DETERMINANTS OF HOUSEHOLD FOOD SECURITY IN LUGARI AND MAKUENI SUB-COUNTIES, KENYA

PRESENTED

BY

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DECLARATION

This research paper is my original work and has not been submitted for any award in any other University.

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This research project has been submitted with our approval as University Supervisors.

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DEDICATION

I dedicate this work to my Parents Dr. Francis Mungai and Mrs. Mary Muthoni Mungai for their relentless encouragement to purse my studies right from class one. Indeed the magnitude of their love, support, upbringing, training, provision, discipline, and wisdom has left me in awe today.

Had it not been for the many teachers in whose hands I have passed since childhood; their institutions, inspirations, teaching, training, discipline and commitment, it would not have been possible to complete this work. In particular; staff at Kandongu Primary School and Muranga High School.

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All the errors and omissions in this research project however remain solely mine.

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ACRONYMS

FAO – Food and Agricultural Organization

GoK – Government of Kenya

Kshs – Kenya Shillings

MDER – Minimum Dietary Energy Requirement

NALEP – National Agricultural and Livestock Extension Program

USDA – United States Department of Agriculture

WFC – World Food Conference

ABSTRACT

The study was carried out to assess the determinants of household food security among households in Lugari and Makueni sub-Counties. Secondary household data collected from 2000 randomly selected households in both sub-counties by the Ministry of Agriculture under the NALEP program was used for analysis. Analytical techniques employed include descriptive statistics to analyze the characteristics of respondent households, and binary regression analysis using a probit model to examine the determinants of food security among the households surveyed. Among the variables considered in the model, household head age, household head education level, household size, land size per capita and house hold income (proxied by household expenditure) were found to significantly influence household food security. Consistent with *a priori* expectation, larger households were found to be food insecure compared with households with fewer household members, *ceteris paribus*. Also, consistent with findings from previous empirical studies, land size per capita, household income and household head education level were found to have significant positive effect on household food security. The study, therefore, recommends among others improved access to credit for rural households and diversification of household economic activities to include off-farm income generating businesses to improve food security at the household level.

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CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Humanity faces the triple challenge of simultaneously feeding a population estimated to reach nine billion by 2050, in the face of increased global warming, remaining securely within the planet's physical capacity to produce food and maintaining the livelihoods generated by agriculture and the associated food industries (Ingram et al., 2010)

Food security has over the years undergone several definitions. Famine Early Warning Systems Network (2014) defines food security as “a state when all people have access at all times to safe, nutritious, sufficient food to maintain an active and healthy life”. It is however a complex issue that encompasses sustainable development, malnutrition, health and economic progress as well as trade, and has over the years elicited debates as different societal members voice their concerns (FAO, 2010). The United States Department of Agriculture (USDA) asserts that food insecurity is a situation characterized by uncertain or limited availability of nutritiously adequate safe foods (Bashir et al., 2010). A food secure individual therefore does not live in hunger nor fear starvation as the production mechanisms surpass the consumption threshold. The measure of Food Security incorporates the resilience from future disruptions of critical food supply emanating from salient risk factors (Famine Early Warning Systems Network, 2014). Drought, fuel shortages, wars, shipping disruptions, and economic instability are among the vile risk factors that affect food security.

Analytical inferences indicate that the current levels of production cannot meet future food requirements (World Food Program, 2007). Opponents to the debate infer that the world has sufficient food to meet the prevailing requirements but distribution is the problem. With the advent of globalization, both opponents and proponents to the debate are yet to agree on the consequences. Without a doubt, food security is a momentous issue that requires urgent redress from both urban and rural dwellers. Given the direct relationship between food security, health, and productivity, governments have the core mandate to mitigate food shortages and safeguard human rights.

Household food security is an imperative element that perturbs governments around the world. In the 2011/2012 fiscal year, over 840 million people around the world faced chronic hunger (FAO, 2011).

In seeking to safeguard the interest of humanity, governments across the globe have envisaged the "Right to Food" in their Constitutions and Kenya is no exemption.

1.2. The food security situation in Kenya and the role of the agricultural sector

In the recent years, and especially starting from 2008, the country has been facing severe food insecurity problems. In 2008, an estimated 1.3 million people in rural areas and 3.5 – 4 million in urban areas were food insecure. An estimated 150,000 persons residing predominantly in high-potential areas of the Rift Valley province were extremely food insecure following the post-election crisis and approximately 100,000 more children became malnourished as a result of the food crisis (Kenya Food Security Outlook, 2009; Save the Children, 2009).

The food security situation in Kenya is also depicted by a high proportion of the population having no access to food in the right amounts and quality. Official estimates indicate over 10 million people in Kenya are perennially food insecure with some of them living on food relief throughout. Maize, being staple food has been in short supply and most households have had limited choices of other food stuffs (Food Security Report, 2014).

One of the key sectors in addressing the food insecurity issue in Kenya is the agricultural sector which through backward and forward linkages accounts for 27% of the country's GDP. Currently, the government derives more than 45% of its revenue from the sector. The sector also contributes up to 75% of the industrial materials, 50% of export earnings and 60% of the total employment in Kenya. More than 80% of the country's population in the rural areas garners their livelihoods from the agricultural sector (Kenya Food Security Outlook, 2014)

Agriculture in Kenya is mainly rain fed and failed short and long rains in many parts of the country in the foregoing years has contributed to exacerbating food insecurity in the country. Marginal agricultural households, agro-pastoralists, pastoralists, and the urban poor in the southeastern and coastal lowlands and have been particularly affected. This has subsequently caused a dramatic increase in cereal prices ranging from 50 – 80 percent as compared to other commodity prices. As a result of the crisis, there has been an increase in school dropout rate, food riot incidents, and crime rate (Root Capital, 2014)

The constrained food supply situation has also resulted in overall general price levels remaining elevated or rising. With constant or declining income-earning opportunities, households' food access has remained constrained. However, various coping strategies are being used to increase income, so in many areas, households are still able to acquire their minimum dietary requirements though they remain stressed in much of the country.

The attainment of a food secure nation has therefore been a prime objective for the agricultural sector in Kenya. The Kenyan Constitution asserts that food security is a human right envisaged under law while the Kenya Vision 2030 is among the numerous undertakings by the government to foster food security in Kenya. Through the strategic initiatives contained in the Medium Term Plans, the government not only seeks to transform the agricultural sector into a profitable endeavor that lures private investors and provides gainful employment opportunities for the masses, but also creates food security both at the national and household level.

1.3. Why Lugari and Makueni

This study focused on Lugari and Makueni sub-counties. According to reviewed studies and literature materials available, both Lugari and Makueni sit in different ecological zones and face high vulnerability to household food insecurity. The food security challenge documented by some of the previous studies and other literature materials for each sub-county is as follows;

1.3.1. Lugari Sub-county

For Lugari sub-county, studies have shown that seasonal patterns have shifted; the rainy season now starts later and ends sooner. Residents now have more intense bouts of torrential rain other times of the year. This extreme variability in rainfall has been blamed for causing either drought or flooding and often ruining the sub-county's food supply, fields and potential income. Soil fertility has also been increasingly declining, as floods wash nutrients away. This has led to even more poverty, starvation, recalcitrant epidemics, ultimately social unrest and political upheaval (Matungu, 2014).

Although over 80% of the residents source their livelihoods from agricultural activities, a portion of the population has remained food insecure (Root Capital, 2014). Given that the rural population of Lugari sub-county has to deal with provisioning uncertainty of food on a daily basis, they remain vulnerable to food insecurity and hunger (Relief web, undated).

1.3.2. Makueni Sub-county

Although agriculture is among Makueni sub-county's core economic activities, most households remain food insecure. In the last two decades, household food security has been declining in the sub-county and it has been reported that three out of every four years are of poor harvest during which households have to depend on rationed food from relief agencies (Lemba, 2009).

In 2002, the sub-county housed the largest proportion (70 percent) of food insecure households in the country while in 2005 the government reported 62 percent of the population to have been in dire need of emergency relief food aid (Lemba, 2009).

Both Lugari and Makueni sub-counties have in the recent years had food security interventions by government, development partners and donor organizations. One such intervention is the National Agricultural and Livestock Extension Programme (NALEP)[1] that provided extension services to farming households. The two sub-counties had been selected for NALEP's impact assessment and the two sub-counties are among parts of the country faced with the food security challenge (Jean-Philippe, 2013).

The documented food insecurity situation in both sub-counties was the primary motivation in using them as the basis of conducting this study. Lugari has great agricultural potential unlike Makueni which is located in the dry lands and therefore form an integral representation of contrasting climatic settings. An assessment of the determinants of food security in the two regions therefore was meant to unearth if there are any differences in the determinants of food security given their different locations.

1.4. Research Objectives

With the foregoing introduction, this study aimed at examining the food security situation in Lugari and Makueni Sub-counties. The study also sought to unearth the key determinants of food security in Lugari and Makueni Sub-Counties.

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[1] NALEP which ran from 2000 to 2011 with the financial support from Swedish Development Authority (SIDA) and GoK was one of the largest development extension programme in the East African. NALEP's thrust was that of promoting socio-economic growth in the agricultural sector as well in order to assist in the national struggle towards poverty reduction through achieving food security.

1.5. Research Questions

Key research questions included the following:

a) What levels of food security are experienced by households of Lugari and Makueni Sub-Counties?

b) What are the determinants of food security in Lugari and Makueni?

1.6. Significance of the Study

Food security is an imperative element in any country, Kenya included. The Government of Kenya has the cardinal responsibility of ensuring that its citizens are well fed in a sustainable manner as this has a direct effect on the social and economic stability of the country.

At a time when food security in the country is currently under threat due to changing weather patterns, which are not as reliable as before due to global warming, increasing food prices, reliance on food imports among other factors, understanding the determinants of food security at household level is important as it will avail formidable recommendations that will aid in fostering food security, not only in Lugari and Makueni, but in the country at large.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews existing literature on the determinants of food security. We looked at both the theoretical and empirical literature.

2.1. Theoretical and conceptual framework

As noted, definitions as well as concepts of food security have been changing over time, more so in the last 30 years. In the 1970's, food security was initially thought of as "food supply that could ensure availability and economic access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life" at the international and national level (IFPRI, 2011). This definition of food and nutrition security reflects two key dimensions: (1) the food and nutrition status and (2) the stability of this food and nutrition status and has been extended to household level.

According to FAO (2004), food security revolves around three substantial pillars that include food access, availability, and utilization. These pillars will play a focal role in analyzing the determinants of food security and their impacts. In the following section, we present the conceptual framework for the analysis of the major drivers of food and nutrition security at the micro-level.

In the conceptual framework depicted in figure 1 below, food availability, food access and food utilization determine the state of affairs, referred to as the food and nutrition status of an individual or a household. Stability refers to two additional important dimensions, notably vulnerability and resilience towards the state of affairs. In line with Sarris and Karfakis (2008), vulnerability is defined as *'the likelihood of experiencing future loss of welfare, generally weighted by the magnitude of expected welfare losse*s; while resilience refers to '*the ability to recover from such welfare losses*.

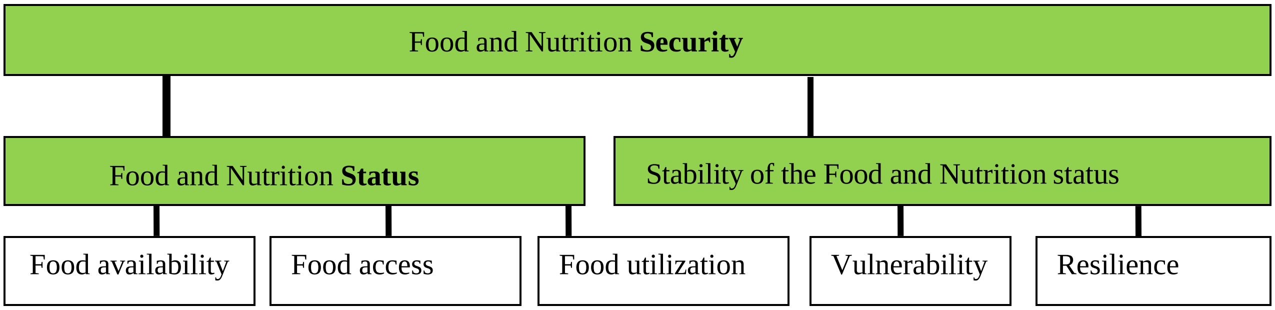

Figure 2.1: ***Dimensions of Food and Nutrition Security at the Micro-Level***

2.1.1. Food Availability

Food availability can be described as the extent to which food is within reach of households (for example in local shops and markets), both in terms of sufficient quantity and quality (FAO, 2006). Food availability at the micro-level is strongly related to the overall availability of food, which is determined by domestic food production, commercial food imports and food aid (FAO, 2006). These are in turn influenced by domestic policies regarding food production, such as policymakers' focus on food self-sufficiency or food self-reliance. Other policies directly affecting food availability are agricultural subsidy programs, exchange rate policies affecting international trade opportunities and policies creating stable and attractive conditions for agricultural investments. In general, the food availability dimension reflects the supply side and will therefore be affected by all the drivers and determinants that have an impact on the domestic supply of food and the ability to finance food imports (Barret and Lentz, 2009).

2.1.2. Food Access

Household-level food access is considered to be achieved when a household has the opportunity to obtain food of sufficient quantity and quality to ensure a safe and nutritious diet (FAO, 2006). To realize this, not only domestic and local food availability must be realized; households must also have access to the necessary resources to acquire food. Important drivers of food access are household resources, food prices, food preferences and socio-political factors such as discrimination and gender inequality.

The quantity and quality of food that a household can acquire given its resources will depend on domestic food prices, which are generally determined by food availability and aggregate food demand. For given prices and income, individual preferences will determine the consumption of different commodities, including food. Dietary preferences can be influenced by factors such as culture, religion and social status (Atkin, 2013).

We note however that at the individual and household level, it is difficult to distinguish food availability from food access. In regions where local markets are malfunctioning, households generally depend on food production as a means to have access to food, in which case (local) food availability and food access strongly overlap. However, even in regions were local markets are well developed, it is not always straightforward to distinguish between the two.

2.1.3. Food Utilization

Food utilization refers to an individual's dietary intake and his/her ability to absorb nutrients contained in the food that is eaten. Hence, food utilization relates not only to the quantity of food that is eaten, but also to the quality of the diet. In particular, the food consumed by an individual must be of sufficient quantity and quality to satisfy not merely subsistence needs, but also energy needs for daily activities, notably income generation (World Food Program, 2007).

Food access, as described in the previous section, is a necessary but not a sufficient condition to ensure an adequate food and nutrition status (Barrett and Lentz, 2009). For example, a household might have access to all the necessary food products for a balanced diet, but still prefer to buy hyper-caloric food. Banerjee and Duflo (2006) indeed document that an increase in household income does not necessarily lead to an increase in the quantity or quality of food consumed, but can be spent on items such as alcohol or fast-food. Alternatively, an unequal distribution of food within the household might cause some members to eat more and others less than required. In both cases, at least some household members will not absorb the required amount of micronutrients, resulting in a poor food and nutrition status.

Factors that determine food utilization include food prices, household incomes and education levels which influence dietary preferences of the household.

2.1.4. Food consumption at household level

Household food consumption is typically used as an indicator for food security. As noted above, food consumption will depend on non economic factors e.g. availability and access as well as economic factors e.g. prices and incomes among others. The question then that arises is how to model food consumption at household level. Theoretically, micro economic theory provides the standard approach by which to model consumption, with the traditional consumption theory investigating the relationship between demand for goods and their prices and the incomes (or expenditures) of consumers under the assumption of utility maximization and rational behavior. However, for food consumption, the assumption is that households consider characteristics such as energy content of the food, taste, health, status and environmental properties and financial cost when deciding what to consume (Fischer, undated). It is assumed that decisions on what to consume and how much to consumer are determined by the household head, where the need for calories can be considered the main driver for food consumption. It is worth noting that intra-household food distribution patterns determine the dietary intake and nutrition level of each individual member.

2.2. Empirical Review

With the foregoing theoretical and conceptual framework on food security, this section provides an empirical literature review on the determinants of food security in households.

Over the years, scholars have remained committed to measuring food security in Africa and any salient factor affecting it. These include Arene and Anyaeji (2010), Feleke *et al* (2003), Aidoo *et al* (2013), Omotesho *et al* (2006), Bashir *et* al (2010) and Babatunde *et al* (2007) among others. Various determinants have been investigated including household farm size, farm and non-farm income, household size, age and education of household head, wealth (proxied by ownership of livestock), marital status and per capita aggregate production. Findings from selected studies have been reviewed below.

Income is a vital element that affects consumer behavior. Given that income either alleviates or inhibits the purchasing power, it immensely alters food security. According to Bashir *et al.*, (2010), households earning high income rarely experience food insecurity. Through the Pakistan based study, the authors unveiled that the population in higher income group of experience food security 15 times more compared to households with no income. With a stable source of income, households manage to offset the impending consumption balance. Given the scarce availability of land, finance, and capital resources, households without income rarely secure their status. This is because the difference between production and consumption cannot finance non-food commodities in a consistent manner.

Additionally, households in the rural setting are yet to secure agricultural produce from uncertain adverse conditions and affliction. Sindhu *et al*, (2008) re-emphasized on the impact income plays in eradicating food insecurity at the household level. From the study they inferred that an increase in monthly income reduces exposure to food insecurity. Using a binary logistic regression, the authors noted that an Rs[2]. 1000 increase in monthly income reduced food insecurity by 30%. Using a similar approach in Nigeria, Babatunde *et al.*, (2007) found that an increase in the household's annual income reduced food insecurity by 63%.

Different families constitute a distinct number of members. Depending on the parent's preferences, some families are large while others are small. Sindhu *et al.*, (2008) asserts that family size is a crucial determinant to food security. According to the study, an additional family member increases the family's exposure to food insecurity by 96%. In a similar study in Nigeria, Amaza *et al.*, (2006) affirmed that every additional family member reduces the household's food security by 1.5%. Given that every household member consumes a significant portion of the family basket, size is a key determinant to food security. In a similar study, Bashir *et al.*, (2010) through a Multinomial Logistic Regression concluded that households having 4 – 6 and 7 – 9 members were 97% food insecure.

Some scholars in the past have aired divergent views on the effect of the age of the head of the household on food security. In a descriptive study, Omonona and Adetokundo (2007) indicated that an increase in the age of the household head subsequently increases the incidence to food insecurity. In their study on food security in Nigeria, the researchers found that food insecurity escalated at the age between 21 – 70 years. Contrary to these assertions, Onianwa and Wheelock (2006) concluded that an increase in the age of households reduced their food insecurity by 2%. In seeking to diffuse the gridlock, Bashir *et al.*, (2010) noted that from 35 years onward, every additional year reduces food security by 83 percent. Although a complex analogy, the age of household head does affect the exposure to food security.

Using a binary logistic regression model, Ojogho (2009) noted that having a household head with both primary and secondary education reduced the probability of food insecurity by 78% while with a tertiary level of education, food insecurity reduced by 92%. In a similar study in Kenya, Mariara *et al.*, (2006) indicated that high education levels among mothers improve food security significantly. Given

[2] Pakistani Rupee

that education empowers household members and avails amicable resolutions to fighting food shortage, the higher the education level, the lower the exposure to food insecurity.

However, Arene and Anyaeji (2010) and Aidoo *et al* (2013) found that education level of household head were insignificant in determining the food security status of households in Enugu state of Nigeria and Sekyere-Afram plains in Ghana respectively.

Livestock assets help rural households in undertaking some strenuous agricultural activities. For instance, a horse or ox assists farmers to cultivate large chunks of land faster and better. In Ethiopia, Haile *et al.*, (2005) found out that households that used an ox were 5% more profitable compared to those that solely relied on human labor. Although on a different perspective, Bashir *et al.*, (2010) also found out that households owning a milking cow were 32 times more food secure compared to families with no milking cow. Animals that aid in undertaking agricultural endeavors foster profitable production as they ease labor requirements. On the other hand, animals that produce substitute food products like eggs, milk, and meat significantly expand the production threshold. In both situations, livestock assets aid in negating food insecurity. Feleke *et al* (2003) however found out that the number of livestock (which was a proxy for wealth) was statistically insignificant in determining food security.

Other variables that have been identified as determinants of food security include access to markets, access to credit and per capita land size. For example, Najafi (2003) postulated that food production can be increased extensively through expansion of areas under cultivation. Therefore, under subsistence agriculture, land size is expected to play a significant role in influencing farm households' food security.

2.3. Overview of the literature

The theoretical and conceptual framework shows the importance of food and nutrition status (determined by the food accessibility, utilization and availability) to the food security status of an individual or household. In the foregoing empirical literature review, different scholars vouch for divergent determinants of food security at the household level even though they remain consistent in most developing countries. Education, livestock assets, family size, per capita land size, age of household head, and income are the notable factors that affect food security.

CHAPTER THREE

METHODOLOGY

This chapter defines the research design and methodology for the study. It contains a description of the study design, data collection technique, and data analysis technique.

3.1. Research Design

Research design refers to how data collection and analysis are structured in order to meet the research objectives through empirical evidence economically. This study made use of a binary probit estimation model with the dependent variable being the status of food security of the sample households.

3.2. Data and variable definitions

The research relied on household data collected for Lugari and Makueni sub-counties under the Kenya National Agricultural and Livestock Extension Program (NALEP). The data was collected through a household survey done in February 2012. The Samples consisted of 1000 households in Lugari and 1000 households in Makueni and the data was collected over 25 consecutive days by 20 enumerators who had been trained for the purpose of the data collection, and supervised directly with the support of the NALEP staff based in Lugari and Makueni.

Table 3.1: ***Variables definitions***

Dependent variable:		**Apriori Expectation (Hypotheses)**
Food security	A categorical variable with 1=food secure; 0=food insecure	No apriori expectation. It's defined as a 0 or 1 variable.
Independent variables:		
Age	A continuous variable representing the age of the household head. In the analysis it is represented as	Negative

	"**hh1age**"	
Household size	Number of household members. In the analysis it is be represented as "**hhsize**"	Negative
Education	A categorical variable representing education level of the household head. In the analysis it is represented as "**hh1edu**"	Positive
Household expenditure	A continuous variable used to proxy household income. In the analysis it is represented as "**hh1exp**"	Positive
Per capita land size	A continuous variable representing per capita land size of a household. In the analysis it is represented as "**landsizepc**"	Positive

3.3. The Model and Data Analysis

The age as well as the education level of a household head was directly captured in the survey questionnaire. The household size was derived by aggregating the members of a household while per capita land size was derived by dividing the land size owned by a household by the size of the household. Household Income was proxied by the household expenditure that in turn was obtained by aggregating a household's expenditures in different areas.

To measure food security at the household level, the study used calorie intake method. The analytical problem was in two stages. First, the food security status was calculated using the calorie intake method. The food access threshold was determined at 2250 Kcal as recommended by the Kenyan Government and used in poverty measures in Kenya (i.e. 2250 kilocalories (kcal) per person per day (Kenya Food Security Steering Group, 2008). This figure represents the Minimum Dietary Energy Requirement (MDER) (Kcal/person/day) which establishes a cut-off point, or threshold, to estimate the prevalence (percentage) of the undernourished population in a country. When the threshold, or cut-off point changes, so does the prevalence of people estimated to be undernourished. Dietary energy requirements differ by gender and age, and for different levels of physical activity. Accordingly, minimum dietary energy requirements, the amount of energy needed for light activity and minimum acceptable weight for attained-height, vary by country, and from year to year depending on the gender and age structure of the population. For an entire population, the minimum energy requirement is the weighted average of the minimum energy requirements of the different gender-age groups in the population. It is expressed as kilocalories (kcal) per person per day.

A household whose daily per capita calorie intake was equal to or greater than this threshold was considered food secure. In the second stage, binary probit regression technique was used to identify the determinants of food security. The probit regression directly estimates the probability of an event occurring for more than one independent variable, that is, for k independent variables (Bashir *et al*., 2010).

To model food security, the study defined Y =1 if household is food secure and Y =0 if household is food insecure.

The general form of the probit regression equation can be written as (Bashir *et al.*, 2010).

$$\Pr(\mathrm{y}=1/x)=\alpha+\beta_1 x_1+\beta_2 x_2+\beta_3 x_3+......+\beta_k x_k \quad \text{.. (1)}$$

Where:

Pr = the probability that a particular household is food secure (y=1) given the household attributes that can determine food security status.

α = the constant of the equation

β = the coefficient of the predictor variables

x = the predictor variables or household characteristics.

Now food security (of either y=1 if household is food secure and y=0 if household is food insecure) is an unobservable outcome. Instead of measuring it directly, the study makes use of level of calorie intake as earlier explained and as recommended by Wooldridge (2002).

From the above, we can define our equation as

$$Y_i^* = \beta X_i + \varepsilon_i \quad \text{... (2)}$$

Where; Y_i^* is the unobservable/latent measure of food security. Y is the observable measure and will be calculated using the levels of calories intake by a household. Y will be used to shed more light on Y_i^*

X_i represents household characteristics that predict whether a household is food secure or not.

If $Y_i^* \geq$ 2250*household size then Y =1 and if Y_i^* < 2250*household size then Y =0

Linking Y_i and Y_i^*, we obtain;

$$\Pr(Y=1)=\Pr(Y_i^*>0)=\Pr(\beta X_i+\varepsilon_i \geq 0)=\Pr(\varepsilon_i \geq -\beta X_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Hence, $Y_i = 1$ when $Y_i^* \geq 0$ and $Y_i = 0$ when $Y_i^* \leq 0$

Thus the probability of being food secure is represented by;

$$\Pr(Y=1)=\Pr(\beta X_i+\varepsilon_i \geq 0) \ldots \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(4)}$$

Since the study assumed the error terms are normally distributed, the study made use of a probit model where the study used the cumulative distribution function of the standard normal distribution. Hence the model is;

$$\Pr(Y_i=1/X)=1-\Phi(-\beta X_i)=+\varepsilon_i \geq 0)=\Phi(\beta X_i) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Where; - Φ is the cumulative density function of the standard normal distribution

Y_i represents the observed food security status

X_i represent household characteristics

The last expression follows from the fact that the standard normal distribution is symmetric about zero. Substituting for Φ we obtain:

$$\Pr(\mathrm{Y}=1/X)=\int_{-\infty}^{\beta' X} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{1}{2}(X)^2\right) dX \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(6)}$$

To estimate the marginal probabilities, the following formula was applied;

$$\frac{\partial \Pr(Y_i = 1/X)}{\partial X} = \Phi(\beta X_i)\beta \quad (7)$$

The marginal effects were estimated at the means for both discrete and continuous independent variables.

CHAPTER FOUR

DATA ANALYSIS, FINDINGS AND DISCUSSIONS

4.1. Descriptive statistics

Summary statistics reported in this section include the mean and standard deviation for all the variables used in the model.

4.2. Summary Statistics

Also as shown in Table 4.1, for Lugari and Makueni sub-counties combined, the typical household head was aged 49 years (s.d. 14.26). Households had on average 5 members with a mean household expenditure of Kshs 65,711.55 (s.d. 44,362.95). The average land size per capita was 0.71 acres (s.d. 1.82).

Table 4.1: ***Descriptive Statistics and Mean Differences***[3]

Variable	Combined		Lugari (A)		Makueni (B)		Mean Diff
	Mean	SD[4]	Mean	SD	Mean	SD	(A-B)
Household head age	49.07	14.26	50.00	13.95	48.24	14.50	1.76139**
Household size	5.60	2.15	6.12	2.18	5.13	2.01	0.985331**
Household exp	65711.55	44362.95	65267.89	44539.95	66112.40	44221.72	-844.510
Land size per capita	0.71	1.82	0.36	0.54	1.01	2.41	-0.646**

**significant at 95% confidence interval

Source: Own calculations based on NALEP survey data

In Lugari sub-county, households had older heads (50 years) and were larger in size (6 members) than those in Makueni sub-county. However the land size per capita (0.36 acres) and household expenditure (Kshs 65,268) among households in Lugari were found to be lower than those in Makueni**.** The mean differences in age, household size, and land size per capita between the two samples were found to be statistically significant.

[3] Detailed tables are in the annexes

[4] Standard deviation

4.3. Food Security situation

Assessment of food security situation for the two sub-counties was conducted. Households were categorized as either food secure or food insecure based on the threshold of 2,250 kilocalories (kcal) per person per day times the number of household members. A frequency tabulation of households by the status of food security is displayed in Table 4.2.

Table 4.2: ***Food security situation***

Food security status	**Lugari and Makueni Combined**		**Lugari**		**Makueni**	
	N	%	n	%	n	%
Food insecure	230	12.39	126	14.43	104	10.57
Food secure	1627	87.61	747	85.57	880	89.43
Totals	**1857**	**100**	**873**	**100**	**984**	**100**

Source: Own calculations based on NALEP survey data

Findings indicate that 87.61 per cent of both the sample population in Lugari and Makueni is food secure. However, the percentage of food secure households was found to be higher in Makueni (i.e. 89.43 per cent) than in Lugari (i.e. 85.57 per cent). As discussed before, food security situation was based on calorie intake calculated from household consumption bundles.

4.4. Regression Analysis

The study used the approach of interpreting categorical dependant variables developed by Long and Freese (2001). The study examined both the probabilities as well as the marginal changes in probabilities.

4.4.1. Predicted probabilities

The means of variables presented in Table 4.1 were used to predict the probability of a household being food secure. This procedure was repeated for Lugari and Makueni sub-counties separately and the two sub-counties combined. Findings are shown in Table 4.3.

Table 4.3: ***Predicted Probabilities of Food Security Situation at the Means***

Sub-County	N	Predicted probabilities of being food secure at the means	95% Confidence Interval
Lugari	873	0.8890	0.8128 – 0.9229
Makueni	984	0.9255	0.9067 – 0.9443
Combined	1857	0.9035	0.8886 – 0.9183

Source: Own calculations based on NALEP survey data

For Lugari sub-county, there is 95% confidence that the predicted probabilities of household being food secure lies in the range of 0.8128 and 0.9229. The actual probability of a household being food secure in the combined sample is 0.8890.

On the other hand, there is 95% confidence that the predicted probabilities of household being food secure in Makueni sub-county lies in the range of 0.9067 and 0.9443. The actual probability of a household being food secure in the combined sample is 0.9255.

There is 95% confidence that the predicted probabilities of household being food secure in Lugari and Makueni sub-counties combined lies in the range of 0.8886 and 0.9183. The actual probability of a household being food secure in the combined sample is 0.9035.

4.4.2. Marginal effects

The results of the marginal effects, established at the means of independent variables, are shown in Table 4.4.

Table 4.4: ***Marginal Effects of covariates on probability of a household being food secure***

Variable	Combined		Lugari		Makueni	
	Marginal effect	P-Value	Marginal effect	P-Value	Marginal effect	P-Value
Household head age	-0.0080**	0.0150	-0.0080*	0.0830	-0.0070*	0.0880
Household head age^2	0.0000**	0.0240	0.0001	0.1020	0.0010*	0.0890
Household head educ	0.0060	0.2930	-0.0070	0.3750	0.0210**	0.0050
Household size	-0.0350***	0.0000	-0.0370***	0.0000	-0.0370***	0.0000
household exp	0.0654***	0.0000	0.0865***	0.0000	0.0732***	0.0000
land size per capita	0.0060	0.2130	-0.0170	0.3520	0.0030	0.5190
Number of obs (n)	1815		866		949	
LR chi2(13)	159.18		89.39		95.37	
Pseudo R2	0.1184		0.1269		0.1502	

***** Significant at 0.01; ** significant at 0.05; * significant at 0.10 levels**

Source: Own calculations based on NALEP survey data

It emerges that an increase in age of the household head ceteris paribus, decreases the probability of being food secure in the combined sample. Specifically, the probability of being food secure decreases by 0.8 per cent in households where the household head is older by an additional year, *ceteris paribus*. The co-efficient on age was found to be significant. This is in line with findings from other studies (Bashir *et al*, 2010).

Results also indicate that an additional level of education for the head of the household increases the probability of being food secure in the combined sample. Similarly, an increase in land size per capita increases the probability of being food secure except for Lugari sub-county. The coefficient on household size and household expenditure are also significant and the results show that *ceteris paribus,* an additional member in a household decreases the probability of being food secure by 3.5 percent while an increase in household expenditure increases the probability of being food secure by 6.5 percent, *ceteris paribus*.

The coefficients on education level of the household head and land size per capita were however found not to be significant.

For Lugari Sub-county, the coefficient on age of household head, household size and household expenditure were found to be significant and the results show that *ceteris paribus*, an additional year of head of the household decreases the probability of the household being food secure by 0.8 percent. An additional member to the household reduces the probability of being food secure by 3.7 percent while an increase in household expenditure increases the probability of being food secure by 8.7 percent.

Like in the combined sample, the coefficients on education level of the household head and land size per capita were found not to be significant.

For Makueni Sub-county, the study found that the co-efficient on education level of household head was significant unlike in the combined and Lugari samples. Other significant coefficients include age of the household head, household size and household expenditure.

The results indicate that an increase in the level of education in Makueni Sub-county increases the probability of being food secure by 2 percent while an increase in household expenditure increases the probability of being food secure by 3.7 percent. Like in the combined sample and in Lugari, an additional household member reduces the probability of being food secure.

CHAPTER FIVE

CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 Summary

The objective of this study was to examine the food security situation in Lugari and Makueni Sub-counties in order to unearth the status of food security as well as the key determinants of food security in these two sub-counties. Secondary household data collected from 2000 randomly selected households in both sub-counties by the Ministry of Agriculture under NALEP project was used for analysis. Analytical techniques employed included descriptive statistics to analyze the characteristics of respondent households, and binary regression analysis using a probit model to examine the determinants of food security among the households surveyed.

Findings of descriptive statistics, as well as statistical tests, indicate that Makueni has a higher probability of food security compared to Lugari. Even though education level of the household head is attributed to a higher probability of food security in Makueni, this is not the case in Lugari. In all, an increase in income (proxied by expenditures) and land size per capita increases the probability of being food secure. Households headed by older individuals are less likely to be food secure compared to households headed by younger household heads.

5.2 Conclusions

The study can thus conclude that age of the household, education level, household size and incomes (proxied by expenditures) are important determinants for food security. A higher level of education promotes adoption of new and improved farming systems that could promote increased food production hence improve food security. Families should be encouraged to have fewer children so that they are able to adequately provide proper nutrients intake. This is given the fact that results show an additional household member decreases the probability of being food secure in both sub-counties.

5.3 Recommendations

In the light of the findings from the study, it is recommended that efforts to improve access to credit by farmers and the promotion of off-farm activities as alternative livelihood options should be pursued by both the National and County Governments in these two regions. Policies that will make micro-credit from government and nongovernmental agencies accessible to rural farmers will go a long way in addressing their resource acquisition constraints and eventually improving household food security in the country.

Institutions which foster agricultural research and extension and efficient land use, should also receive priority attention in policy making at both the national and the county governments in these two regions.

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APPENDIX 1: SIGNIFICANCE TESTS

1. Household head age

Two-sample t test with equal variances

```
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
1. Lugar |     871    50.00344    .4725951    13.94756    49.07588      50.931
2. Makue |     975    48.24205    .4642281    14.49552    47.33105    49.15305
---------+--------------------------------------------------------------------
combined |    1846    49.07313    .3319648     14.2629    48.42206     49.7242
---------+--------------------------------------------------------------------
    diff |            1.761393    .6639002                .4593178    3.063468
------------------------------------------------------------------------------
    diff = mean(1. Lugar) - mean(2. Makue)                        t =   2.6531
Ho: diff = 0                                     degrees of freedom =     1844

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0

 Pr(T < t) = 0.9960         Pr(|T| > |t|) = 0.0080      Pr(T > t) = 0.0040
```

2. Household expenditure

Two-sample t test with equal variances

```
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
1. Lugar |     871    65267.89    1509.179    44539.95    62305.84    68229.95
2. Makue |     964     66112.4    1424.286    44221.72    63317.34    68907.46
---------+--------------------------------------------------------------------
combined |    1835    65711.55    1035.625    44362.95    63680.42    67742.67
---------+--------------------------------------------------------------------
    diff |           -844.5092    2074.386               -4912.918      3223.9
------------------------------------------------------------------------------
    diff = mean(1. Lugar) - mean(2. Makue)                        t =  -0.4071
Ho: diff = 0                                     degrees of freedom =     1833

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0

 Pr(T < t) = 0.3420         Pr(|T| > |t|) = 0.6840         Pr(T > t) = 0.6580
```

3. Household size

Two-sample t test with equal variances

```
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
1. Lugar |     873    6.117984    .0738241     2.18125     5.97309    6.262878
2. Makue |     980    5.132653    .0643003    2.012919    5.006471    5.258835
---------+--------------------------------------------------------------------
combined |    1853     5.59687    .0499547    2.150376    5.498896    5.694843
```

```
---------+--------------------------------------------------------------------
    diff |            .9853309    .0974484                .7942106    1.176451
------------------------------------------------------------------------------
    diff = mean(1. Lugar) - mean(2. Makue)                        t =  10.1113
Ho: diff = 0                                     degrees of freedom =     1851

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

4. Land size per capita

Two-sample t test with equal variances

```
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
1. Lugar |     873    .3639938    .0183159    .5411713    .3280454    .3999421
2. Makue |     984    1.010023    .0769086    2.412528    .8590992    1.160947
---------+--------------------------------------------------------------------
combined |    1857    .7063162    .0423097     1.82325    .6233366    .7892959
---------+--------------------------------------------------------------------
    diff |           -.6460293    .0834567               -.8097082   -.4823504
------------------------------------------------------------------------------
    diff = mean(1. Lugar) - mean(2. Makue)                        t =  -7.7409
Ho: diff = 0                                     degrees of freedom =     1855

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

APPENDIX 11: REGRESSION RESULTS

(*Scott Long and Jeremy Freese approach to regression models for categorical dependent variables)

1) . ***Overall regression**

. xi:probit foodsecure hh1age hh1age2 hh1edu hhsize hh1exp landsizepc

```
Iteration 0:   log likelihood = -672.31803
Iteration 1:   log likelihood = -594.49702
Iteration 2:   log likelihood = -592.73153
Iteration 3:   log likelihood = -592.72918
Iteration 4:   log likelihood = -592.72918

Probit regression                                 Number of obs   =       1815
                                                  LR chi2(6)      =     159.18
                                                  Prob > chi2     =     0.0000
Log likelihood = -592.72918                       Pseudo R2       =     0.1184

------------------------------------------------------------------------------
  foodsecure |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      hh1age |  -.0424677   .0174471    -2.43   0.015    -.0766634    -.008272
     hh1age2 |   .0003783   .0001672     2.26   0.024     .0000505    .0007061
      hh1edu |   .0322342   .0306423     1.05   0.293    -.0278236    .0922919
      hhsize |  -.195348    .0222901     8.76   0.000      .151661    .2390365
      hh1exp |   7.61e-06   8.00e-07    -9.51   0.000    -9.18e-06   -6.04e-06
  landsizepc |   .0309596   .0248778     1.24   0.213       -.0178    .0797191
       _cons |   1.713126   .4194922     4.08   0.000     .8909363    2.535315
------------------------------------------------------------------------------
```

probit: Predictions for foodsecure

```
Confidence intervals by delta method

                               95% Conf. Interval
  Pr(y=1|x):          0.9035   [0.8886,    0.9183]
  Pr(y=0|x):          0.0965   [0.0817,    0.1114]

        hh1age     hh1age2      hh1edu      hhsize      hh1exp      landsizepc
x=   49.035262   2604.3036    2.200551   5.6022039   65910.866   .71229475


. *change in probabilities
. prchange

probit: Changes in Predicted Probabilities for foodsecure

            min->max      0->1     -+1/2    -+sd/2  MargEfct
    hh1age   -0.8052   -0.0001   -0.0073   -0.1044   -0.0080
   hh1age2    0.3757    0.0001    0.0001    0.0975    0.0001
    hh1edu    0.0261    0.0059    0.0055    0.0075    0.0055
    hhsize   -0.3344   -0.0743   -0.0334   -0.0721   -0.0334
    hh1exp    0.9318    0.0000    0.0000    0.0581    0.0654
landsizepc    0.0975    0.0053    0.0053    0.0097    0.0053

              0       1
Pr(y|x)  0.0965  0.9035

            hh1age     hh1age2      hh1edu      hhsize      hh1exp  landsizepc
```

```
    x=     49.0353      2604.3     2.20055      5.6022     65910.9     .712295
sd(x)=     14.2221     1494.17     1.35712     2.14841     44501.6     1.84076
```

2) . *Lugari

. xi:probit foodsecure hh1age hh1age2 hh1edu hhsize hh1exp landsizepc if District==1

```
Iteration 0:   log likelihood = -352.07523
Iteration 1:   log likelihood = -308.71029
Iteration 2:   log likelihood = -307.38704
Iteration 3:   log likelihood = -307.38214
Iteration 4:   log likelihood = -307.38214

Probit regression                                 Number of obs   =        866
                                                  LR chi2(6)      =      89.39
                                                  Prob > chi2     =     0.0000
Log likelihood = -307.38214                       Pseudo R2       =     0.1269

------------------------------------------------------------------------------
  foodsecure |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      hh1age |  -.0437447   .0253231    -1.73   0.084    -.0933771    .0058877
     hh1age2 |   .0003896    .000239     1.63   0.103    -.0000789    .0008581
      hh1edu |  -.0375962   .0423438    -0.89   0.375    -.1205886    .0453962
      hhsize |  -.1928572   -.0311995    - 6.18  0.000    -.1317073    .2540071
      hh1exp |   7.35e-06    1.10e-06    6.67   0.000    -9.51e-06    -5.19e-06
  landsizepc |  -.0886911    .095488    -0.93   0.353    -.2758441    .0984619
       _cons |   1.772706   .6283655     2.82   0.005     .5411325     3.00428
------------------------------------------------------------------------------
```

probit: Predictions for foodsecure

```
Confidence intervals by delta method

                                95% Conf. Interval
  Pr(y=1|x):          0.8890   [0.8659,    0.9121]
  Pr(y=0|x):          0.1110   [0.0879,    0.1341]

        hh1age     hh1age2      hh1edu      hhsize      hh1exp  landsizepc
x=   50.027714   2694.0196   2.2078522   6.1327945   65331.314   .36296177

. *change in probabilities
. prchange

probit: Changes in Predicted Probabilities for foodsecure

            min->max      0->1     -+1/2    -+sd/2  MargEfct
    hh1age   -0.6850   -0.0001   -0.0083   -0.1162   -0.0080
   hh1age2    0.4312    0.0002    0.0001    0.1086    0.0001
    hh1edu   -0.0377   -0.0066   -0.0071   -0.0094   -0.0071
    hhsize   -0.3931   -0.0761   -0.0365   -0.0799   -0.0365
    hh1exp    0.9209    0.0000    0.0000    0.0622    0.0865
landsizepc   -0.1442   -0.0170   -0.0168   -0.0091   -0.0168

              0       1
Pr(y|x)  0.1110  0.8890
```

	hh1age	hh1age2	hh1edu	hhsize	hh1exp	landsizepc
x=	50.0277	2694.02	2.20785	6.13279	65331.3	.362962
sd(x)=	13.9331	1463.85	1.32586	2.18183	44595.2	.542461

3) . *Makueni

. xi:probit foodsecure hh1age hh1age2 hh1edu hhsize hh1exp landsizepc if District==2

```
Iteration 0:   log likelihood = -317.41519
Iteration 1:   log likelihood = -271.17464
Iteration 2:   log likelihood = -269.73181
Iteration 3:   log likelihood = -269.72925
Iteration 4:   log likelihood = -269.72925

Probit regression                                 Number of obs   =        949
                                                  LR chi2(6)      =      95.37
                                                  Prob > chi2     =     0.0000
Log likelihood = -269.72925                       Pseudo R2       =     0.1502

------------------------------------------------------------------------------
  foodsecure |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      hh1age |  -.0425325    .024929    -1.71   0.088    -.0913923    .0063274
     hh1age2 |   .0004159   .0002442     1.70   0.089    -.0000628    .0008946
      hh1edu |   .1369744   .0481926     2.84   0.004     .0425187    .2314301
      hhsize |  -.2367198    .035546    -6.66   0.000     .1670491    .3063904
      hh1exp |   8.15e-06    1.19e-06     6.88   0.000    -.0000105    -5.83e-06
  landsizepc |    .016085   .0249437     0.64   0.519    -.0328038    .0649738
       _cons |   1.453871   .5809621     2.50   0.012     .3152066    2.592536
------------------------------------------------------------------------------
```

probit: Predictions for foodsecure

```
Confidence intervals by delta method

                                95% Conf. Interval
  Pr(y=1|x):          0.9255   [ 0.9067,    0.9443]
  Pr(y=0|x):          0.0745   [ 0.0557,    0.0933]

       hh1age     hh1age2      hh1edu      hhsize      hh1exp  landsizepc
x=    48.12961   2522.4341   2.1938883    5.118019   66439.731   1.0310749


. *change in probabilities
. prchange

probit: Changes in Predicted Probabilities for foodsecure

            min->max      0->1     -+1/2    -+sd/2  MargEfct
    hh1age   -0.7742   -0.0000   -0.0060   -0.0879   -0.0070
   hh1age2    0.3468    0.0002    0.0001    0.0905    0.0001
    hh1edu    0.0756    0.0263    0.0193    0.0268    0.0193
    hhsize   -0.3152   -0.0887   -0.0334   -0.0673   -0.0334
    hh1exp    0.8651    0.0000    0.0000    0.0513    0.0732
landsizepc    0.0629    0.0023    0.0023    0.0056    0.0023
```

	0	1
Pr(y|x)	0.0745	0.9255

	hh1age	hh1age2	hh1edu	hhsize	hh1exp	landsizepc
x=	48.1296	2522.43	2.19389	5.11802	66439.7	1.03107
sd(x)=	14.4287	1517.46	1.3857	1.99915	44432.9	2.44989

APPENDIX 111: RESULTS OF EARLIER STUDIES

Variables	Units	Study	Economy	Methods	Coefficient Values	Interpretations*
Income	Pak Rupee	Bashir *et al.*, 2010 C	Pakistan	Multinomial Logistic Regression	15.06	Households in higher income group (Rs. 5001 – 10000) were 15 times more likely to become food secure as compared to the households having zero net income
	Indian Rupee	Sindhu *et al.*, 2008 C	India	Binary Logistic Regression	-0.00036	An increase of Rs. 1000 in the monthly income of households reduces the probability of food insecurity by 30%
		Babatunde *et al.*, 2007 C	Nigeria	Binary Logistic Regression	0.488	An increase in the annual income of household will increase the chances of its becoming food secure by 63 %
	US $	Onianwa and Wheelock, 2006 C	USA	Binary Logistic Regression	-0.06 and -0.05	An increase in the annual income of household with children and without children reduces the chances of them becoming food insecure by 6 and 5 %, respectively
	Can $	Che and Chen, 2002 C	Canada	Multivariate logistic regression	7.96 (low income)	Households in lower income group were 7.96 times more likely to become food insecure as compared to the households in upper middle income group
Age of Household Head	Years	Bashir *et al.*, 2010 D	Pakistan	Multinomial Logistic Regression	-1.808	From 35 years of age onward every year reduces the chances of becoming food secure by 83 percent
	Years	Titus and Adetokubo, 2007 C	Nigeria	Descriptive and Food security incidence	0.58	Increasing age of household heads increase the incidence of food insecurity. It was highest for the age group of 61 – 70 years at 0.58

	Years	Onianwa and Wheelock,	USA	Binary Logistic Regression	-0.02	An increase in the age of household head reduces the chances of them becoming food insecure by 2 %
Family Size	Number of HH	Bashir *et al.*, 2010 C	Pakistan	Multinomial Logistic	-4.056	Households with family members of 4-6 and 7-9 were 97 percent less likely to be food secure and 10+ were 100
	Number of HH	Sindhu *et al.*, 2008 C	India	Binary Logistic Regression	0.6743	An increase of one additional family member increases the probability of food insecurity by 96%
	Number of HH	Amaza *et al.*, 2006 C	Nigeria	Binary Logistic Regression	-0.014	With an increase of an additional family member the probability of food security decreases by 1.5%
Family Structure	Joint or Nuclear	Bashir *et al.*, 2010	Pakistan	Multinomial Logistic Regression	1.665	Households with joint family system were 5.287 times more likely to be food secure as compared to the households with nuclear family system
Livestock Assets	Numbers of (Cows and	Bashir *et al.*, 2010	Pakistan	Multinomial Logistic Regression	3.612	Households having two milking animals were 37.027 times more likely to be food secure than the households having no milking animal
	Number of Ox	Haile *et al.*, 2005	Ethiopia	Binary Logistic Regression	0.046	Having livestock (especially Ox) increased the probability of a household becoming food secure by 5%
Education	Years of education	Bashir *et al.*, 2010 C	Pakistan	Multinomial Logistic Regression	1.857 (middle) and 3.037	Having an education level of middle (8 years of schooling) the odds of becoming food secure increased by 6.402 and with graduation level of education the odds increased to 20.833
	Years of education	Ojogho, 2009 C	Nigeria	Binary Logistic Regression	-1.503 (secondar and -2.562 (tertiary)	With an increase of educational level from primary to secondary the probability of food insecurity decreases by about 78% and with tertiary level of education it decreased by 92%

	Years of education	Amaza *et al.*, 2006 C	Nigeria	Binary Logistic Regression	-0.8957	Higher education levels of household head help decreasing the chances of the household becoming food insecure by 59%
	Years of education	Mariara *et al.*,2006 C	Kenya	Regression	0.0475	With an increase in the educational level of mothers within the household improves the food security by 0.0475
	Years of education	Kaiser *et al.*, 2003 C	USA	Binary Logistic Regression	-0.34	Higher education levels of mothers within households help decreasing the chances of the household becoming food insecure by about 29%

*C = Confirmed by current study or Similar pattern of results | D = Different / contradicting results of current study

APPENDIX 1V: FOOD CALORIES

	CROPS	Unit	Calories		ANIMAL PRODUCTS	Unit	Calories
1	Maize	Kg	1250.00	1	Milk	Litres	3,366.67
2	Maize meal	Kg	3650.00	2	Other Dairy Products	Litres	760.00
3	Flour	Kg	3750.00	3	Goat Meat	Kgs	1,200.00
4	Other grains ground or whole	Kg	2750.00	4	Goat milk	kg	634.93
5	Bread	Kg	840.00	5	Chicken broiler meat	kg	2,190.00
6	Cooking Oil, Lard, Margarine	kgs	9000.00	6	Chicken kienyenji meat	Kgs	2,400.00
7	Beans	Kg	1141.67	7	Rabbit meat	kg	2,057.65
8	Irish potatoes	Kg	770.00	8	Sheep meat	Kgs	1,300.00
9	Rice	Kg	1100.00	9	Beef	Kgs	1,400.00
10	Coffee	Kg	0.00	10	Wool	n/a	n/a
11	Tea	Kg	10.00	11	Honey	Kgs	3,100.00
12	Bananas	Kg	1200.00	12	Hide	n/a	n/a
13	Plantains/Matoke	Kg	1200.00	13	Eggs	Kg/no	2,040.00
14	Sweet potatoes	Kg	860.00	14	Fish	Kgs	3,633.33
15	Cassava	Kg	1590.00				
16	Arrow roots	Kg	650.00				
17	Sorghum	Kg	3700.00				
18	Millet	Kg	820.00				
19	French beans	Kg	310.00				
20	Groundnuts	Kg	5950.00				
21	Chickpeas and Cowpeas	Kg	1150.00				
22	Pigeon peas	Kg	900.00				
23	Pawpaws	Kg	610.00				
24	Mangoes	Kg	700.00				
25	Kales (Sukuma Wiki)	Kg	260.00				
26	Other Vegetables	Kg	300.00				
27	Tomatoes	Kg	250.00				
28	Onions	Kg	1000.00				
29	Spinach	Kg	225.00				
30	Cabbage	Kg	266.67				
31	Pumpkin	Kg	400.00				
32	Sugarcane	Kg	2500.00				
33	Grain Amaranth	Kg	1030.00				
34	Sunflower	Kg	9000.00				
35	Other Fruits	Kg	520.00				
36	Green Grams	Kg	500.00				
37	Sugar	Kg	3870.00				
38	Salt	Kg	0.00				
39	Beer	Kg	420.00				
40	Soda	Kg	380.00				
41	Other Drinks	Kg	350.00				
42	Purchased Meals	Kg	400.00				

Source: FAO (http://www.fao.org/economic/ess/ess-fs/ess-fadata/en/#.VEeI7fmSySo)