouse
    3. Joint decision (myself and spouse)
    4. Other (Please Specify)_____

E. PRODUCTION CHANGES

31. Please provide the following information on your groundnut production during the last season.

	2010
	Major Season
Total acreage planted with groundnuts (all varieties)	
Total quantity produced (in gunny bags, **unshelled**)	
Total quantity sold (in gunny bags, **unshelled**)	
Total quantity consumed (in basins/bowls, **shelled**)	
Total quantity sold (in gunny bags, **shelled**)	
Total quantity lost due to pests/disease post-harvest	

***Please specify units if different than listed**

F. PRICES

32. What is the current price per gunny bag of groundnuts? Please indicate by variety, if applicable.

Variety	Price for Unshelled	Price for Shelled
1.		
2.		
3.		

33. What was the lowest and highest price per gunny bag of groundnuts in 2010?

Lowest Price (unshelled) _____ Highest Price (unshelled) _____
Lowest Price (shelled) _____ Highest Price (shelled) _____

G. MARKETING

34. Are you able to sell your produce now more easily than a decade ago?
    1. Yes
    2. No

35. Do you grade/sort your produce/product before selling?
    1. Yes
    2. No

36. Do you now have more easy access to new technology than in the last decade?
    1. Yes
    2. No
    3. Cannot tell

H. USE OF INCOME IN THE HOUSEHOLD

37. How do you spend the money **you** earn from the sale of groundnuts and groundnut-related products from **your individual plot(s)** within the household? (CIRCLE ALL THAT APPLY) Please indicate the portion/percentage of expenditures for each category.
    1. Food items _____
    2. Alcohol and tobacco _____
    3. Health expenses _____
    4. Children clothes, school fees and books _____
    5. Personal clothing items _____
    6. Household items_____
    7. Housing issues_____
    8. Hire labor _____
    9. Purchase farming inputs (such as seeds, fertilizer, pesticides or machinery) _____
    10. Other (Please Specify)_____

38. Who initiates the expenditure decision regarding groundnut income from your plot(s)?
    1. Myself
    2. Spouse
    3. Joint decision (myself and spouse)
    4. Other (Please Specify) _____

39. Did you give any harvested groundnut as a gift to others in 2010?
    1. Yes (Please specify the number of groundnut basins)_____
    2. No

40. Have you seen any changes in your income from groundnuts over the last decade?
    1. Increase in Income
    2. Decrease in Income
    3. No Change in Income
    4. Fluctuations in Income
    5. Cannot tell

41. What was the total household income **from all sources** in 2010?

    TOTAL HOUSEHOLD INCOME (including farming, and non-farming activities)

    _____

I. EXTENSION

42. In the past 12 months, during which months did the local extension agent visit your village?

43. How many times in the last two years has an agricultural extension officer contacted you?
    _____

44. How many times in the last two years have you gone to the offices of the agricultural extension officer for help?

    _____

45. Does your village offer Farmer Field School (FFS) classes or any training programs on groundnuts?
    1. Yes (Please Specify) _____
    2. No

46. What technologies from the FFS have you used with your other crops?

    _____

47. Which crops have you used FFS Techniques/Technology with?

_____

48. How satisfied have you been with the FFS training?
    1. Very Satisfied
    2. Somewhat Satisfied
    3. Somewhat Unsatisfied
    4. Very Unsatisfied
    5. N/A

49. How many fellow farmers or family members have you shared information with about your new practices and/or FFS technologies? (If you have participated in the FFS)

_____

50. Of the farmers/persons you shared information with, how many of them do you think are using the new practices?

_____

51. Do you have a way of acquiring/demanding new peanut related technologies?
    1. Yes (Please Specify Source) _____
    2. No

Comments

_____
_____
_____
_____
_____

L. Food Security questions

	Questions should be asked to the household head cook!					
FS1	For these questions, we would like to speak to the head cook for the household. Are you the primary cook for this household?	1	YES → skip to question FS2	2	NO → Go to FS1B	
FS1B	If you are not the head cook, would you please direct me to the head cook for the household.					
FS2	Yesterday, how many meals did the members of your household eat?	a. Adults	|__|	b. Children **above 5 years** (write 9 if no children in household)		
FS3	Could you please tell me how many **days** in the **<u>past week</u>** your household has eaten the following food items, prepared and/or consumed at home, and what their source was. **Use acquisition codes on the right.**					

	Food Items	Number of days eaten in the past **7 days**	How was this food acquired?	
	Focus on food eaten <u>INSIDE</u> the house	0 = not eaten 1 = 1 day 2 = 3 days 4 = 4 days 5 = 5 days 6 = 6 days 7 = 7 days	**Write the main source of food for the past 7 days**	**<u>Food acquisition codes</u>**
A	Maize	|__|	|__|__|	00= not eaten
B	Rice	|__|	|__|__|	01 = Own production (crops, animals)
C	Sorghum	|__|	|__|__|	02 = hunting, fishing
D	Millet	|__|	|__|__|	03 = gathering
E	Wheat	|__|	|__|__|	04 = borrowed
F	Cassava	|__|	|__|__|	05 = market (purchase on credit)
G	Potatoes	|__|	|__|__|	06 = market (purchase with cash)
H	Yams	|__|	|__|__|	07 = exchange

				labor for food 08 = exchange items for food 09 = gift (food) from family relatives or friends 10 = beg for food 11 = food aid from civil society, NGO's government, WFP, etc 12 = Other specify: _____ _____ __
I	Bread, Mandazi, chapati, etc.	|__|	|__|__|	
J	Matooke	|__|	|__|__|	
K	Beans and Peas	|__|	|__|__|	
L	Vegetables	|__|	|__|__|	
M	Ground nuts, Sim sim, sunflower	|__|	|__|__|	
N	Fresh fruits	|__|	|__|__|	
O	Fish	|__|	|__|__|	
P	Meat (including chicken and pork)	|__|	|__|__|	
Q	Blood (if appropriate)	|__|	|__|__|	
R	Eggs	|__|	|__|__|	
S	Oil, fat, butter, ghee	|__|	|__|__|	
T	Sugar	|__|	|__|__|	
U	Milk	|__|	|__|__|	
V	Beer residue	|__|	|__|__|	
W	Condiments	|__|	|__|__|	

FS4	In the past 7 days, how many days has your household had to: **(if no days, write '0')**			
	a. Rely on less preferred and less expensive foods?	|__| days		
	b. Borrow food, or rely on help from a friend or relative?	|__| days		
	c. Limit portion size at mealtimes?	|__| days		
	d. Restrict consumption by adults in order for small children to eat?	|__| days		
	e. Reduce number of meals eaten in a day?	|__| days		
FS5	Do all household members eat roughly the same diet? **Circle one.**	1	Yes → **skip to question FS7**	2

FS6	If no, who in the household usually eats a more diverse variety of foods, a less diverse variety of foods, or a similar variety of foods?														
	Tick one per group		More Diverse		Less Diverse				Same				Don't know/not applicable		
	Men														
	Women														
	Children (3 years and older)														
FS7	In the past 12 months, during which months did your household have difficulty getting enough food to eat? **(circle all that apply)**														
	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	Ju	July 2011	Aug. 2011	A l w a y s	

Appendix C: Ghana Peanut CRSP Questionnaire and FCS Questionnaire

Peanut CRSP IPM Practices of Farmers and their Impacts in Ghana

Questionnaire

Enumerator # ☐

Interview date ☐

Household ID ☐

Region ☐

District ☐

Village ☐

Latitude of house ☐ **Longitude of house** ☐

Latitude of farm ☐ **Longitude of farm** ☐

Ecological zone ☐

(1 =Coastal Savannah, 2 = Forest, 3 = Transition, 4 = Guinea Savannah)

Respondent's name ☐

Respondent is Head of Household **YES** ☐ **NO** ☐

Counting yourself, how many people live in your household? _____

How far is your house from the nearest market? _____ **miles**

How far is your house from the nearest major road? _____ **miles**

How far is your house from the nearest extension agent? _____ **miles**

ROSTER OF ALL HOUSEHOLD MEMBERS

Name of Family Members	**Gender** 1=Male 2=Female	**Age**	**Years of Schooling**	**Relationship to the Head of the Household** 1=Head 2=Spouse 3=Son/Daughter 4=Grandchild 5=Step Child 6=Parent of Head or Spouse 7=Sister/Brother of Head or Spouse 8=Nephew/Niece 9=Other Relatives 10=Servant 11=Non-Relative 99=Other (specify)	**Number of Groundnut Fields for Which You are the Primary Cultivator or Manager**
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

PLEASE INTERVIEW EACH MEMBER OF THE HOUSEHOLD LISTED IN PAGE 2 THAT CULTIVATES/MANAGES THEIR PERSONAL GROUNDNUT FIELD(S). FOR EACH MEMBER YOU INTERVIEW, PLEASE FILL OUT A SEPARATE SURVEY.

Respondent's Name (from page 2) _____
Household ID _____

We are interested in learning about your groundnut production. We would therefore like to ask you a few questions about your groundnut production.

5. Did you grow groundnuts in 2010/2011?
1. Yes
2. No

6. How many years have you been cultivating groundnuts? _____

7. If you started cultivating groundnuts in **the last five years**, what is the main reason for doing so? Were you convinced by: (CIRCLE ALL THAT APPLY)

6. Farmer Field School (FFS)
7. Other Research/Extension Activities
8. Fellow Farmers
9. Relatives
10. Media
11. Income opportunities
12. Nutritional values/Food
13. Employment
14. Other (Please Specify) _____
15. N/A

8. Please provide the following information on all the crops you grew last year.

Crop	Number of Acres (if other than acres please specify unit)	Number of Seed Bowls Used to Plant the Field	Distance of Field From Your House (miles)
1. Groundnut field 1			
2 Groundnut field 2			
3			
4			
5			
6			
7			
8			
9			

10			
Total			

*** Please specify units if different than listed**

9. What do you look for when you are selecting good land (the site) for planting groundnuts?
   1. Weeds with green leafy growths
   2. Other (Please Specify) _____

10. Where did you learn the site selection from? (CIRCLE ALL THAT APPLY)

1. Farmer Field School (FFS)
2. FFS Farmer
3. Non-FFS Fellow Farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Can't tell
10. N/A

11. How do you determine good soil for groundnut production?
3. By looking at the texture of the soil
4. By looking at the existing vegetation
5. Asking fellow farmers for advice
6. Other (Please Specify) _____

12. Where did you learn the determination of good soil from? (CIRCLE ALL THAT APPLY)

1. Farmer Field School (FFS)
2. FFS farmer
3. Non-FFS Fellow farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Can't tell
10. N/A

A. SEED

13. Are regular/local groundnut seeds available for purchase?
    1. Yes
    2. No

14. What is your main source for regular/local groundnut seeds? (CIRCLE ALL THAT APPLY)
    5. Seed retail store/agro-dealer
    6. Seed company stores
    7. Own saved seeds
    8. Fellow farmers
    9. Open market (from traders)
    10. Extension/research station
    11. Other (Please Specify)

_____ 13. N/A
12. Can't tell

15. Do you test your seed before planting?
1. Yes
2. No

16. Where did you learn the seed testing from? (CIRCLE ALL THAT APPLY)
6.
1. Farmer field school (FFS)
2. FFS farmer
3. Non-FFS Fellow farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Cannot tell
10. N/A

B. PLANTING

17. What do you do if some groundnut seeds do not germinate?
1. Re-plant new seeds
2. Nothing
3. Other (Please Specify) _____

18. Where did you learn the re-filling from? (CIRCLE ALL THAT APPLY)

1. Farmer field school (FFS)
2. FFS farmer
3. Non-FFS Fellow farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Cannot tell
10. N/A

C. DISEASE AND PEST CONTROL

19. Do you spray your groundnuts with local soap to control diseases (*alata* or *amonkye*)?
1. Yes
2. No

20. Where did you learn the practice of spraying groundnuts with local soap from? (CIRCLE ALL THAT APPLY)
1. Farmer field school (FFS)
2. FFS farmer
3. Non-FFS Fellow farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Cannot tell
10. N/A

21. If you find plants that are diseased, what do you do? (CIRCLE ALL THAT APPLY)
    1. Nothing
    2. Pull the plant
    3. Spray with chemicals
    4. Spray with local soap
    5. Other (Please Specify) _____

22. Where did you learn this from? (CIRCLE ALL THAT APPLY)

1. Farmer field school (FFS)
2. FFS farmer
3. Non-FFS Fellow farmers
4. Extension
5. NGO
6. Media
7. Experience
8. Other (Please Specify) _____
9. Cannot tell
10. N/A

23. How did you manage your primary groundnut pests and diseases last year? (e.g. rosette virus, leaf spots, rust, termites, aphids, thrips, beetles, weeds, etc.)

1.
2. Fungicide Application
3. Use of Resistant Varieties
4. Field Monitoring
5. Plant extracts
6. Hand weeding
7. Herbicide application
8. Soap Treatment
9. Use of Treated Seeds
10. Row spacing
11. Plowing
12. Nothing
13. Other (Please Specify) _____

Name/Type of Pest	Control Method (Use Pest Control Code Above)
1.	
2.	
3.	
4.	
5.	

24. Are you aware that there are beneficial insects that can help manage pests on groundnuts?

3. Yes
4. No

25. How did you hear about the beneficial insects? (CIRCLE ALL THAT APPLY)

3.
4. Farmer field school (FFS)
5. FFS farmer
6. Non-FFS Fellow farmers
7. Extension
8. NGO
9. Media
10. Experience
11. Other (Please Specify) _____
12. Cannot tell

13. N/A

D. VARIETIES

26. Please list your groundnut varieties planted in the **MAJOR SEASON** last year.

Name of Variety Planted in **Major Season**	Variety is: 1 = improved 2 = local	Acres of Variety Planted	Why did you use this variety? See codes below	Who Decided on the Choice of Variety?
1.				
2.				
3.				

1 = High Yield, 2 = Resistant to Disease, 3 = Seed Availability, 4 = Taste, 5 = Easily Marketable, 6 = Oil Content, 7 = Others (Please Specify)

27. Please list your groundnut varieties planted in the **MINOR SEASON** of last year

Name of Variety Planted in **Minor Season**	Variety is: 1 = improved 2 = local	Acres of Variety Planted	Why did you use this variety? See codes below	Who Decided on the Choice of Variety?
1.				
2.				
3.				

1 = High Yield, 2 = Resistant to Disease, 3 = Seed Availability, 4 = Taste, 5 = Easily Marketable, 6 = Oil Content, 7 = Others (Please Specify)

28. Where did you learn about these varieties? (CHECK ALL THAT APPLY)

	Variety 1	**Variety 2**	**Variety 3**
1. Farmer Field School	☐	☐	☐
2. Other Research/Extension Activities	☐	☐	☐
3. Fellow Farmers	☐	☐	☐
4. Relatives	☐	☐	☐
5. Media	☐	☐	☐
6. Other (Please Specify)_____	☐	☐	☐

29. Are resistant (improved) varieties groundnut seeds available for purchase?

3. Yes

4. No

30. How difficult is it to obtain resistant/improved variety groundnut seeds to plant?
    1. Very difficult
    2. Somewhat difficult
    3. Somewhat easy
    4. Very easy
    5. Cannot tell

31. What is your main source for resistant/improved varieties of groundnut seeds? (CIRCLE ALL THAT APPLY)

8.
9. Seed retail store/agro-dealer
10. Seed company stores
11. Own saved seeds
12. Fellow Farmers
13. Open market (from traders)
14. Extension/research station
15. Other (Please Specify) _____
16. Cannot Tell
17. N/A
32.

33. Are you aware of the presence of a Farmer Field School (FFS) in your village?
    1. Yes
    2. No

34. Have you participated in a Farmer Field School (FFS) for Integrated Pest Management (IPM)?
    1. Yes
    2. No

35. What year(s) did you attend the FFS? (CIRCLE ALL THAT APPLY)

3. 2001
4. 2002
5. 2003
6. 2004
7. 2005
8. 2006
9. 2007
10. 2008
11. 2009
12. 2010
13. N/A
36.

37. Have you used no-till with herbicides as land preparation method for your groundnut production before?
    1. Yes
    2. No

38. How did you hear about the practice of no-till with herbicide for land preparation? (CIRCLE ALL THAT APPLY)
    i. Farmer Field School (FFS)
    ii. Other research/extension activities
    iii. Fellow farmers
    iv. Relatives

v. Media
vi. Other (Please Specify) _____
vii. N/A

39. When did you first learn/hear about the practice of no-till with herbicide for land preparation?

_____

E. PRODUCTION

40. Please provide the following information on your groundnut production during the last season.

	2010
	Major Season
Total acreage planted with groundnuts (all varieties)	
Total quantity produced (in maxi bags, **unshelled**)	
Total quantity sold (in maxi bags, **unshelled**)	
Total quantity consumed (in bowls, **shelled**)	
Total quantity sold (in maxi bags, **shelled**)	
Total quantity lost due to pests/disease post-harvest	

***Please specify units if different than listed**

41. Who makes the decisions (e.g. purchasing of inputs, hire of labor, harvesting and marketing) regarding farming activities for **your individual plot**?
5. Myself
6. Spouse
7. Joint decision (myself and spouse)
8. Other (Please Specify)_____

F. PRICES

42. At the time of selling most of your groundnuts, what was the price of a gunny bag?

Price for Unshelled_____ Price for Shelled _____

43. What month did you sell most of your groundnut production?

_____

44. What is the current price per maxi bag of groundnuts? Please indicate by variety, if applicable.

Variety	Price for Unshelled	Price for Shelled
1.		
2.		

3.		

45. What was the lowest and highest price per maxi bag of groundnuts of 2010?

Lowest Price (unshelled) _____ Highest Price (unshelled) _____

Lowest Price (shelled) _____ Highest Price (shelled) _____

G. MARKETING

46. Are you able to sell your produce now more easily than a decade ago?
    1. Yes
    2. No

47. Do you grade/sort your produce/product before selling?
    1. Yes
    2. No

48. Do you now have more easy access to new technology than in the last decade?
    1. Yes
    2. No
    3. Cannot tell

H. USE OF INCOME IN THE HOUSEHOLD

49. How do you spend the money **you** earn from the sale of groundnuts and groundnut-related products from **your individual plot(s)** within the household? (CIRCLE ALL THAT APPLY) Please indicate the portion/percentage of expenditures for each category.

3. Food items _____
4. Alcohol and tobacco _____
5. Health expenses _____
6. Children clothes, school fees and books _____
7. Personal clothing items _____
8. Household items _____
9. Housing issues _____
10. Hire labor _____
11. Purchase farming inputs (such as seeds, fertilizer, pesticides or machinery) _____
12. Other (Please Specify)_____

50. Who initiates the expenditure decision regarding groundnut income from your plot(s)?
    1. Myself
    2. Spouse

3. Joint decision (myself and spouse)
4. Other (Please Specify) _____

51. Did you give any harvested groundnut as a gift to others in 2010?
    1. Yes (Please specify the number of groundnut bowls) _____
    2. No

52. Have you seen any changes in your income from groundnuts over the last decade?
    1. Increase in Income
    2. Decrease in Income
    3. No Change in Income
    4. Fluctuations in Income
    5. Cannot tell

53. What was the total household income **from all sources** in 2010?

TOTAL HOUSEHOLD INCOME (including farming, and non-farming activities)

_____

I. EXTENSION

54. In the past 12 months, during which months did the local extension agent visit your village?

55. How many times in the last two years has an agricultural extension officer contacted you?

_____

56. How many times in the last two years have you gone to the offices of the agricultural extension officer for help?

_____

57. What technologies from the FFS have you used with your other crops?

_____

58. Which crops have you used FFS Techniques/Technology with?

59. How satisfied have you been with the FFS training?
    a. Very Satisfied
    b. Somewhat Satisfied
    c. Somewhat Unsatisfied
    d. Very Unsatisfied
    e. N/A

60. How many fellow farmers or family members have you shared information with about your new practices and/or FFS technologies? (If you have participated in the FFS)

61. Of the farmers/persons you shared information with, how many of them do you think are using the new practices?

62. Do you have a way of acquiring/demanding new peanut related technologies?
    1. Yes (Please Specify Source)
    _____
    2. No

Comments

N. Food Security questions

	Questions should be asked to the household head cook!					
FS1	For these questions, we would like to speak to the head cook for the household. Are you the primary cook for this household?	1	YES → skip to question FS2	2	NO → Go to FS1B	
FS1B	If you are not the head cook, would you please direct me to the head cook for the household.					
FS2	Yesterday, how many meals did the members of your household eat?	a. Adults	|__|	b. Children **above 5 years** (write 9 if no children in household)		
FS3	Could you please tell me how many **days** in the **<u>past week</u>** your household has eaten the following food items, prepared and/or consumed at home, and what their source was. **Use acquisition codes on the right.**					

	Food Items	Number of days eaten in the past **7 days**	How was this food acquired?	
	Focus on food eaten <u>INSIDE</u> the house	0 = not eaten 1 = 1 day 2 = 3 days 4 = 4 days 5 = 5 days 6 = 6 days 7 = 7 days	**Write the main source of food for the past 7 days**	**<u>Food acquisition codes</u>**
A	Maize, millet (including maize products, guinea corn banku, Tuo Zafi, Kenkey, etc.)	|__|	|__|__|	00= not eaten
B	Rice, “rice-water”	|__|	|__|__|	01 = Own production (crops, animals) 02 = hunting, fishing 03 = gathering 04 = borrowed 05 = market (purchase on credit) 06 = market (purchase with cash) 07 = exchange labor for food
C	Wheat flour/bread and other cereals	|__|	|__|__|	
D	Cassava (fufu, gari, tapioca, etc...)	|__|	|__|__|	
E	Other roots and tubers (potatoes, yam, cocoyam, etc...)	|__|	|__|__|	
F	Plantain	|__|	|__|__|	
G	Fish and other acquatic animals (crabs, snails, shrimps, lobster, etc...)	|__|	|__|__|	
H	Poultry (chicken, guinea fowl, duck, turkey, etc...)	|__|	|__|__|	

I	Red meat (goat, mutton, beef, pork, etc...)	|__|	|__|__|	08 = exchange items for food 09 = gift (food) from family relatives or friends 10 = beg for food 11 = food aid from civil society, NGO's government, WFP, etc 12 = Other specify: _____ _____ __
J	Wild meat (antelope, rabbit, etc...)	|__|	|__|__|	
K	Eggs	|__|	|__|__|	
L	Pulses, Beans, Nuts (including peas, cowpeas, neri, akatua, cashew, soyabean, etc...)	|__|	|__|__|	
M	Vegatables (green leafy, tomatoes, okro, mushrooms, etc...)	|__|	|__|__|	
N	Oil/Butter/Shea butter	|__|	|__|__|	
O	Fruits (banana, mango, pawpaw, etc...)	|__|	|__|__|	
P	Sugar, honey, sweets, sweetened drinks	|__|	|__|__|	
Q	Milk/milk products	|__|	|__|__|	
R	Condiments (Dawadawa, maggi, spices, fish for flavor only, fish powder, galbanum/prekese …)	|__|	|__|__|	

FS4	In the past 7 days, how many days has your household had to: **(if no days, write '0')**			
	a. Rely on less preferred and less expensive foods?	|__| days		
	b. Borrow food, or rely on help from a friend or relative?	|__| days		
	c. Limit portion size at mealtimes?	|__| days		
	d. Restrict consumption by adults in order for small children to eat?	|__| days		
	e. Reduce number of meals eaten in a day?	|__| days		
FS5	Do all household members eat roughly the same diet? **Circle one.**	1	Yes → **skip to question FS7**	2
FS6	If no, who in the household usually eats a more diverse variety of foods, a less diverse variety of foods, or a similar variety of foods?			

Tick one per group	More Diverse	Less Diverse	Same	Don't know/not applicable
Men				

	Women												
	Children (3 years and older)												
FS7	In the past 12 months, during which months did your household have difficulty getting enough food to eat? **(circle all that apply)**												
	Aug. 2010	Sept. 2010	Oct. 2010	Nov. 2010	Dec. 2010	Jan. 2011	Feb. 2011	Mar. 2011	Apr. 2011	May 2011	June 2011	July 2011	Aug. 2011	Always

Appendix D: Food Consumption Score Code

Uganda Food Consumption Score STATA Code:

```
replace fs2a_meals_adults=. in 185
replace fs3a_maize_days=0 if fs3a_maize_days==. & fs2a_meals_adults~=.
replace fs3b_rice_days=0 if fs3b_rice_days==. & fs2a_meals_adults~=.
replace fs3c_sorghum_days=0 if fs3c_sorghum_days==. & fs2a_meals_adults~=.
replace fs3d_millet_days=0 if fs3d_millet_days==. & fs2a_meals_adults~=.
replace fs3e_wheat_days=0 if fs3e_wheat_days==. & fs2a_meals_adults~=.
replace fs3f_cassava_days=0 if fs3f_cassava_days==. & fs2a_meals_adults~=.
replace fs3g_potatoes_days=0 if fs3g_potatoes_days==. & fs2a_meals_adults~=.
replace fs3h_yams_days=0 if fs3h_yams_days==. & fs2a_meals_adults~=.
replace fs3i_bread_days=0 if fs3i_bread_days==. & fs2a_meals_adults~=.
replace fs3j_matooke_days=0 if fs3j_matooke_days==. & fs2a_meals_adults~=.
replace fs3k_beans_days=0 if fs3k_beans_days==. & fs2a_meals_adults~=.
replace fs3l_vegetables_days=0 if fs3l_vegetables_days==. & fs2a_meals_adults~=.
replace fs3m_groundnuts_days=0 if fs3m_groundnuts_days==. &
        fs2a_meals_adults~=.
replace fs3n_fruit_days=0 if fs3n_fruit_days==. & fs2a_meals_adults~=.
replace fs3o_fish_days=0 if fs3o_fish_days==. & fs2a_meals_adults~=.
replace fs3p_meat_days=0 if fs3p_meat_days==. & fs2a_meals_adults~=.
replace fs3q_blood_days=0 if fs3q_blood_days==. & fs2a_meals_adults~=.
replace fs3r_eggs_days=0 if fs3r_eggs_days==. & fs2a_meals_adults~=.
replace fs3s_oil_days=0 if fs3s_oil_days==. & fs2a_meals_adults~=.
replace fs3t_sugar_days=0 if fs3t_sugar_days==. & fs2a_meals_adults~=.
replace fs3u_milk_days=0 if fs3u_milk_days==. & fs2a_meals_adults~=.
replace fs3v_beer_days=0 if fs3v_beer_days==. & fs2a_meals_adults~=.
replace fs3w_condiments_days=0 if fs3w_condiments_days==. & fs2a_meals_adults~=.

gen starch = fs3a_maize_days + fs3b_rice_days + fs3c_sorghum_days +
fs3d_millet_days +fs3e_wheat_days  + fs3f_cassava_days + fs3g_potatoes_days +
fs3h_yams_days + fs3i_bread_days + fs3j_matooke_days
gen pulse = fs3k_beans_days + fs3m_groundnuts_days
gen veg = fs3l_vegetables_days
gen fruit = fs3n_fruit_days
gen sugar = fs3t_sugar_days
gen oils = fs3s_oil_days
gen meat = fs3o_fish_days + fs3p_meat_days + fs3q_blood_days + fs3r_eggs_days
gen milk = fs3u_milk_days

replace starch = 7 if starch > 7 & starch < .
replace pulse = 7 if pulse > 7 & pulse < .
replace veg = 7 if veg > 7 & veg < .
replace fruit = 7 if fruit > 7 & fruit < .
replace sugar = 7 if sugar > 7 & sugar < .
replace oils = 7 if oils > 7 & oils < .
```

```
replace meat = 7 if meat > 7 & meat < .
replace milk = 7 if milk > 7 & milk < .

gen fcs = (2*starch + 3* pulse + 1*veg + 1*fruit + 4*meat + 4*milk + .5*sugar +
        .5*oils)/112
```

Ghana Food Consumption Score STATA Code:

```
gen starch = fs3amaizedays + fs3bricedays + fs3cwheatdays + fs3eotherrootsdays +
        fs3dcassavadays + fs3fplantaindays
gen pulse = fs3lpulsesdays
gen veg = fs3mvegetablesdays
gen fruit = fs3ofruitsdays
gen sugar = fs3psugardays
gen oils = fs3noildays
gen meat = fs3gfishdays + fs3hpoultrydays + fs3iredmeatdays + fs3jwildmeatdays +
        fs3keggsdays
gen milk = fs3qmilkdays

replace starch = 7 if starch > 7 & starch < .
replace pulse = 7 if pulse > 7 & pulse < .
replace veg = 7 if veg > 7 & veg < .
replace fruit = 7 if fruit > 7 & fruit < .
replace sugar = 7 if sugar > 7 & sugar < .
replace oils = 7 if oils > 7 & oils < .
replace meat = 7 if meat > 7 & meat < .
replace milk = 7 if milk > 7 & milk < .

gen fcs = (2*starch + 3* pulse + 1*veg + 1*fruit + 4*meat + 4*milk + .5*sugar + .
5*oils)/112
```