EFFECTS OF SELECTED FACTORS ON FOOD SECURITY AMONG SMALL-SCALE FARMERS IN KAKAMEGA CENTRAL SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

I declare that this thesis is my original work and has not been submitted or presented for award of diploma or degree in this or any other university.

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DEDICATION

To my Mother Rael, my children; Brian and Jeaniter and sister Vicky thank you for your patience and moral support that enabled this achievement.

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A great thanks is to the Almighty God for the free gift of life, provisions, health, intellect, grace and wisdom during this research process. Much thanks to Egerton University, for providing me the necessary learning and research conditions for the success of this degree. The successful completion of this thesis is through the efforts and contribution of different persons and institutions. Special thanks and appreciation go to my supervisors: Professor John Gowland Mwangi of Egerton University, and Professor Joash Kibett of the University Kabianga for their consistent technical input, encouragement, mentoring, guidance and availability throughout the research process. I am specifically grateful for their tireless effort and readiness to review the various drafts that led to the final production of this thesis. Further l am thankful to the Department of Agricultural Education and Extension of the Faculty of Education and Community Studies for the great ideas and criticism during defense and consultation. I also thank the Agricultural Extension Officer Mr. A. Opwolo and Mr. M. Wafula for their assistance during mobilization of farmers for data collection. Also I thank all the 96 farmers for their courteous welcome to their home and the data they contributed for successful compilation of thesis. I am grateful to mother, sister, my children, colleagues and friends for the moral support and also encouragement during the period of research. God bless you all.

ABSTRACT

Food security is the Millennium Development Goals (MDGs) one which for Kenya is relevant for eradicating poverty and hunger. Increased agricultural productivity would be solution to the world's 870 Million (M) food insecure people. Approximately 10M people in Kenya, 51.45% of Western Kenya population and 50-70% of households in Kakamega County suffer chronic food insecurity. Small farm sizes, low yields, production shift from food crops to cash crops and low levels of skills and technological information in farming are considered the principal factors contributing to food insecurity among household heads without higher education and employment. The study therefore sought to investigate the effects of farm size allocated to food crops, sugarcane farming, type of improved maize varieties (IMV) used and education level on food security among small-scale farmers (SSFs) in Kakamega Central Sub-county. The study used a Cross Sectional Survey Research design. Multi-stage proportional-to-size sampling procedure was used to select a sample size of 96 SSFs in 5 locations and 13 sub-locations of Lurambi and Municipality divisions. A questionnaire was constructed and validated by two experts from Agricultural Education and Extension Department of Egerton University. A pilot test, using 30 subjects with similar characteristics from Butere Sub-county, indicated a reliability coefficient of at least 0.70 (Cronbach alpha) at 0.05 significance level indicating the instrument had acceptable reliability threshold. The farmers were mobilized and the researcher introduced by the agricultural extension officer in the area of study. The respondents' informed consent was obtained from each respondent before they filled a questionnaire. The results were summarized using means frequencies and percentages and then analyzed using regression analysis. The study revealed that farm size allocated to food crops had a statistically significant effect on food security while the use of IMV, sugarcane farming and farmer education level were not. The IMV contributed 12.9%, farm size to food crops 12.1% , farmer education 8.2% and sugarcane farming 3.5% to food security respectively. It was concluded that higher farm size to food crops, use of IMV and higher education level are important for improved food security. The study recommends that farmers should always allocate higher proportion of their farm to food crops and use recommended IMV. The Ministry of Agriculture should always collaborate with stockists of farm inputs and research and extension service providers in order to increase the level of farmer awareness on the new and more yielding crop varieties that improve food security.

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LIST OF ABBREVIATIONS AND ACRONYMS

AKIS	Agricultural Knowledge Information Systems
A.S.L	Above sea level
CBO	Community Based Organization
Educ	Education
ERS	Economic Recovery Strategy
FAO	Food and Agriculture Organization
FIAN	Food-First Information and Action Network
FSS	Food Security Scale
GoK	Government of Kenya
Ha	Hectare
HFSSI	Household Food Security Scale Index
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IMV	Improved Maize Varieties
INTERPAKS	International Programme for Agricultural Knowledge System
KARI	Kenya Agricultural Research Institute
KNBS	Kenya National Bureau of Statistics
KSC	Kenya Seed Company
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture
MSV	Maize Streak Virus
NGOs	Non-Governmental Organizations
RAPDA	Reseau africain pour le droit a' l'alimentation (African Network on the Right to Food
SIMV	Selected Improved Maize Varieties
SPSS	Statistical Packages for the Social Science
SSA	Sub-Saharan Africa
SSFs	Small-scale Farmers
WFP	World Food Programme
WSC	Western Seed Company

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Food security is the Millennium Development Goals (MDGs) one which for Kenya is relevant for eradicating poverty and hunger and other nations. Contrarily, according to Food and Agriculture Organization (FAO), an approximate 870 million (M) of the world's population is food insecure of whom 98% are in the developing countries (FAO, 2012). In Sub-Saharan Africa (SSA) one person in every four, lacks adequate food for a healthy and active life (Bremner, 2012**).** The poor people who are the majority and undernourished, live in rural areas, rely mainly on small-scale agriculture for their food security, have little or no education and own less than 2 hectares (Ha) of land.

Food self-sufficiency, a production-based food entitlement, is the principal indicator of food security contrary to purchased entitlement to food in developing countries. According to FAO, International Fund for Agricultural Development (IFAD) and World food Programme (WFP) (2013) food access in developing countries and specifically in the rural areas is limited by inadequate marketing channels, limited non-farm employment and high and unstable food prices. Furthermore, a shift from subsistence crops to the production of cash crops has sometimes been linked to an increased malnutrition rates in SSA (Waswa, Gweyi-Onyango & Mcharo, 2012). The expectation is that through cash crops production rural households can generate adequate monetary incomes to be able to buy more food from the markets. Contrarily in many African countries weak agricultural markets, transport infrastructure and macroeconomic policy factors often play a destabilizing role in misaligning producer and consumer prices (Nah Tiepoh, 2012). According to Nah Tiepoh cash crop production is not an effective way to achieve national food security. In his study Nah Tiepoh, found that about 66 % Liberians do not afford enough grain to feed themselves because they have devoted the bulk of their land into foreign-owned oil palm or cocoa plantations, and turning farmers and other able-bodied men and women into plantation workers. Further the prices that farmers pay for food grains in the markets are often substantially higher than the farm gate or producer prices received from their cash crops due to high food-marketing costs.

About half of Kenya's estimated 41.8M people are poor and live in the rural areas, suffer from chronic food insecurity and poor nutrition according to Government of Kenya-GoK (2012a). The target of Economic Recovery Strategy (ERS) is to reduce people affected by

food insecurity from 48.4% to 23.5 % in 2008 and to 10% by 2015 (GoK, 2012b). The GoK's new 2010-2020 Agricultural Sector Development Strategy targets a 30% reduction of food insecurity and 25% reduction of poverty in 2014 to surpass the MDG target2015. These may not be achieved without improved, sustainable agricultural productivity which offers a recognized way to escape the poverty trap in many rural areas (FAO *et al.*, 2013). Investing in sustainable family farming is crucial since family farmers produce a high proportion of the food consumed and the biggest source of employment in the world. They are also the custodians of the world's agricultural biodiversity and other natural resources. According to Owuor (2013) rural households in Kenya put more emphasis in producing part of their food needs rather than wholly relying on the market.

In Western Kenya food insecurity is 51.45% compared to the national figure of 48.8% (MoA, 2011). In the year 2011 about 50% SSFs in Kakamega County had kept between 1 to 3 bags of maize for home consumption and the rest of the farmers relied on unreliable market sources which are beyond the influence of individual poor farmers (Langat, Sulo, Nyangweso, Ngeno, Korir & Kipsat, 2010; MoA, 2011). A household is food secure when it has access to the food needed for a healthy life for all its members and when it is not at undue risk of losing such access due to poor production, high food prices, inadequate wages or inadequate access to market (FAO, 2012). In Kakamega County food situation declined in the months of April and May 2012 owing to disposal of stocks by households to meet the cost of farm inputs and other household needs like school fees and increased food commodity prices on the market (FAO, 2012). Food security is achieved when a household has both physical and economic access to adequate food for all its members and when it is not under undue risk of losing such access (FAO, 2012). Higher crop yields especially maize and diversification in food crops can lead to a reduction of hunger and improved food security because of increased physical access (FAO *et al.*, 2013).Self-sufficiency in maize production has been equated to food security in Kenya. However on-farm yields are low averaging 1.5–2.6 tonnes per hectare (ha) compared to on-station yields of about 5–8 tonnes/ha (MoA, 2010). According to GoK (2010a) the use of improved seed has remained low due to poor distribution systems. GoK, (2010a) report indicates that about 99% of households use retained seed with 63% frequency of use while the formal seed purchases is done by 83% households with only 18% frequency of use. Therefore lack of diversification and reliance on market for food has resulted in food insecurity of approximately 70% of households in the cash cropping zone especially sugarcane and about 50% of households in the mixed farming (FAO, 2012).

The production of sugar cane has decreased food security in the western region since SSFs are putting significantly larger portions of land to sugar cane. This is contrary to the sugar factory recommendation that farmers should not use more than one third of their land for sugarcane cropping (Food-First Information and Action Network (FIAN), 2010). Competition for land use among crops in Western Kenya is biased towards sugarcane and maize production. Moreover, land under sugarcane increases inversely with the size of land under individual food crops such as maize, simsim, finger millet, bambara, groundnuts, sorghum, cassava and sweet potatoes (Netondo, Waswa, Maina, Naisiko, Masayi & Ngaira, 2010). A study by Waiswa (2011) shows that 97.3% of the respondents in Kakamega owned a mean of 3 acres of land and 91.8% of the HH had more than a third of the land on sugarcane growing. Instability in the output and prices of sugarcane has also reduced the purchasing power needed to buy food (Waswa *et al.*, 2012). The area has a high potential of food security due to extensive extension services provided by government, private and Non-Governmental extension providers. The area also has well distributed bimodal, abundant annual rainfall, fertile soils and favourable climate (Jaetzold, Schmidt, Hornetz & Shisanya, 2007).

Education plays a critical role in food security since it empowers individuals and families to make informed decisions on production (Pieters, Guariso & Vandeplas, 2013). Educational status influences adoption level of technologies among farmers which ultimately lead to food Security. Educated farmers have a better opportunity to acquire and process information on new technologies. Low educational attainment and low household income are significantly associated with food insecurity across a population. However, in Western Kenya those who can read and write forms 72.7%, those with primary education are 70.9% and 11.0% have secondary education which is relatively lower than the national targets of 80% (Commission for Revenue Allocation 2013). According to Kenya National Bureau of Statistics (KNBS), (2010) and National Council for Population and Development (2011),52.1 % of the population in Kakamega faces poverty compared to the national figure of 47%. The most affected include the landless, less educated, subsistence farmers, female-headed households and the unemployed youths. The farmers hold at most 0.7 ha on which they grow a variety of both food and cash crops. Higher inequalities of dietary energy consumption than the national level has been recorded in rural areas, household heads without higher education and employment, female headed households and those with age less than 35 and over 60 years

(KNBS, 2010). Therefore there is a great need to investigate and document from farmers on specific factors that affect improvement of their food security and livelihoods.

1.2 Statement of the Problem

Lack of crop diversification has contributed to maize being the main food security crop in Kenya. However maize productivity per hectare is relatively lower ranging at 12-14 bags/ha than the national target yields of 25-33 bags/ha. In Western Kenya food insecurity is 51.45% compared to the national figure of 48.8%. Income from sugarcane production cannot support household food budget due to unreliable incomes. Small farm sizes, low yields, production shift from food crops to high value cash crops as well as low levels of skills and technological information in farming are considered the principal factors contributing to food insecurity yet these have not been studied and clearly documented in Kakamega Central Sub-county. In view of these factors, it was necessary to investigate the effects of farm size allocated to food crops, sugarcane farming, type of improved maize varieties used and education level on food security among SSFs in Kakamega Central Sub-county.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of selected factors on food security among SSFs in Kakamega Central Sub-county. The factors investigated were farm size allocated to food crops, sugarcane farming, type of maize varieties seed used and education level.

1.4 Objectives of the Study

The objectives of the Study were to:

i. Determine the effects of farm size allocated to food crops on food security among SSFs in Kakamega Central Sub-county;
ii. Determine the effects of the type of improved maize variety seed used on food security among SSFs in Kakamega Central Sub-county;
iii. Determine the effects of sugarcane farming on food security among SSFs in Kakamega Central Sub-county and
iv. Determine the effects of farmer's education level on food security among SSFs in Kakamega Central Sub-county.

1.5 Hypotheses of the Study

Ho1: The farm size allocated to food crops has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county;

Ho2: The type of improved maize variety seed used has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county;

Ho3: Sugarcane farming has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county;

Ho4: Farmer's education level has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county;

1.6 Significance of the Study

The results of the study were to provide information on the effects of farm size allocated to food crops and sugarcane farming, type of seed maize variety seed used, farmers' education level on household food security. The result would be helpful to policy makers on planning strategies for ensuring food security in Kakamega Central sub-county. Moreover, it could be used by the Ministry of Agriculture in formulating national and county policies that enhance sustainable agricultural productivity and food security. Further more, it could be used by extension providers to make farmers aware of the implications of decreasing farm sizes, increasing population, choice of crop enterprises and education on food security.

1.7 Scope of the Study

The study focused on the effects of farm sizes allocated to food crops, sugarcane farm sizes and income, types of IMV seed used and farmer's education level of household head on food security with respect to production-based entitlement to food security. The study captured data from both male and female maize farmers with less than 5 acres under maize and other food crops in Lurambi and Municipality Divisions of Kakamega Central Sub-county.

1.8 Assumptions

The farmers in Lurambi and Municipality divisions are relatively homogeneous in farming practices and face similar socio-economic problems which influence food security status of households. In addition the farmers would provide reliable and accurate data.

1.9 Limitation of the Study

The study covers Kakamega SSFs and any generalizations are limited to the farmers from the area but may be useful to farmers in other areas with similar environmental and socio-economic conditions. The Study focused on availability dimension of food security yet utilization, access and stability dimensions are important in measuring food security of individual and household. Further language barrier was foreseen to create communication barrier between the researcher and the respondents who could not speak English or Kiswahili. However an interpreter was used to administer the questionnaire where the need aroused.

1.10 Definitions of Terms

The following terms are defined and operationalized in the context of this study:-

Education is acquiring or improving the ability to perform a behavioral pattern through training, experience and practice (Dubey & Bishnoi, 2008). In the study education refers to levels of academic qualification. It affects farmer's sources of maize farming technologies/information and experiences that motivate them to adopt or adapt the maize technologies.

Household food security means when a household has both physical and economic access to adequate food for all its members and when it is not under undue risk of losing such access (FAO, 2012). For this study food security refers to the average number of months a household can meet its food needs from own production and the income allocated to household food purchase as well as the share of households that can meet all their food needs.

Self-sufficiency (per capita food crop production) is ability to meet consumption needs (particularly staple food crops) from own production rather than buying or importing (Peljor & Minot, 2010). In this study it means having adequate maize stock in the family from own-farm production that is kept to last one year equivalent to two crop seasons.

Small scale farmers are farmers with less than 5 acres on unit enterprise for production (GoK, 2010a). In this study it means farmers with 5 acres or less land allocated to maize production for subsistence.

Sugarcane farming is the growing of commercial sugarcane (Waswa *et al*., 2012). In this study it means farm size allocated to sugarcane and the proportion of sugar cane income allocated to household food purchase.

Type of improved maize variety seed means varieties with improved genetics to incorporate characteristics such as higher yield, disease resistance or earlier maturity (O'Connor, Funk & Wamache, 2012). In this study it means improved maize varieties (IMV), H614D, WS 403, WS 505 and KS-H 6217 that will enhance maize productivity.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents thematic studies that have been done by various researchers and the theoretical and conceptual framework in relation to the objectives and the problem of this study. The chapter covers methods of measuring food security and factors that have effect on food security such as size allocated to food crops type of maize varieties used, sugar cane farming and education level.

2.2 Measuring Food Security

A household is food secure when it has access to the food needed for a healthy life for all its members and when it is not at undue risk of losing such access due to poor production, high food prices, inadequate wages or inadequate access to market (FAO, 2012). In Kakamega County food situation declined in the months of April and May 2012 owing to disposal of stocks by households to meet the cost of farm inputs and other household needs like school fees. Lack of food stocks was compounded by the increased food commodity prices on the market further stressing households. Consequently, 70% of households in the cash cropping zone and about 50% of households in the mixed farming zone were stressed in 2011 as they mainly depended on the market for their stable food supply (FAO, 2012).

Food self-sufficiency is ability to meet consumption needs (particularly for staple food crops) from own production rather than by buying or importing (FAO *et al* 2013; Peljor & Minot, 2010). Food self-sufficiency is a useful strategy to achieve food security. Relying on the market to meet food needs is a risky strategy because of volatility in food prices and possible interruption in supplies. Indicators of food self-sufficiency include home-produced food as share of all food consumed, home-produced cereals as a share of all cereals consumed, and home-produced maize as a share of all maize consumed (Peljor & Minot, 2010). The measures of food self-sufficiency, measures of food shortages, per capita cereal production and per capita maize production are positively correlated with the average number of months of food self-sufficiency (Peljor & Minot, 2010).

2.2.1 Methods of measuring food security

Measuring food security helps to identify and understand the basic aspect of well-being of the population or subgroups and regions with unusually severe conditions (Bickel, Nord, Price,

Hamilton & Cook, 2000). The methods used are various. Price level differences across markets reflect a real cost of transferring food from one market to another. However data is not available to measure price difference index. The concept of household economic access to food can be measured by a short-term effective demand which is monitored using real income and prices. The data for this is beyond the economic resources of many developing countries (Bickel *et al*., 2000). The other method is household food security index which comprises the use of the per caput food production, per caput export earnings, degree of deviation of per caput agricultural production from trend, budget allocation for targeted income transfers and food subsidies and a sub-index of food price inflation relevant for low-income households. The index is limited by an unknown degree of imprecision in specific situations. This can be improved by replication in diverse situation of similar economies.

2.2.2 Household food security scale (FSS) method

This study used FSS. The scale measures the degree of severity of food insecurity/hunger experienced by a household in terms of a single numerical value (Bickel *et al*., 2000). The statistical procedure that determines a household's scale value depends on the number of increasingly severe indications of food insecurity that the household has experienced. A household with a scale value of 6, for example, has responded affirmatively to more and typically more severe, indicators of food insecurity than a household with a scale value of 3. A household that has not experienced any of the conditions of food insecurity covered by the core module questions would be assigned a scale value of 0, while a household that has experienced all of them would have the highest scale value like 10. FSS uses a small set of categories, each one representing a meaningful range of severity on the underlying scale. The categories are:

i. Food secure: Households show no or minimal evidence of food insecurity. This was assigned 1 in the study.
ii. Food insecure without hunger: Food insecurity is evident in household members' concerns about adequacy of the household food supply and in adjustments to household food management, including reduced quality of food and increased unusual coping patterns. Little or no reduction in members' food intake is reported (Bickel *et. al*., 2000). This was assigned 2 in this study.
iii. Food insecure with hunger (moderate): Food intake for adults in the household has been reduced to an extent that implies that adults have repeatedly experienced the physical sensation of hunger. In most (but not all) food-insecure households with

children, such reductions are not observed at this stage for children (Bickel *et. al*., 2000). The scale value was given 3

iv. Food insecure with hunger (severe): All households with children have reduced the children's food intake to an extent indicating that the children have experienced hunger. For some other households with children, this already has occurred at an earlier stage of severity. Adults in households with and without children have repeatedly experienced more extensive reductions in food intake (Bickel *et. al.*, 2000). This was combined with food insecure with hunger and was assigned the scale value of 3. This classification is shown in Table 1.

Table1

Food Security Scale Values and Status Levels Corresponding to Number of Affirmative Responses

Number of Affirmative responses		**1998 Food Security Scale Value***	**Food Security**	**Status Level**
(Out of 12) Households Score	Standard 0-10 metric (HFSSI x 0.7143)		Code	Category
0	0.00	0.0	1	Food Secure
1	0.95			
2	1.43			
3	2.14	2.4		
4	2.86	3.0	2	Food Insecure Without Hunger
5	3.81			
6	4.29			
7	5.00	4.4		
8	5.71	4.7	3	Food Insecure with Hunger
9	6.43			
10	7.14			
11	7.86			
12	8.57	9.3		

***** Source: Adapted from Bickel *et al.*, (2000).

Kenya government has initiated various food security initiatives and programmes to assist farmers improve agricultural productivity and therefore food security. For instance Njaa

Kenya Marufuku that supports Community Based Organization and farmers groups on food security initiatives. Other programmes include Kenya Agricultural Productivity and Agribusiness Project and Kenya Research Institute (KARI) that facilitated the carrying out of agricultural research resulting into the release of new crop varieties and other crop; empowerment of farmers and their organizations to strengthen demand for services (MoA, 2011).

2.3 Effects of Farm Size on Food Security

The farm size allocated to food security influence the production level and therefore food security. According to Tscharntke *et al*., (2012) the majority of poor people live in rural areas with little or no access to productive agricultural lands. Hence, hunger is linked to farm size whereby 90% of farmers worldwide farm on less than 2 ha, producing food where it is needed – in much of the developing world. Eighty percent of the hungry live in developing countries with 50% being smallholders. It is believed that a farmer first tests and then adopts improved technology like seeds by allocating part of the land and then decides to use other field operations based on socio-economic conditions and the relative importance of the technology being promoted (Dubey & Bishnoi 2008). A study by Makombe, Lewin and Fisher (2011) in the North, Central, and South regions of Malawi revealed that an increase of 0.25 ha per capita of cultivated land would decrease the likelihood of food insecurity by 22, 24, and 27 percent respectively.

2.4 Effects of Improved Maize Varieties on Food Security

Improving food production (the availability component of food security) for the African small-scale farmer remains one of the biggest and most important challenges. This is because low levels of agricultural productivity are at the root of the problems of food security in SSA (FAO, IFAD & WFP, 2014). In Kenya food security has been equated to self-sufficiency in cereal production especially maize production for many years. However on-farm yields are low averaging 1.5–2.6 tons per hectare compared to on-station yields of about 5–8 tonnes/ha (MoA, 2010). Smale, Byerlee and Jayne (2011) noted that adoption of modern maize in Kenya appears to have leveled at 70-75% of maize as compared to Zimbabwe whose adoption rates reached 96% as early as 1990. Smale *et al*., (2011) observed that H614D, derived from H164 released in 1986, was planted on 42% of maize area in 1992, 51% area in 1998 and 4% in 2010 indicating a decline. Seed quality as based on variety is related to yield variability. Agro-ecological characteristics, varieties of specific maturity, reduction in yields

and the characteristics of the technology influence on which technology to adopt or not adopt (O'connor *et al*., 2012). Farmers avoid improved maize seeds that are highly variable in yields as they pose food insecurity. If farmers who were willing to adopt certified seeds are disappointed, they go back for local varieties or retained seeds (Schroeder *et al.,* 2013). In Kakamega, suitable maize varieties are ecologically zoned into highland maize varieties recommended for medium to high altitudes (1500-2400M) and medium altitude varieties (1000 and 1800M A.S.L) as indicated in Table 2.

Table 2

Characteristics of Seed Maize Varieties for High and Medium Altitudes

Variety	**Year release**	**Owner/s**	**Altitude (M a.s.l)**	**Maturity (Months)**	**Yield; ton/ha**	**Special attributes**
H614D	1986	KSC KARI	1200-1500	5-7	8-9	Stable over locations and seasons, most popular among farmers
WH505 WH403	2003	WSC	500-2100	4.5-5.5 4-5	6-9 5-8	Suitable for low input production, resistant to MSV
KS-H6217	2008	KSC	1500-2100	6-7	8-10	Lodging resistance, flint kernel

Source: Kangethe (2011)

Access to extension services and commercial markets affect technology use since farmers' awareness of existing or newly released hybrid varieties strongly depends on their access to agricultural information (Schroeder *et al*., 2013). Professional extension providers and seed retailers improve farmer education and awareness on the characteristics of the seeds on the market. According to GoK (2010a) the use of improved seed has remained low due to poor distribution systems. About 99% of households use retained seed with 63% frequency of use while the formal seed purchases was 83% households with only 18% frequency of use (GoK, 2010a).

2.5 Effects of Sugarcane Farming on Food Security

Policies guiding commercialization of agriculture in Kenya assume that realization of increased household incomes, through cultivation of cash crops, would guarantee improved

food security and subsequent reduction of poverty (Langat *et al.*, 2010). However, most communities in Kenya growing cash crops have been reported to have a challenge purchasing food (Langat, *et al.*, 2010). Despite the possibility of attractive cash earnings, the sugarcane returns have been actually low when considering the amount of work put in and the diversion of land from food crops leading to decreased food security in Western Kenya region. A study in Lurambi, Koyonzo and Chemelil showed that on average farmers retained only 32%, 31% and 34% respectively of the gross income from contract sugarcane farming (Waswa *et al.*, 2012). Sugarcane takes between 18-24 months to mature and during this time the farmers receive no payment for their services (FIAN, 2010). Diversion of land to sugarcane makes it harder for the women to feed their families and they have no choice about how land is used but to act on the decisions of their husbands (FIAN, 2010). Repayment of debts reduces the farmers' propensity to buy and or grow food for their own subsistence, hence the persistent food insecurity and malnutrition (Waswa *et al.*, 2012). Further, land under sugarcane increases inversely with the size of land under individual indigenous crops such as simsim, finger millet, bambara, groundnuts, sorghum, cassava and sweet potatoes (Netondo *et al.*, 2010).

2.6 Effects of Farmer's Education Level on Food Security

Education is linked to the development of cognitive skills that are likely to support income generation and food production (Pieters *et al.*, 2013). According to Pieters *et al.*, enhanced cognitive skills may raise income levels and employability through better decision-making in the allocation and distribution of resources and an increased marginal productivity. Thus education levels decrease the probability of being in chronic and seasonal food insecure categories and increasing the probability of being in vulnerable and food secure categories (Nata, Mjelde & Boadu, 2014). There is direct relationship between adoption of improved maize varieties and educational status, indicating that as educational status increases, adoption level also increases among farmers (Kudi, Bolaji, Akinola & Nasa'I, 2011). However rural youth often have limited access to educational programmes that respond to skill needs in agriculture thus reducing youth participation in the agricultural sector in many developing countries (FAO, 2012). Further education is given first priority in expenditure of income followed by food items and agriculture promotion. This expenditure patterns is a positive indication of food self-sufficiency and ultimately food security only if provided with better off-farm employment and better market for both farm produce and essential input (FAO *et al.*, 2012). The greater the inequality in distribution of assets such as education, land,

water, capital and health, the more difficult it will be for the poor to participate in the growth process, and progress in reducing undernourishment is likely to be slow. Poor people often have little education, which prevents them from participating in new dynamic labour markets that offer higher wages (FAO *et al*., 2012).

2.7 Theoretical Framework

The theoretical framework that informed this study is International Programme for Agricultural Knowledge System (INTERPAKS) model of Swanson of 1985 (Figure 1) which evaluates Agricultural Knowledge Information Systems (AKIS). In AKIS agricultural information is generated, transformed, transferred, consolidated, received, utilized and a feedback is given in such a manner that the process functions synergically to support knowledge utilization by agricultural producers (Dubey & Bishnoi, 2008). This model was used in this study to reveal knowledge gap between technology generation, technology transfer and its utilization. In AKIS farmers take the central position as they are responsible for improvement of research and extension and in policy formulation in the right direction.

The analytical framework model uses four components to evaluate AKIS. First is the technology development component which entails applied and adaptive agricultural research. Breeders and researchers develop and maintain new varieties with the desired variety characteristics (O'connor *et al.*, 2012). The second element is the policy, which includes the external factors that directly affect technology system and technology utilization by farmers. Policies for agriculture consist of government decisions that influence the level and stability of input and output prices, public investments affecting agricultural production, costs and revenues and allocation of resources. Policy makers and regulators control distribution of new crop varieties. Approximately 164 maize varieties have been released in Kenya since 1950 (O'connor *et al.*, 2012).

Technology transfer component concerns the sub-function of knowledge transfer and input transfer. National Agricultural Sector Extension Policy creates an enabling environment for agricultural development. Marketers consisting of seed companies, extension agents, Non-Governmental organizations (NGOs) are responsible for transfer of knowledge on seed varieties and awareness. Distributors; agents and agro-dealers, private seed companies and NGOs purchase seed, from seed companies and other producers and then sell it to the farmers as the end users.

The fourth component is technology utilization of farmers with emphasis on small-scale farmers. Farmers utilize technologies by incorporating it into their farming system for higher productivity. Utilization of technology is influenced by various factors: resources availability such as size of land owned, perceived characteristics of the technology and the compatibility of that technology with the farmer's situation. The expected overall aim of technology utilization is increased production that enhances household food security. INTERPAKS model is limited by just focusing on the science-based technology as the only relevant technology to measure. There is ineffective feedback in the model because the farmer has little or no control over formulation of policy and regulations.

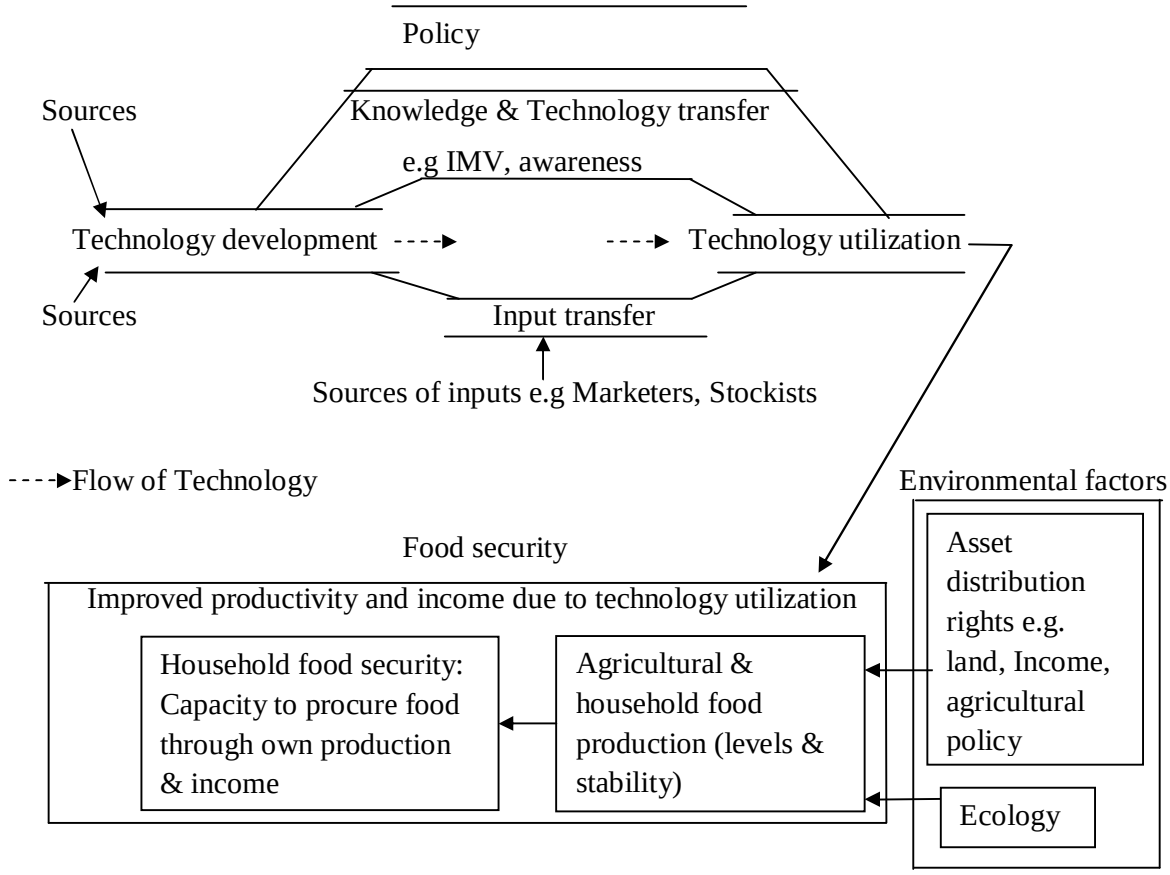

Figure1. Theoretical framework adapted from INTERPAKS model after Swanson (1985)
Source: adapted from Dubey and Bishnoi (2008).

2.8 Conceptual Framework

This study borrowed heavily from technology utilization and input transfer components of the INTERPAKS model. Utilization of improved technologies such as improved maize varieties is influenced by farmer's socio-economic factors as determined by asset rights like size of

land owned and education level of the head of the household who is final decision maker. Utilization of improved technologies can improve food security as a result of improved crop productivity. The factors affecting food security are those factors which influence productivity. These included agricultural and household production levels and stability as influenced by the portion of the farm allocated to food crops, the types of IMV used (H614D, WH 403, WH505,KS-H6217). In addition, the capacity of household to procure food which is influenced by income from sugarcane farming (size of land and income allocated to food). The farmer's education levels influence household food security since it determines farmer's ability to access technologies and opportunities for off farm employment. The dependent variable was food security which was measured by the number (No.) of bags of maize from own production, Number of months a household has food self-sufficiency in a year and score on household Food Self-sufficiency Scale (HFSS) index. Number of months a household has food self-sufficiency in a year was included in the study since it was not included in HFSS and to also allow better understanding of period of food self-sufficiency. Extraneous variables included climatic conditions and policy environment which impact on productivity and determine accessibility to technology by farmers respectively. These two factors were held constant in this study by assuming that farmers are accessible to various maize varieties as guided by the extension as well as input supply and distribution policies. Further farmers are influenced by the same national land policy and National Agricultural Sector Extension Policy. Farmers selected do farm under similar environmental conditions.

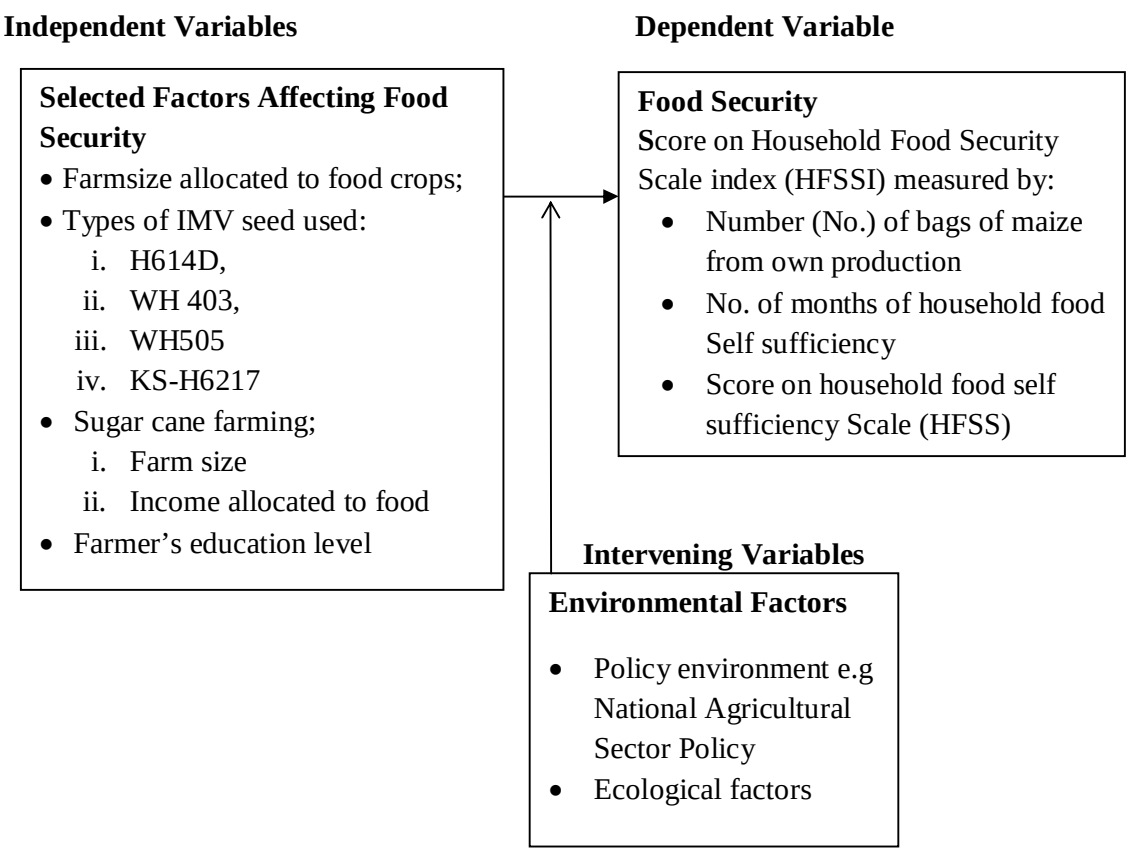

Figure 2. Conceptual framework of food security

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research design, population, sample size and sampling. It also explains the procedures for data collection and data analysis.

3.2 Research Design

The study applied a Cross-Sectional Survey Research Design. The design allows observation of all of a population, or representative subset, at one specific point in time in a geographic place (Monette, Sullivan & Dejong, 1990). In this study a cross-sectional survey was to allow collection of original, large amount of data to describe and make inferences about food security status of SSFs. Lurambi and Municipality Divisions formed administrative unit where data was collected from representative households across locations, sub-locations and villages for the two previous harvest seasons.

3.3 Location of the Study

The Kakamega Central Sub-county is located in Kakamega County in the Western part of Kenya and covers an area of 246.6 km^2 with an arable land of 220 square kilometres. The Sub-county consists of Lurambi Division and Municipality Division with 5 locations (wards) and 13 sub-locations. The Sub-county lies within altitude 1,250m-2,000m A.S.L. with an average annual rainfall ranging from 1200-2000mm-bimodal per year. The average temperature range between 42- 27º Celsius most of the year. There are two main cropping seasons in the Sub-county; long rains (March to June) and short rains (August to October). The Sub-county is long rains dependent. These ecological conditions favour sugarcane, tea, sunflower and soya beans as cash crops and the food crops are maize, beans, sweet potatoes cassava and bananas. The main agricultural Zones are Upper Midland zone: UM0 UM1, and Lower Midland: LM1- and LM2. The extension staff-farmer ratio is 1:2594 (DAO, 2012). Average population density is 580 persons per square kilometer.

3.4 Target Population

The target population for the study was the small-scale farmers in Kakamega Central Sub-county. The Sub-county population from the 2009 population census was 160,229 persons with 11,508 farm families distributed in 37,989 households (Commission on Revenue Allocation, 2013). The population consists of 79,218 males and 81,011 females. The average land holding in the Sub-county per household is 0.7ha, with an average household number of

8 persons. Those who can read and write forms 72.7%, those with primary education are 70.9% and 11.0% having secondary education which is relatively lower than the national targets of 80% (Commission on Revenue Allocation, 2013). According to Kenya National Bureau of Statistics (KNBS), 52.1 % of the population in Kakamega faces poverty compared to the national figure of 47% (KNBS, 2010; National Council for Population and Development, 2011).The average dependency ratio is 88.9% while food insecurity is 51.5% (KNBS, 2010). The total population distribution is given in Table 3.

Table 3

Distribution of Households per Division, Location and Sub-location

Division	Location	Sub-location	Households
Lurambi	South Butsotso	Matioli	1,387
		Eshibeye	1,130
		Emukaya	1,235
	Sub-total		**3752**
	Central Butsotso	Shibuli	2,417
		Shiyunzu	1,919
		Eshisiru	989
	Sub-total		**5325**
	East Butsotso	Indangalasia	1,566
		Shirakalu	1,173
		Murumba	2,104
	Sub-total		**4843**
Municipality	Shieywe	Township	2,991
		Sichilayi	10,475
	Sub-total		**13466**
	Bukhungu	Shirere	7,738
		Mahiakalo	2,865
	Sub-total		**10603**
Grand Total			**37,989**

Source: Commission for Revenue Allocation (2013)

3.5 Sampling Procedure and Sample Size

This study used multistage random sampling design using three levels of administrative areas; divisions, locations, and sub-locations where households were used as sampling unit. Multistage sampling was used to allow more accurate and convenient sample from the Sub-county. In this study multi-stage proportional-to-size sampling design was chosen to allow selection of small sample from the two divisions at various stages without a complete list of the households. Farmers with farm size 5 acres and below under maize from the Lurambi and Municipality divisions formed the sample. Simple random sampling was used to give equal chances of inclusion in the sample of each of the sampling unit.

The sample size from the division, location, and sub-location was at least 30% of the total units while the household representatives was proportionate to the overall sample size of the study. The overall sample size was arrived at by using Fidells formula (n=n>50 + 8m) and 17% upward adjustment to take care of non responses. Thus the formula: n= (n>50+8m) + ([n>50+8m]*0.17) was used to ensure generalizability and regression analysis (Pallant, 2001).

Where, n= sample size, m=number of independent variables. Thus the sample was worked out as: 50+ (4 x 8) + (82 x 0.17) = 96.12 household representatives which was rounded off to 96.

The four sampling stages used are as follow:

i. One location from municipality division and three locations from Lurambi were randomly selected out of 5 locations;
ii. Four sub-locations were randomly sampled proportionately from the total 13 sub-locations. Simple random sampling was used to give equal chances of inclusion and therefore better generalizability of data.
iii. From the selected sub-locations a representative sample of SSFs from each division was randomly picked proportionately to the overall sample size 96 from a list of households.

The households were selected proportionately to sample as in table 4.

Table 4

Distribution of Sample Size According to Administrative Units (N=96)

Division	Location		Sub location		Sample size (Households)	
	Total	**Sample**	**Total**	**Sample**	**Total**	**Sample**
Lurambi	3	3	9	3	13,920	72 (75% of sample)
Municipality	2	1	4	1	23,769	24 (25% of sample)
Total	**5**	**4**	**13**	**4**	**37,689**	**96**

3.6 Instrumentation

The researcher constructed a questionnaire for data collection. The questionnaire was used to allow collection of data from greater number of respondents with greater confidentiality and at minimum cost across the study area. Both closed ended and open ended items were included. The instrument was structured into sub sections to take care of all the objectives of the study. Section A generated respondent's general information on gender, number of family members and residence. Section B focused on factors influencing food security; farm size allocated to food, type of IMV used sugar cane farming and farmer education level. Section C focused on measuring household food security using module questions.

3.6.1 Validity of the data collection instrument

Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform (Monette *et al.,* 1990). It is concerned with how accurately the data obtained in the study represent the variables of the study (Mugenda & Mugenda, 2003). Content validity refers to the appropriateness of the content of an instrument's items to accurately address the objectives of the study (Monette *et al.,* 1990). For the instrument to ensure content validity it was checked and reviewed by two supervisors (experts) from Department of Agricultural Education and Extension of Egerton University.

3.6.2 Reliability of the data collection instrument

Reliability is a measure of degree to which a research instrument yields consistent data after repeated trials (Mugenda & Mugenda, 2003). Reliability in research is caused by random errors which result from inaccurate coding, ambiguous instructions to subjects and researcher fatigue. To ensure higher internal consistency and reliability a pilot-test was carried using 30 similar subjects from one location of the neighboring Butere sub-county. From the pilot data a reliability coefficient of at least 0.7 (using Cronbach alpha procedure) was to be accepted at

a confidence level of .05 (Pallant, 2001). This was to ensure that items in the instrument consistently measure the concepts of the study. Using Cronbach coefficient alpha would help to reduce the time needed to work out reliability using other methods and it also results in a more homogenous estimate of reliability (Mugenda & Mugenda, 2003). The reliability test on total farm size, farm size under sugarcane and farm size under maize was 0.70 Cronbach Alpha indicating good internal consistency and the threshold reliability while that of food security module was 0.918 which was excellent. According to Shumiye (2007) study Cronbach Alpha value of 0.628 indicated that the data had good internal consistency reliability. According to Shumiye it is a common misconception that if Alpha is low; it must be a bad test since the test may measure several attributes/dimensions rather than one and thus the Cronbach Alpha is deflated which is also supported by Pallant (2001).

3.7 Data Collection

A research permit was obtained from National Commission of Science, Technology and Innovations with the assistance of Egerton University Graduate School. Sub-county agricultural officials were informed about the study by a copy of the research permit. Agricultural extension officer assisted in mobilizing farmers for data collection in the villages. The researcher was introduced by the research guide to the respondent and the respondent was requested to fill a questionnaire. Where the respondent could not read and write an interpreter (from that community) was used to help interpret the items as answers of the respondent were being entered.

3.8 Data Analysis

The questionnaires were first carefully checked for completeness, accuracy and uniformity and the data entered into the computer. Data was analyzed using descriptive statistics (frequencies, means and percentages) and regression analysis by using SPSS version 17 and the results tabulated or graphically represented.

Multiple regressions analysis (using Method=Enter) was used for the following purposes at 5% significance level:

i. To estimate the mean of the dependent variable ($\hat{y}$) from the independent variable or Predictors (X) at different levels using moderator variables. R-Squared values were used to measure model performance.
ii. To predict the mean value of the dependent variable from the values of the larger population. Regression coefficient values were used to measure the strength of

contribution of each independent variable to the mean values of the dependent variable.

iii. To test the hypothesized relationship between the dependent and the independent variable at 0.05 significance level. P-values (Sig.) for the overall model relationship and the coefficients associated with each independent variable were used to measure the significance.

Standard multiple regression analysis equation was performed using the formula:

$y=a+b_1X_1+b_2X_2+\dots b_iX_i+ ę$ where

y=Household Food Security Scale Index (HFSSI) (dependent variable)

a=the y intercept when all values of the predictor variables are zero (0)

b_1=regression coefficients for each independent or explanatory variable X

X= farm size allocated to food crops, improved maize variety used, sugarcane farming and education level of household head (independent variable)

X_i=the independent variable at different X_i^{th} level as given below:

X_1=Farm size under groundnuts

X_2= Farm size under maize

X_3= Farm size under bananas

X_4= Farm size under Sweet potatoes

X_5= H614D,

X_6=WS403,

X_7=WS505

X_8=Sugar Cane income to food

X_9=Farm size under sugarcane

X_{10}=No Formal Education;

X_{11}=Primary level;

X_{12}=Secondary Level;

X_{13}=College Level

X_{14}=University Level

ę=the uncorrelated random error term such that it's mean is zero and variance is squared deviation. It was estimated using the sample data. All tests were interpreted at 0.05 significance level (95% acceptance level) and a probability significance of

($P<0.05$) which is commonly used for applied sciences and education research (Kozak, A., Kozak, R., Staudhammer &Watts, 2008).

The overall food security was measured in terms of HFSSI which calculated as the average of percentage of farmers with adequate number of stock of maize from own farm production to last for a normal year (two cropping seasons=12 months), the number of months of food self-sufficiency and the score on household food self-sufficiency. The percentage of food insecure households was categorized into three categories: food secure (1) food insecure without hunger (2) and food insecure with severe hunger (3) using the Standard 0-10 metric and HFSSI.

Farmers were requested to indicate the total acres of land allocated to food crops so as to determine the effects of farm sizes on food security. Regression analysis was used to measure how much of the variance in the dependent variable can be explained by independent variable and also to test the hypothesis

The effect of using selected type of improved maize varieties was measured using H614D, WS 403, WS 505 and KS-H 6217. The types of seed included in the study were included based on suitability for season, maturity period, market availability, yields as well as recommendation by research. Data was summarized graphically in terms of percentages. The nominal data was changed into dummy variables to allow for regression analysis in order to measure the relative contribution of each on the dependent variable and to test the null hypothesis.

The effects of sugar cane farming was measured by the amount of farm size and the amount of sugarcane income allocated to food purchase while the education level of household head was measured based on the academic level attained from a list of five possible choices: no formal education=1 primary=2, secondary=3, college=4, and university=5. The results were summarized graphically in terms of percentages. The categorical data was changed into dummy variables by coding 1= yes and 0= No where applicable. Regression analysis was performed to test the null hypothesis. Hypothesis testing is summarized in Table 5.

Table 5

Summary of Data Analysis per Hypothesis

Hypothesis	**Independent variable**	**Dependent variable**	**Analysis**
Ho1: The portion of farm size allocated to food crops has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county	Farm size (continuous variable in acres	Food security: measured by Household Food security Scale index (HFSSI)	Multiple Regression analysis
Ho2: The type of improved maize variety seed used has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county	Type of seed improved maize variety used (Dummy) H614D, WH 403, WH505 & KS-H6217	Food security: (HFSSI)	Multiple Regression analysis
Ho3: Sugarcane farming has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county;	Sugar cane farming: Land size Sugarcane Income allocated to food	Food security: (HFSSI)	Multiple Regression analysis
Ho4: Farmer's education level has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county	Education level (Dummy): no formal education=1 primary=2, secondary=3, college=4, university=5	Food security (HFSSI)	Multiple Regression analysis

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the summary of the respondent's general information: division, location and sub-location; the factors affecting food security: total farm size (acres), farm size under selected food crops, the type of maize variety used and the approximate yields in the previous cropping seasons; the farm size under sugarcane and the approximate income on education, food and development from the previous sugarcane harvest and the education level of the head of the family. It also gives the variables that were used in measurement of food security which include the main source of food (farm or purchase), number of maize bags stocked from the previous cropping season, the number of months of maize security and scores on food security scale. The results are presented using bar graphs, pie charts and tables.

4.2 Background Information of the Respondents

The study randomly sampled 96 small-scale farmers randomly from four sub-locations of Municipality and Lurambi divisions. Of the 96 respondents males were 61 and females were 35. The following subsections illustrate respondents' geographical location, gender, marital status and age of the respondents.

4.2.1 Respondents' Geographical location

Table 6 shows that most respondents came from Lurambi division (75%) implying that 75% of the farm families live in the rural areas. There were 29.2% respondents from Central Butsotso Location while least (19.8% came from South Butsotso.

Table 6

Sample Size per Division, location and Sub-Location (n=96)

Division			**Location**	**Sub-Location**		
	F	%			F	%
Lurambi	72	75	Central Butsotso	Shibuli	28	29.2
			East Butsotso	Indangalasia	25	26.0
			South Butsotso	Emukaya	19	19.8
Municipality	24	25	Shieywe	Shirere	24	25
Total	**96**	**100**			**96**	**100.0**

Table 7 indicates that male respondents were 63.5% and females respondents were 36.5% which meets the constitutional requirement of at least 30% representation from either gender. Majority (84.4%) of the respondents was married, 13.5% were widowed and 2.1% were single.

Table 7

Respondent's Gender and Marital Status (n=96)

Gender			**Marital Status**		
	Frequency	Percentage		Frequency	Percentage
Male	61	63.5	Married	81	84.4
Female	35	36.5	Widowed	13	13.5
			Single	2	2.1
Total	**96**	**100.0**		**96**	**100**

Figure 3 shows that less than half (42.71%) of the respondents were 50-59 years while 26.04% were 40-49 years. Those seventy years and above were 3.13%. For this study it was hoped that the older the household head is the more food secure the family. In Kuwornu, Suleyman and Amegashie (2013) study an older household head was found to be more stable economically than a younger household head due to relatively richer experiences of the social and physical environments, accumulated wealth and farming experience. Older household heads were expected to have better access to land than younger ones (Kuwornu *et al*., 2013).

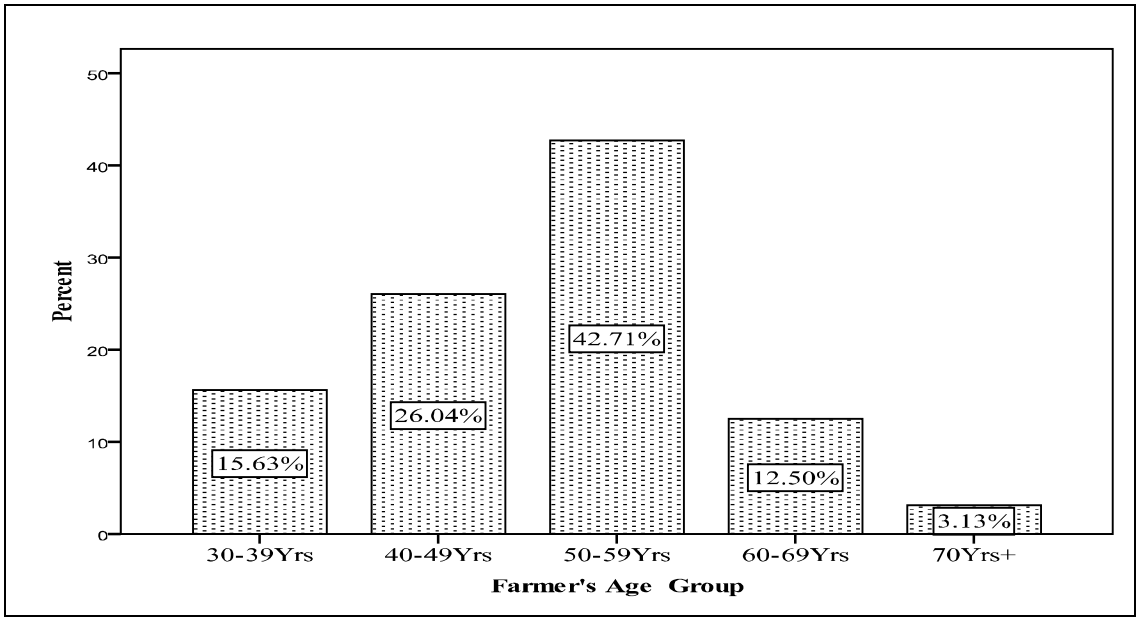

Figure 3. Respondent's age category in years

4.3 Selected Factors which have Effect on Food Security

The selected factors that affected food security of farmers in the study were farm size under food crops, the type of seed maize variety used, sugarcane farming and a farmer's education level.

4.3.1 Farm sizes allocated to selected food crops

According to Figure 4 farmers in the area own 3.28 acres on average and 38.54% own between 1.1-2.0 acres. Those who own 3.1-4.0 acres were 26.04%; 2.1-3.0 acres were 17.71% and 0.1-1.0 acres were 12.50%. The highest land size (above 4.1 acres) was owned by only 5.21%. For this study, land size was a sign of wealth and under subsistence agriculture, holding size is expected to play a significant role in influencing farmer households' food security (Kuwornu *et al*., 2013). According to Makombe *et al.* (2011) an increase of 0.25 ha per capita of cultivated land would decrease the likelihood of food insecurity by 22, 24, and 27 percent in the North, Central, and South regions of Malawi.

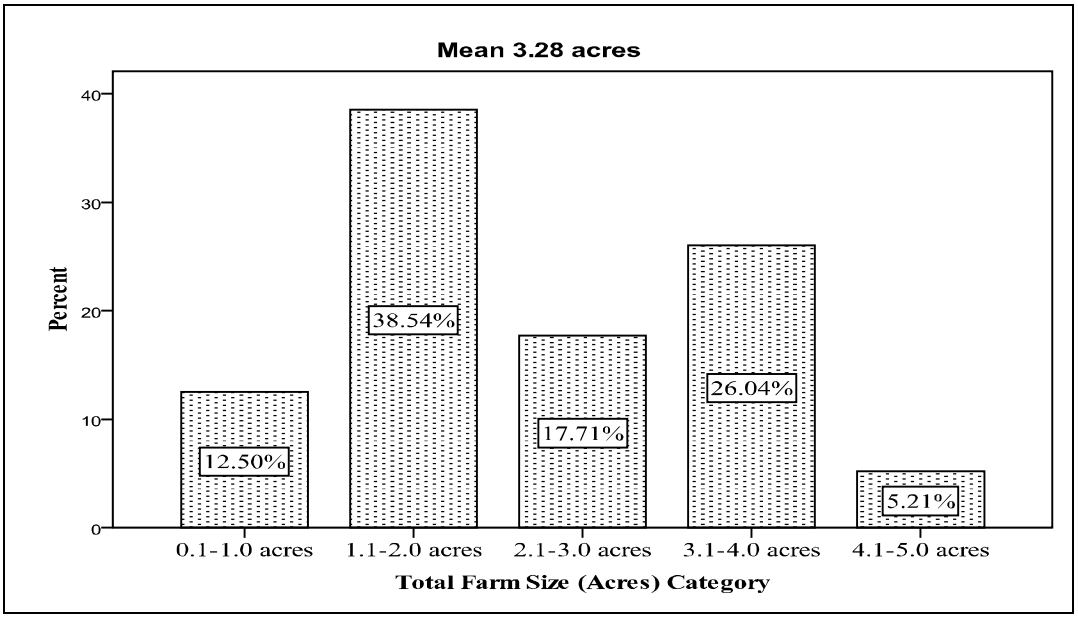

Figure 4. Farmers categorized according to farm size

Table 8 represents the portion of farm size under various food crops. The least farm size under maize ranged between 0.05-1.0 acres with 78.1% respondents and the highest was between 1.1-2.0 acres with 19.8 % respondents. There were 2.1% farmers who did not grow maize during the reporting season. The mean farm size under maize was 1.177 acres. The bean crop was intercropped with maize and on average it was grown in 1.031 acres. The least

farm size was beans with 0.05-1.0 acres with 70.8% respondents and the highest farm range was between 1.1-2.0 acres with 14.7% respondents. The respondents who did not plant beans were 13.5%. Sweet potatoes were grown under 0.05-1.0 acres by 40.2% of the respondents while 59.4% did not plant sweet potatoes during the reporting season. Banana crop was grown under farm size range 0.05-1.0 acres by 30.2% respondents and a mean farm size 0.302 acres. The respondents who did not grow banana crop were 69.8 %. Groundnut crop was the least grown crop with 12.5 % respondents in the category 0.05-1.0 acres. The study used maize self-sufficiency as an indicator of food security because farmers still valued maize as the stable food crop. They allocate more farm size to maize than other food crops. The size of the farm allocated to each food crop was on the lowest range for most farmers which would threaten their food security status.

Table 8

Farm Size under Selected Food Crops (n=96)

Farm size (Acres)	**Maize**	**Sweet Potato**	**Bananas**	**Beans***	**Groundnuts**
0.05-1.0	78.1%	40.6%	30.2%	70.8%	12.5%
1.1-2.0	19.8%	-	-	14.7%	-
0	2.1%	59.4%	69.8%	13.5%	87.5%
Total	**100.0**%	**100.0**%	**100.0**%	**100.0**%	**100.0**%
Mean (Acres)	1.177	0.406	0.302	1.031	0.125

Note: *Beans crop is intercropped with maize where a farmer grew it.

Table 9 shows the respondents per household food security category based on the portion of farm under food crops. More than half of respondents (60.42%) had allocated between 0.1-1 Ha of land and out of these only 9.37% were food secure (1), 32.29% were food insecure without hunger and 18.75% were food insecure with hunger. It was followed by those who had allocate between 1.1-2.0Ha of whom 4.17% were food secure. Although 2.08% had not allocated any farm to food crops they were food secure and could be that they had allocated more of their income to food purchase..

The result supports the literature by Bremner (2012) that declining farm size has made it harder for farmers to grow enough food to secure a livelihood and to feed their families.

According to Bremner a survey in Kenya indicated that majority of farmers' land production is not sufficient to support their families. Two out of three felt that there is not available land for their children to stay in the community and farm. Sugarcane farming has replaced most indigenous food crops and vegetables, despite their ecological suitability and high nutritive value. The actual land area devoted to food crops in sugarcane farming areas would be much lower than 50% and there is high risk of hunger and famine in the region given the long cropping cycle of sugarcane and its low net income (Waswa *et al.*, 2009).

Table 9

Respondents per Household Food Security Category Based on the Portion of Farm under Food Crops

Total farm size food crops * House Hold Food Security Category				
Portion of farm under food crops	House Hold Food Security Index			Total
	1.00/ (0.24-2.62)*	2.00/ (2.86-5.58)*	3.00/ (5.6-9.05)*	
0.0(Zero) Ha	2.08%	0.00%	0.00%	2.08%
0.1-1.00 Ha	9.37%	32.29%	18.75%	60.42%
1.1-2.00 Ha	4.17%	15.63%	8.33%	28.13%
2.1-3.00 Ha	3.13%	2.08%	4.17%	9.37%
Total	**18.75%**	**50.00%**	**31.25%**	**100.0%**

NB*: Household food Security Index score measured in 1998 Food Security Scale Value

4.3.2 Type of maize variety used during the previous cropping season

Figure 5 shows H614D was used by 44.7%) for either long or short season used and was followed by 42.10% who used WS505. Only 13.20% used WS403. None of the respondents had used or even aware of KS-6217 variety. Since 44.7% respondents used H614D it contradicts the observation made by Smale *et al.*, (2011) that H614D, planted on 42% of maize area in 1992, 51% area in 1998 and 4% in 2010. The stability of H614D and its popularity among farmers could be responsible for its increased use. A study by O'connor, *et al*., (2012) showed that most popular maize HB614 was grown by 62.6% of farmers in Kenya which was released 25 years ago. According to O'Connor *et al*., intensity of extension service was the major factor that positively influenced the adoption of improved maize seeds. With good field management the farmers are likely to get high yield since H614D has 8-9ton/Ha compared to WS403 whose yield is 5-8ton/Ha. Farmers should be sensitized on the availability and yield potential of KS-6217.

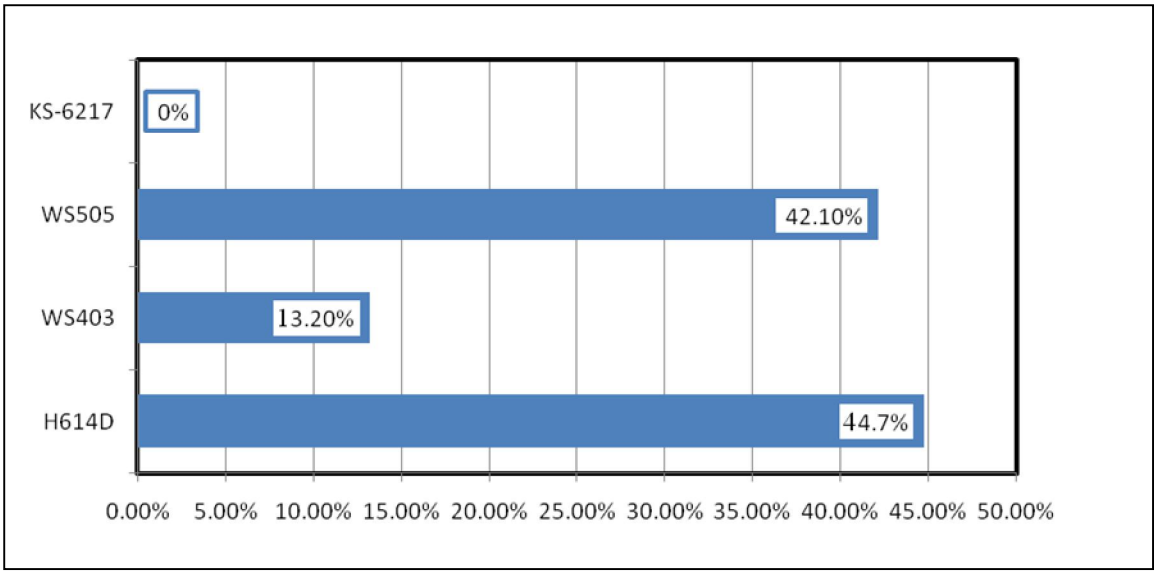

Figure 5. Type of improved maize variety used by the respondents

The use or none use of the selected IMV was then cross tabulated with the score on household food security index in order to establish the effect of IMV and the results are summarized in Table 10. The table shows that 44.83% of the majority respondents (82.42%) who used the selected IMV were food insecure without hunger, 26.04% were food insecure with hunger and 13.54% were food secure. The minority who did not use the selected IMV were 14.58% and 5.21% were food secure. As farmers use high yielding and ecologically adapted seed varieties the productivity improves which improve household food security.

Table 10

Percentage of Households Using IMV in each Household Food Security Category

IMV Use * House Hold Food Security Category				
IMV Use	House Hold Food Security Index			Total
	1.00/ (0.24-2.62)**	2.00/ (2.86-5.58)**	3.00/ (5.6-9.05)**	
No	5.21%	6.25%	3.13%	14.58%
Yes	13.54%	44.83%	26.04%	85.42%
Total	**18.75%**	**52.08%**	**29.17%**	**100.00%**

The use of other maize varieties by the respondents which were not selected for the study is shown in Figure 6.The results indicated that selected improved maize varieties (SIMV) were used by 47.06%. WS513 variety was used by 17.65%; 13.73% used local varieties and the rest used PANA (9.8%), KS-6210 (3.92%), H625D (3.92%) and DK8031 (1.96%). The use of IMV is relatively lower than a reported range of 70-75% found by Smale, Byerlee and

Jayne (2011) who noted that adoption of modern maize in Kenya appears to have leveled at 70-75% of maize as compared to Zimbabwe whose adoption rates reached 96% as early as 1990. Farmers use local varieties due to lack of money to purchase improved varieties while those using other varieties which were not selected for the study reported good yields and easy availability as the influencing factors for use. If farmers who were willing to adopt certified seeds are disappointed, they go back for local varieties or retained seeds (Schroeder *et al.*, 2013). In a study by Ali-Olubandwa, Kathuri, Odero-Wanga and Shivoga (2011) farmers in Western Kenya are confused on which seed to purchase as a result of the presence of a wide variety of maize seeds in the market and that there are over thirty companies manufacturing or importing farm inputs including maize seed.

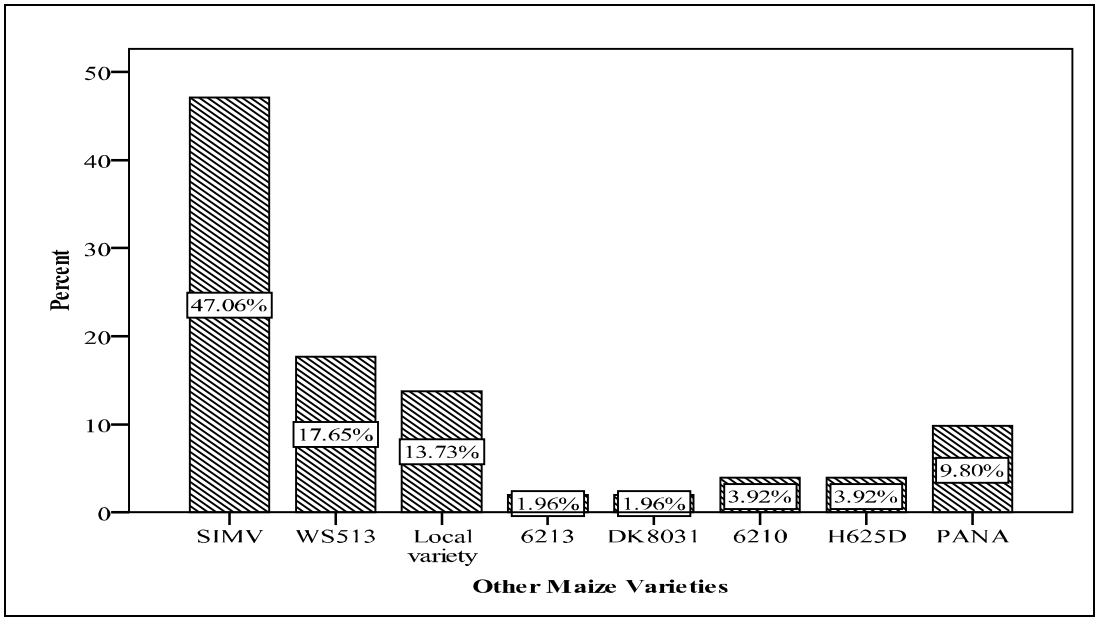

Figure 6. Respondents' use of other maize varieties

The study further sought to relate the effects of IMV on productivity based on the yields. Yields per year were calculated by adding yields given for short and long season. The average yield was 7.08 bags per acre during the long planting season (Figure 7). Most respondents (39.58%) harvested between 0.05-5 bags/Ha followed by 6-10 bags/Ha (33.33%). The least (1.04%), but the highest yield category reported was that of above 26 bags/ Ha. Although they had planted maize 7.29% of the respondents got no yields.

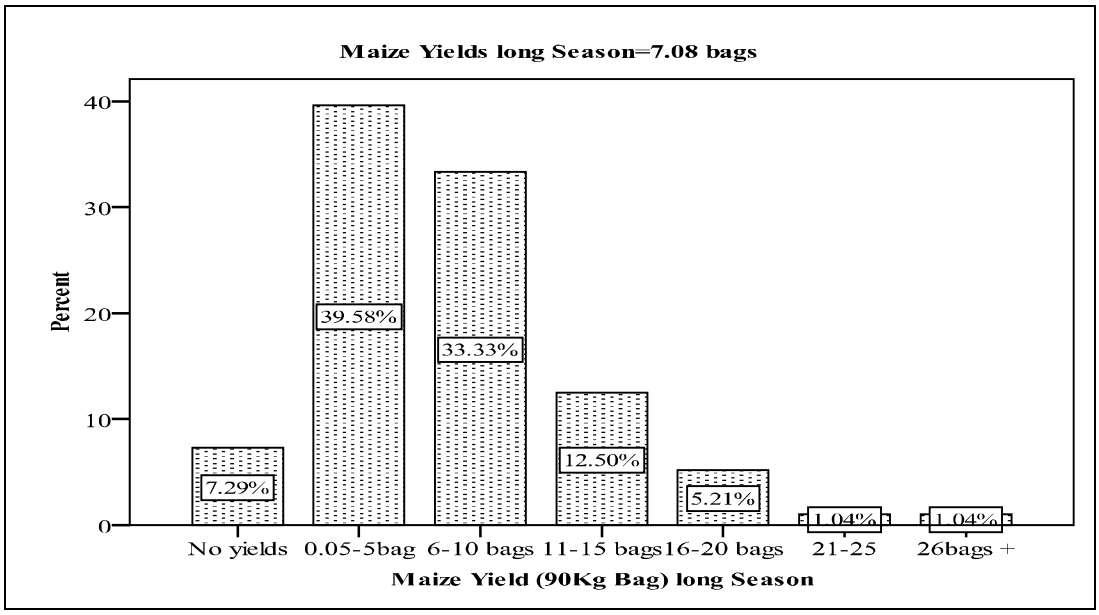

Figure 7. Respondents' maize yield (90kg bag) during long planting season

From Figure 8 almost half (42.71%) of respondents reported no yield either because they did not plant or due total loss caused by diseases like lethal maize necrotic diseases. Only 34.38% of the farmers harvested between 1-3 bags during the short season and 6.25% got between 7-10 bags/Ha. Yields were generally low during the short planting season averaging 2.43 bags/Ha.

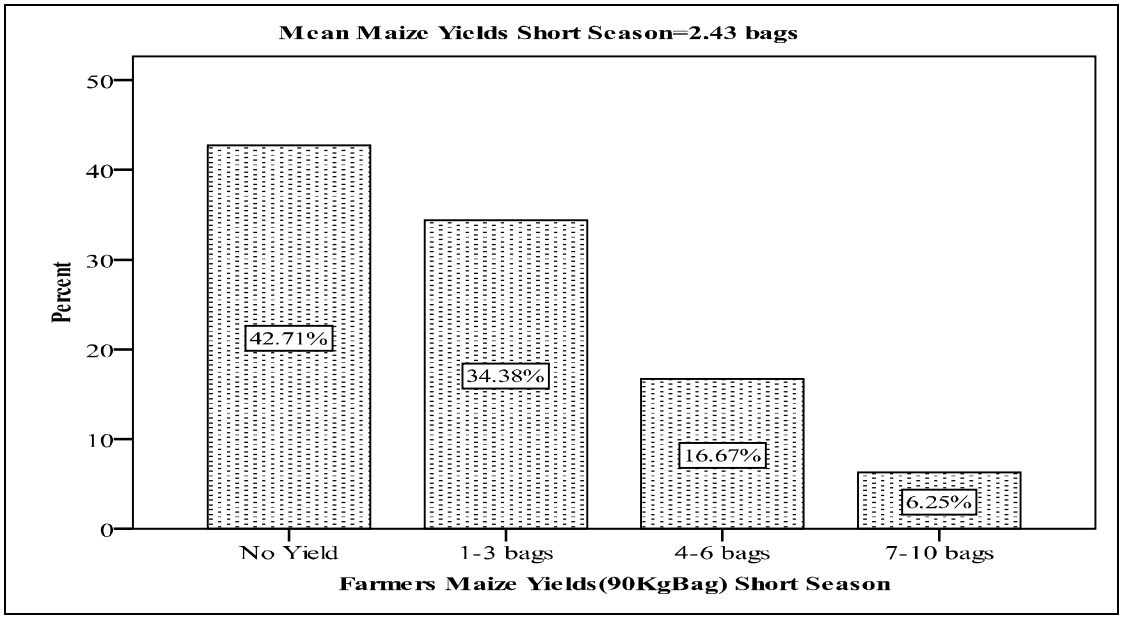

Figure 8. Respondents' maize yields in short planting season

Annual yield per farmer was summarized in figure 9.There were 39.58% respondents who got between 0-5 bags and 26.04% reported a yield of 6-10 bags while the farmers with the

highest yield (26 and above bags/acre/year) were 4.17%. The mean annual maize yield was 9.26 bags for each farmer.

In this study the quantity of household own production increases the probability of production based food security. The lower the amount of grain food obtained from own production, the more likely the household is food insecure (Kuwornu *et al*., 2013). The findings compared with those quoted by FAO (2012) and MoA (2010) that household's average cereal production in a staple harvest years is persistently lower than annual food requirements resulting in many households being food secure only for less than a quarter of the year. Empowering farmers to adopt IMV and modern farming technologies is important to enhance productivity. Further farmers should be encouraged to practice double cropping to reduce seasonal vulnerability to food insecurity.

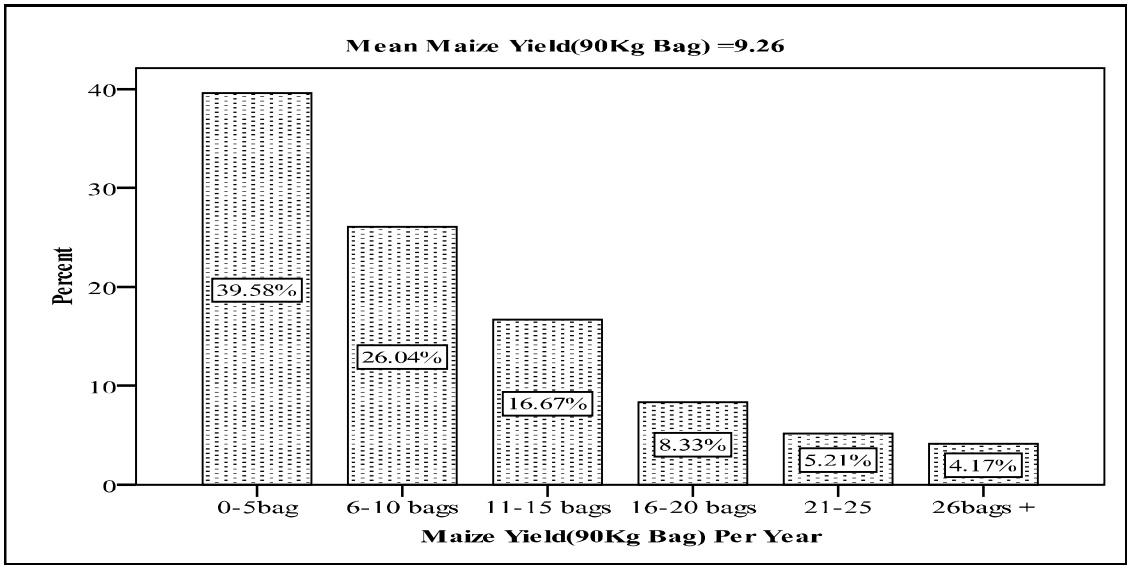

Figure 9. Maize yields per year per farmer

4.3.3 Effect of farm size under sugarcane

Farmers were asked to indicate the size of farm allocated to sugarcane. Their responses were categorized as in Figure 10. Most respondents 46.88% had allocated between 0.1-1.0 acres to sugarcane, 28.08% had between 1.1-2.0 acres, 12.50% had not allocated any farm and 4.17% had allocated between 3.1-4.0 acres. The mean sugarcane farm size was 1.26 acres. Being cash crop sugar cane is hoped to improve food security based on the fact that income from it could be used to purchase food for household consumption. The more land allocated to

sugarcane the higher the income expected and thus the more likely a household is food secure when other factors are held constant.

On comparison farmers allocate smaller farm (average 1.17 acres) to maize and other food crops than sugar cane (1.26 acre) from their average 3.28 acres of land. This result is similar to that of Netondo *et al.* (2010) who noted that the land under sugar cane increases inversely with the size of land under individual indigenous crops such as simsim, finger millet, Bambara, groundnuts, sorghum, cassava and sweet potatoes.

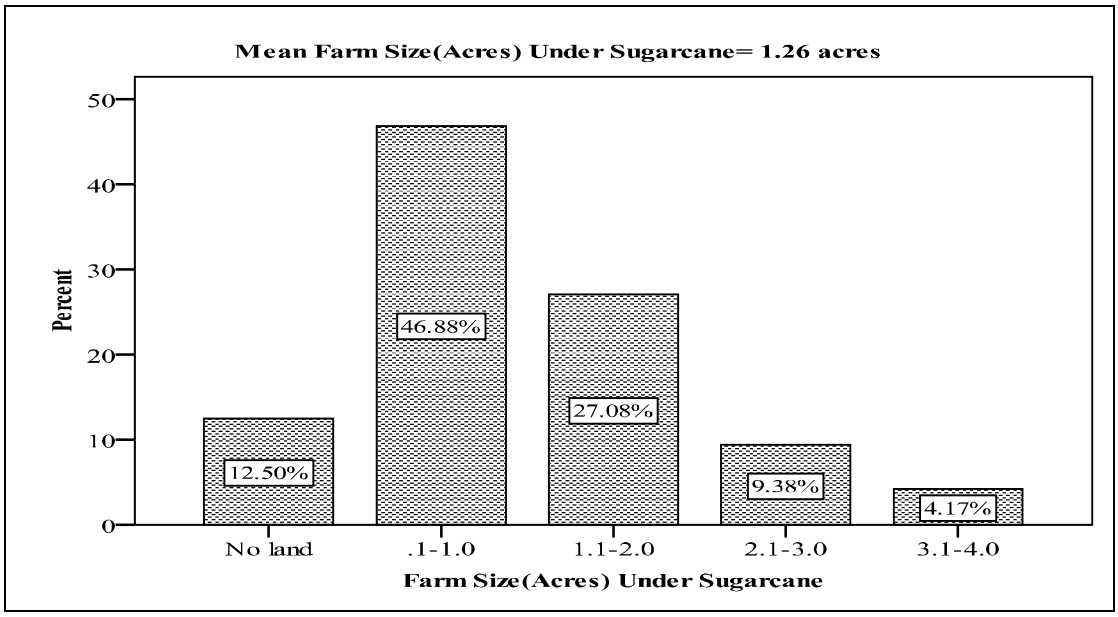

Figure 10. Respondents' farm size allocated to sugarcane

Table 11 shows that the majority of the respondents (46.88%) had allocated 0.1-1.0 Ha of land to sugar cane of whom 10.41 % were food secure. The rest were food insecure. Out of the 96 respondents 4.17% had allocated 3.1-4.0 Ha of land of which only 1.04% were food secure. The second minority of the respondents (12.05%) had not allocated any land to sugar cane. Of the 12.05% only 3.13% were food secure. Due to competition for land between sugar cane and food crops sugar cane is given priority by most farmers and has substantially reduced food production. Netondo *et al.*, (2010) found that expansion of sugar cane farming poses a high risk to the existence of varietal diversity of indigenous vegetables such as pumpkin, African nightshade, amaranths and food crops like sorghum, finger millet, cassava and sweet potatoes. This was also noted in a study by FIAN (2010) that the land available for producing food had decreased substantially and in some instances no land at all was left for growing food among small land owners in Mumias.

Table 11

Respondents' Household Food Security Category Based on Farm Size under Sugar Cane (n=96)

Farm size under Sugar Cane * House Hold Food Security Category				
Farm Size under Sugar Cane	House Hold Food Security Index			Total
	1.00/ (0.24-2.62)**	2.00 (2.86-5.58)**	3.00/ (5.6-9.05)**	
0.0(Zero) Ha	3.13%	7.29%	2.08%	12.50%
0.1-1.00 Ha	10.41%	23.96%	12.50%	46.87%
1.1-2.00 Ha	3.13%	14.58%	9.38%	7.09%
2.1-3.00 Ha	1.04%	4.17%	4.17%	9.38%
3.1-4.0 Ha	1.04%	2.08%	1.04%	4.16%
Total	**18.75%**	**52.08%**	**29.17%**	**100.00%**

** Standard 1998 Food Security Index

Further, farmers were requested to give an estimate of their sugarcane income allocated to education, food purchase and other developments. The results are shown in figure 11, 12 and 13 respectively. Figure 11 indicates that 30.21% of respondents had allocated between Ksh 1-25000 to education, 27.08% had allocated Ksh 25001-50000, 5.21% had allocated between Ksh 50001-75000 while 31.25% had not allocated any income to education. The mean farmers' sugarcane income given to education was Ksh 37093.75. The allocation of income to education by majority of the respondents is relatively low.

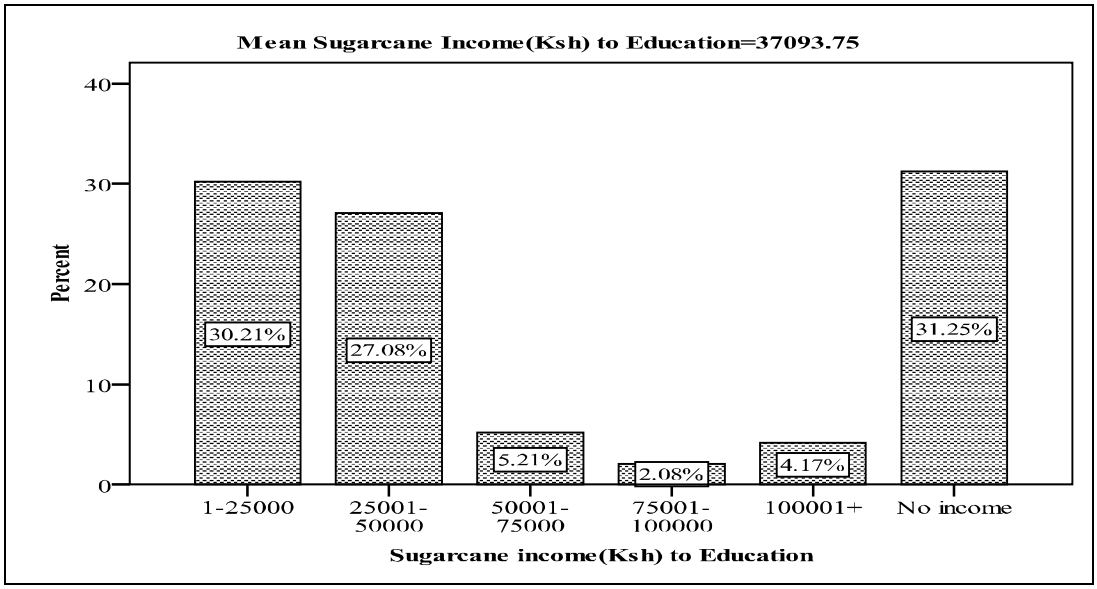

Figure 11. Respondents' sugarcane income allocated to education

In Figure 12,63.54% of respondents had allocated between Ksh 1-25000, to family food. Those who had allocated 25001-50000 were 5.21%, while 31.25% had not allocated any sugarcane income to food. Food seems not to be given priority in terms of sugarcane income. The mean farmers' sugarcane income to food was Ksh 10447.92 which is comparatively lower than that allocated to education and developments.

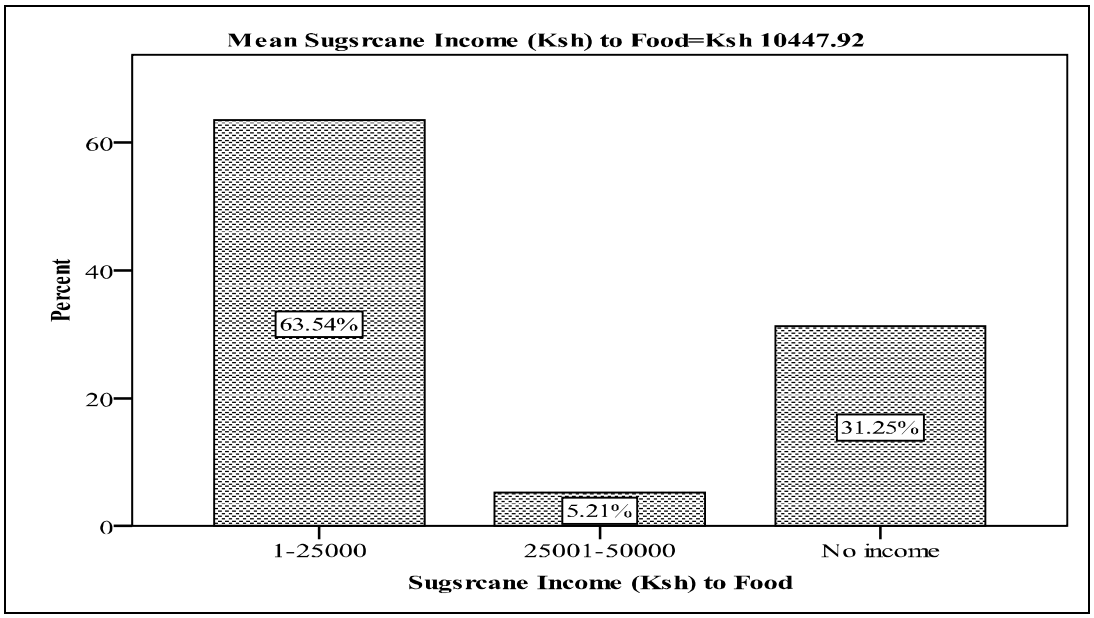

Figure 12. Respondents' sugarcane income allocated to food

Table 12 shows that 60.42% of the respondents had allocated between Ksh. 0-2500 to food and only 11.46% were food secure while 32.29% were food insecure without hunger. Second category (31.25%) had not allocated any money to food of which only 6.25% were food secure and the rest were food insecure. The minority of the respondents (5.21%) had allocated Ksh. 25001 to 50000 and only 1.04% were food secure. This finding is similar to a study by FIAN (2012) showed that sugar cane income was controlled by men who make the decisions on how to spend the proceeds and allocate the money not necessarily to food or pay for school fees. Even when the money is used for food, the increased prices on the market have made it virtually impossible to provide adequate food with the payment received from sugarcane, even where the entire land was used for cane production (FIAN, 2012).

Table 12

Respondents' Household Food Security Category According to Sugarcane Income to Food (n=96)

Sugar Cane Income to Food * House Hold Food Security				
Sugarcane Income to Food (Ksh)	House Hold Food Security Index			Total
	1.00/ (0.24-2.62)**	2.00 (2.86-5.58)**	3.00/ (5.6-9.05)**	
0-25000	11.46%	32.29%	19.79%	60.42%
25001-50000	1.04%	1.04%	3.13%	5.21%
0.0(Zero)	6.25%	18.25%	6.25%	31.25%
Total	**18.25%**	**52.08%**	**29.17%**	**100.00%**

**1998 Food Security Scale Value

In terms of allocation of sugarcane income to development (Figure 13) 39.58% of respondents had allocated between Ksh 1-25000, 14.58% had allocated Ksh 25001-50000, 1.04% had allocated over Ksh 100001while 44.79% had not allocated any income. The mean farmers' sugarcane income to development was Ksh 13,083.33.

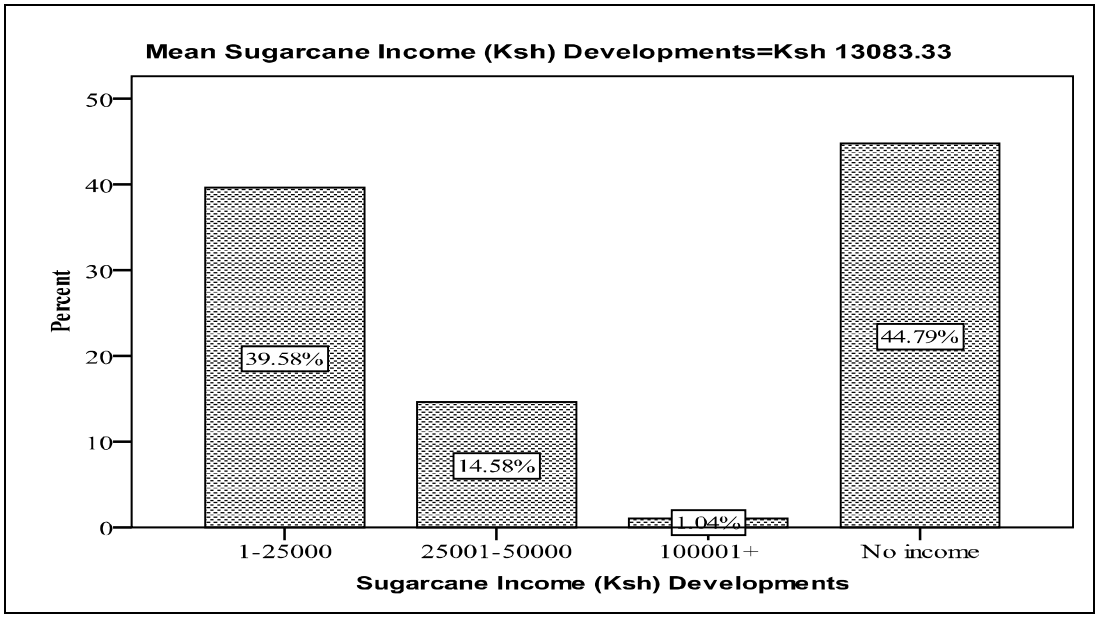

Figure 13. Respondent's sugarcane income allocated to developments

Farmers gave the highest priority to education followed by development and food thus threatening household food security. This was also observed by Waswa *et al.*, (2012) that most farmers engaged in sugarcane farming to raise income for education of their children

and acquisition of descent family shelters. According to Arene and Anyaeji (2010), 60% of the households whose monthly per capita food expenditure fell below two-third of the mean monthly per capita food expenditure was food insecure. Waswa *et al.,* (2012) found that repayment of debts involved in sugarcane production reduced the farmers' propensity to buy and/or grow food for their own subsistence, hence the persistent food insecurity and malnutrition.

4.3.4 Farmers' education level

The farmers were requested to indicate the highest level of education (educ) attained. The results are summarized in Figure 14.Those who had attained Primary level were 47.92% followed by 34.38% with secondary education, 9.38% college education and then 7.29% with no formal education. Only 1.04% of the respondents had university education.

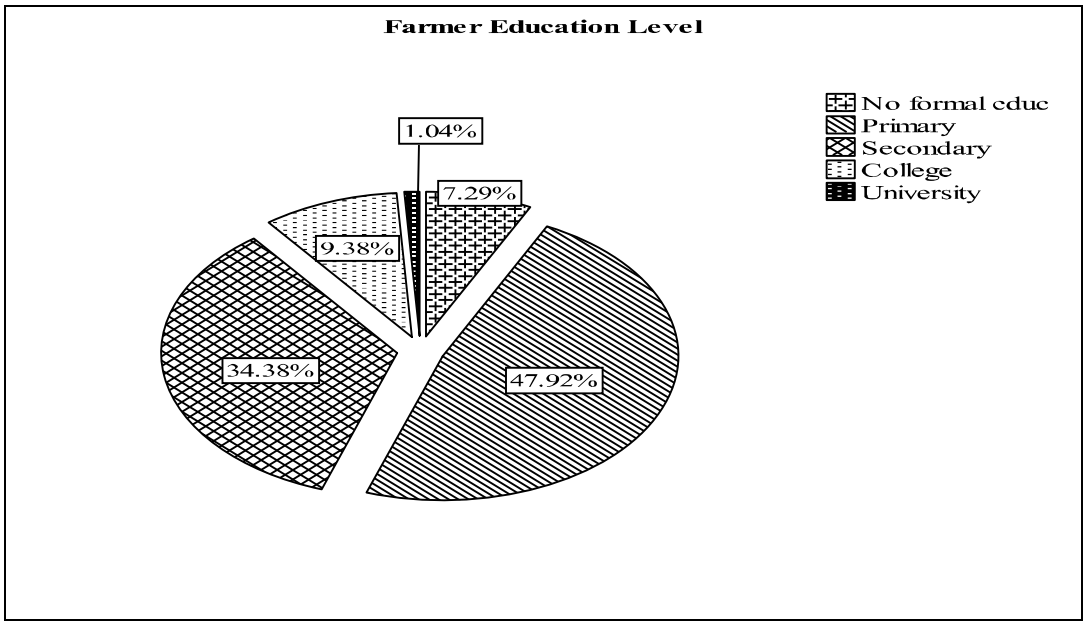

Figure 14. Farmer's education level

The study used education level as empowerment to adoption of modern productive technologies, information access on better market for farm produce and essential inputs as well as access to off-farm employment opportunities which can improve household food security. Majority of the farmers in the area had attained primary education (47.92%) and secondary education (34.38%) and thus could read and understand extension messages.

Table 13 indicates that the majority of the respondents (92.71%) had formal education. Out of those with formal education 48.96% were food insecure without hunger and only 17. 71%

were food secure. Since the majority of those with formal education 47.92% had primary education could explain why 48.96% were food insecure without hunger and 26.04% were food insecure with hunger. Just being literate didn't necessarily offer farmers off-farm better paying employment for better food access to higher quality diets. This finding was also reported by FAO (2012) that poor people often have little education, which prevents them from participating in new dynamic labour markets that offer higher wages and thus reduce progress in reducing undernourishment. Further a study in Ghana indicated that increases in non-working members of households worsened the food security status of farming households (Kuwornu, *et al*., 2013).

Table 13

Respondents' Household Food Security Category Based on Farmer's Education Level

Farmer Education Level * House Hold Food Security Category				
Farmer education level)	House Hold Food Security Index			Total
	1.00/ (0.24-2.62)**	2.00 (2.86-5.58)**	3.00/ (5.6-9.05)**	
No Formal education	1.04%	3.13%	3.13%	7.29%
Formal Education	17.71%	48.96%	26.04%	92.71%
Total	**18.75%**	**52.08%**	**29.17%**	**100.00%**

4.4 Household Food Security

The following were used to determine food self-sufficiency of households over the last 12 months: main source of food; own farm production and purchase food entitlement; number of family members; annual maize requirement and stock from the previous harvest season/s, months of maize self-sufficiency and household food security conditions**.**

4.4.1 Main source of family food

The study sought to find out the main source of food from the respondents in order to determine production based food security. Figure 15 summarizes the findings. The majority of the respondents (65.63%) obtained food from farm production while 34.38% purchased their food from the market. Households in Kakamega Central Sub-county were dependent on production based food security and were food secure when productivity was high. According to FAO *et al.*, (2013), a production-based food entitlement, is the principal indicator of food security contrary to purchased entitlement to food in developing countries where food access

in the rural is limited due to inadequate marketing channels, limited non-farm employment and high and unstable food prices.

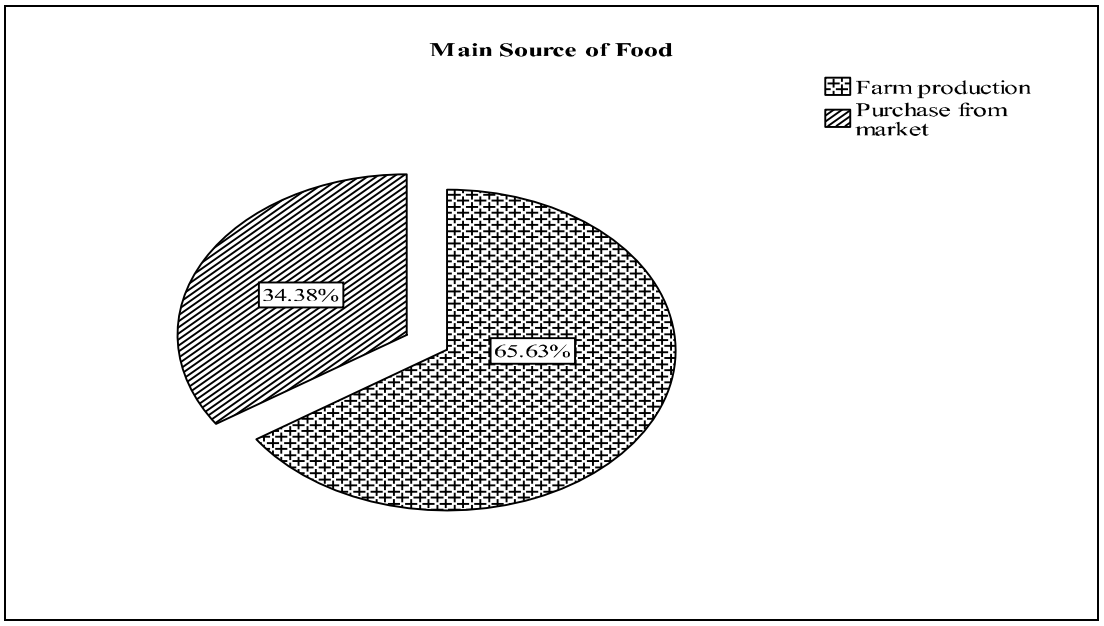

Figure 15. Respondents' main source of food

Further the study sought to determine the extent to which sugarcane farming contributes to family food security. Respondents were asked to choose from three categorical levels as not at all (1); little extent (2) and great extent (3). The findings are summarized in Figure 16. Less than half (45.83%) of the respondents felt that sugar cane contributed to a little extent to food security, 33.33% thought it contributed greatly while 20.83% thought it didn't contribute anything at all to their food security. This was probably due to low prices and unreliable sugarcane payments. Waswa *et al,*. (2012) had noted that instability in the output and prices of sugar cane had reduced the purchasing power needed to buy food. Their study showed that farmers' net incomes were 32, 31 and 34% of the gross incomes for Lurambi, Koyonzo and Chemelil respectively. According to their study the companies retained at least 60% of the gross income per ton of sugar cane delivered.

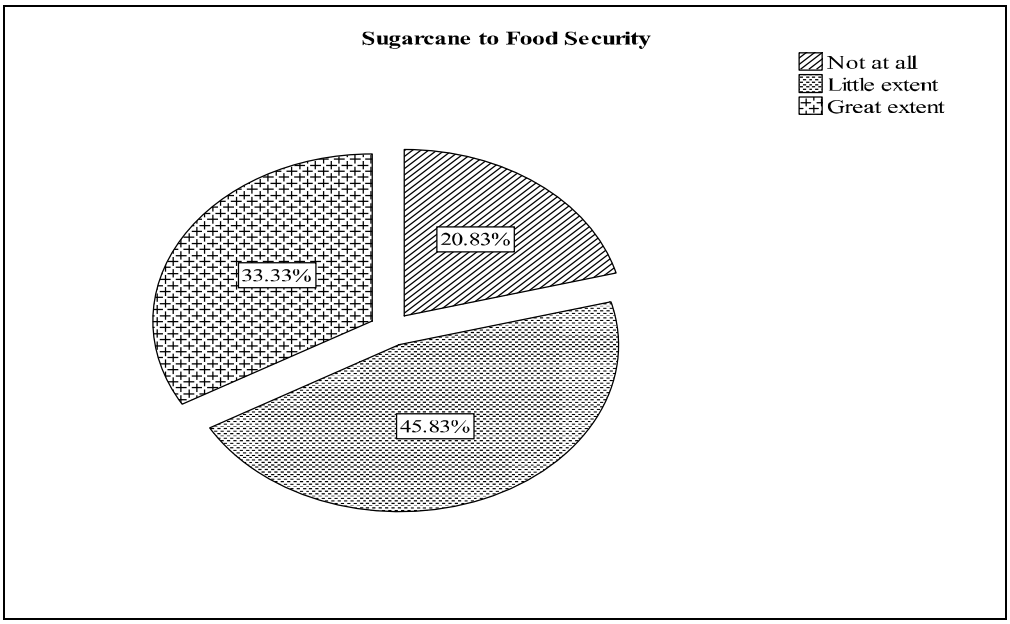

Figure 16. Respondents' opinion on the extent of sugarcane contribution to family food security

4.4.2 Influence of family size on food security

The respondents were requested to indicate the number of family members under their care under different age categories. The data indicates the dependency ratio which affects food security. The total family size was calculated by adding the number given under the categories and the results summarized in Table 14. The smallest family size consisted of 2 persons and the largest was 15. The highest (14.6%) number of the respondents reported 8 persons in a household. Two family sizes 5 and 7 were reported by 13.5% of the respondents. Mean number of family members was equal 7 persons. The family size was used as an indication of food dependency ratio and food insecure households tended to be somewhat larger. A mean of 7 is higher than statistic mean of 5 which is the regional mean (KNBS, 2010).

Table 14

Number of Persons per Household Expressed in Frequencies and Percentages (n=96)

Persons Per Household	Frequency	Percent
2	2	2.1
3	2	2.1
4	11	11.5
5	13	13.5
6	11	11.5
7	13	13.5
8	14	14.6
9	8	8.3
10	9	9.4
11	5	5.2
12	1	1.0
13	2	2.1
14	4	4.2
15	1	1.0
Total	**96**	**100.0**

4.4.3 The number of maize bags needed by a family per year

The respondents were asked to give an estimate number of maize bags they required to last one year in order to determine their household food needs. Figure 17 shows that 30.21% of the respondents reported that they needed 12 bags per year, 16.67% needed 10 bags while the least 1.04% reported that they required 3 bags, 18, 22 and 24 bags respectively. On average 9.99 bags was needed to meet the maize needs of the target population. This figure is higher than the annual average yields 9.26 bags and 5.63 bags kept. Therefore the households are likely to be food insecure.

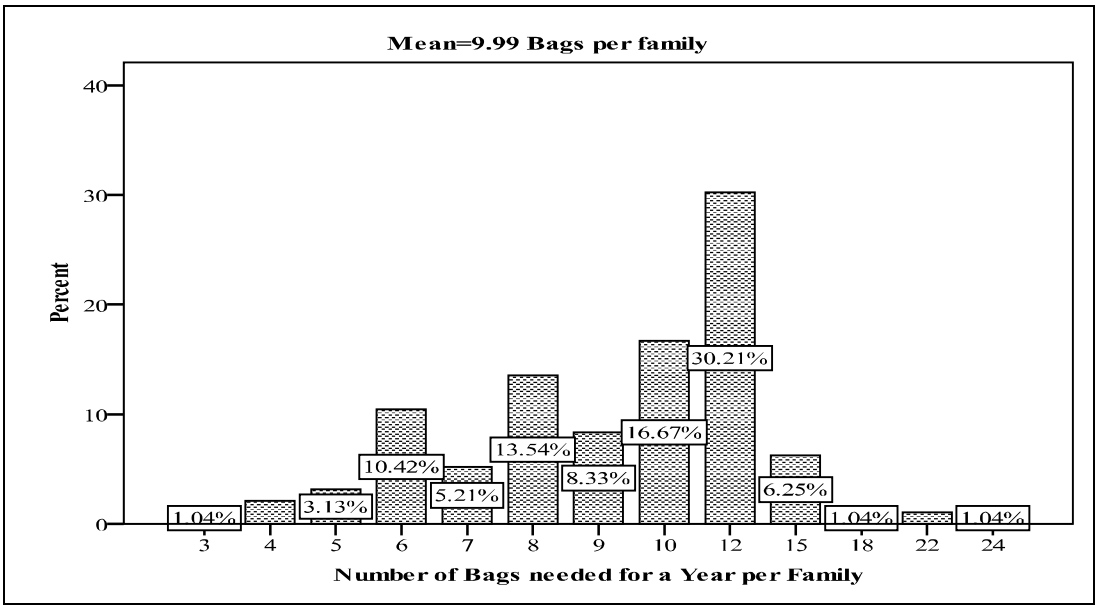

Figure 17. Number of maize bags needed by a family per year

4.4.4 Number of maize bags stored from the previous year

Farmers were requested to indicate an approximate number of maize bags they had stored from the previous year.Figure18shows that46.88% of the farmers had kept between 0.5-5 bags, 39.58% had kept between 6-10bags and 6.25% had kept between 11-15 bags and the least (2.08%) had stored between 16-20 bags. Farmers who had no stock were 5.21%. The mean number of bags kept was 5.63 bags. The study expected farmers to stock adequate maize stock it being the main staple and a food security crop and those farmers allocated more farm size relative to other food crops. However during the study it was discovered that farmers sell their maize to meet other basic needs like paying school fees and purchase of farm inputs.

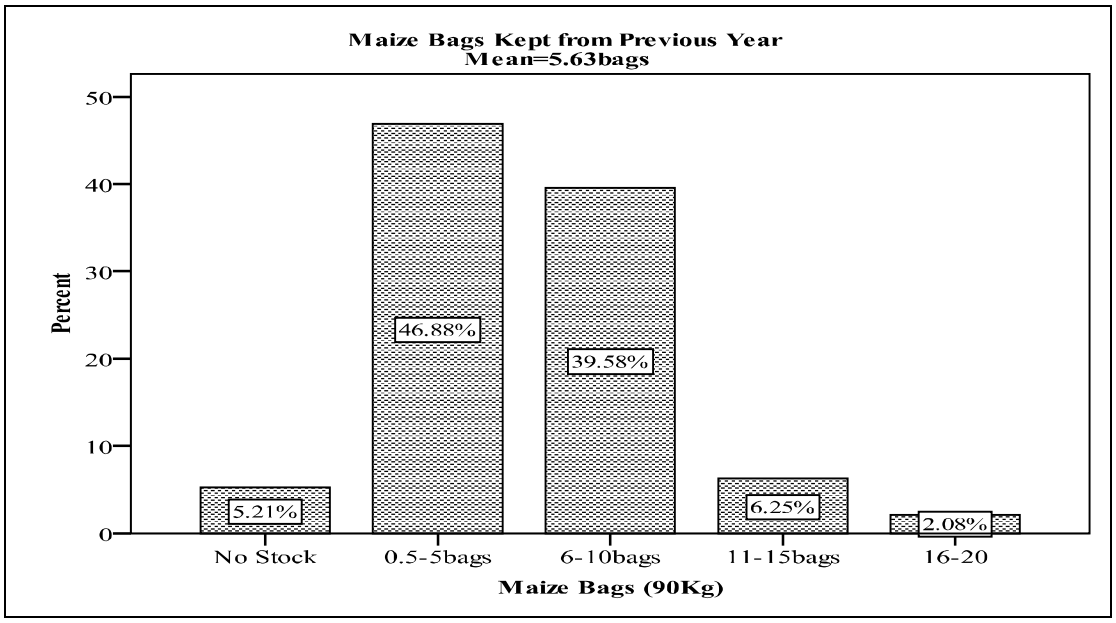

Figure 18. Number of maize bags stored from previous year

4.4.5 Months of maize security

Farmers were asked to give an estimate of how long the stock from the previous year lasted. Their answers were then categorized into quarters with the least being three months. The results are presented in Figure 19. Relatively more respondents (28.13%) reported up to 12 months maize security while 27.08% up to 6 months, 26.04% up to 3 months and 18.75% up to 9 months. The mean months of maize security was 6.69 months. The study revealed that over 70% of respondents remained seasonally food insecure for as early as the first one-quarter of the year.

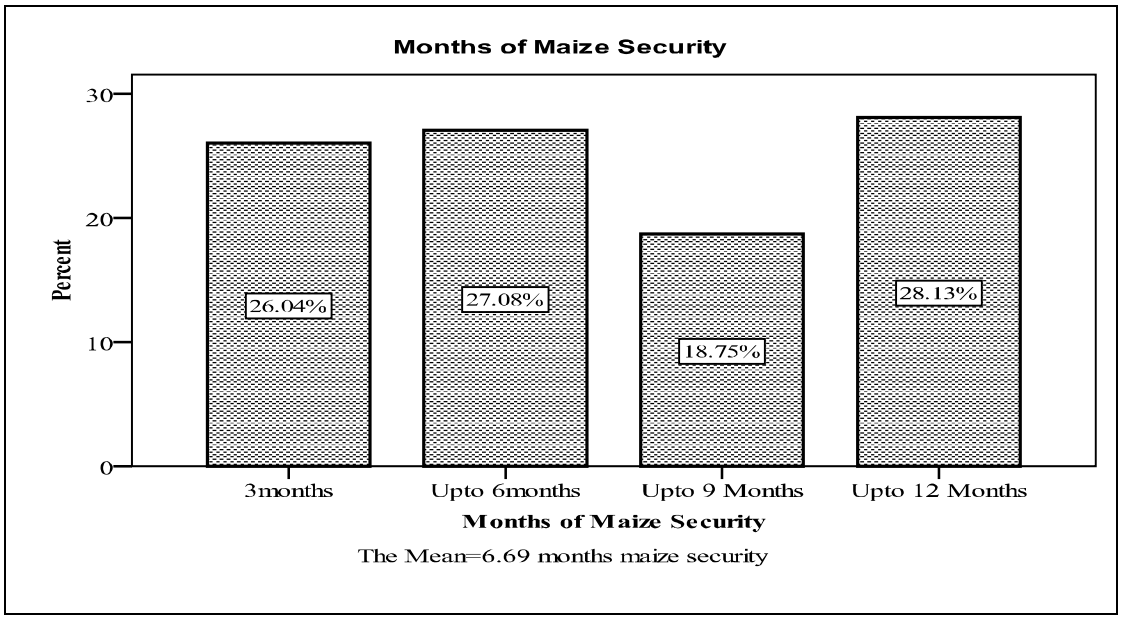

Figure 19. Respondents' months of maize self-sufficiency

4.4.6 Household food security status

Food security with 6-item scale was used to classify households. The standard6-item version was used to approximate closely the three main categories of the food-security-status measure: i.e., "food secure," "food insecure without hunger," and "food insecure with hunger" during the past 12 months a scale used by Bickel *et al.*, (2000).

The set of food security questions included in the core survey module was averaged to change into a single continuous overall household food security scale index (HFSSI) in order to measure the degree of severity of food insecurity experienced by a household in terms of a single numerical value. In this study the unit of measure has been chosen such that the full range of severity measured by the food security scale is expressed by numerical values ranging from 0 to 12 and then converted to standard food security scale 0 to 10 by multiply by the standard computational metric 0.7143 (Bickel *et al.*, 2000). For this study the scale, measures the sufficiency of household food as directly experienced by household members and not necessarily the nutritional adequacy of diets. The scale represents the condition of household members as a group, not necessarily the condition of any particular person in the household.

The continuous food security scale was further computed into categorical variable by assigning another scale value of 1-3 as: Food secure household assigned 1, food insecure

without hunger assigned 2 and food insecure with hunger assigned 3. The findings are shown in Figure 20.

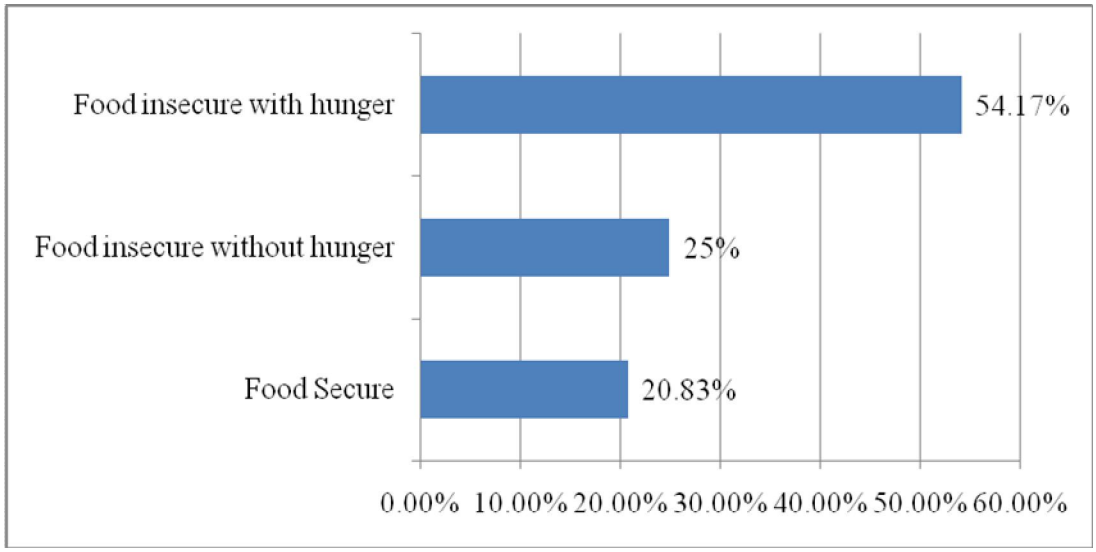

Figure 20. Respondents' food security categories

The largest portion of the respondents (54.17%) was food insecure without hunger, 25.00% was food insecure with hunger while 20.83% was food secure. The overall food insecure households were 79.17% which is higher than 70% and 50% reported by FAO, (2012) for households in cash cropping zone and mixed cropping zone respectively.

4.5 Effects of Factors on Household Food Security

The following subsections give the results and discussion of Multiple Regression was performed on based on the hypotheses of the study.

4.5.1 Effects of farm size allocated to food crops on household food security

The effect of farm size allocated to selected food crops commonly grown in the area was measured by asking the respondent the size of farm they had allocated. The crops which met significant regression limit were entered into the regression equation as: farm size under groundnuts, farm size under maize, farm size under bananas and farm size under Sweet potatoes.

From Table 15 farm sizes allocated to food crops; groundnuts, maize bananas and sweet potatoes contributed 0.101 (10.1%) of the variation in food security index of the households. From a p-value (0.045) the contribution of the farm size under food crop as a whole is statistically significant at significance level of 0.05. Therefore farm size allocated to food

crops has statistically significant effect on food security of a household. This finding is support that of Makombe, Lewin and Fisher (2011) that an increase of 0.25 ha per capita of cultivated land would decrease the likelihood of food insecurity by 22, 24, and 27 percent in the North, Central, and South regions of Malawi. Shumiye (2007) that the proportion of food insecure households was 80.2% and 80.9% among households who have farm size less than the average of the sample households and yearly grain production less than the sample average yield.

To compare the strength of contribution of each food crop to food security the standardized coefficients (Beta) values were used. Sweet potatoes had largest contribution of 0.274, however showed negative correlation. Bananas followed with a positive contribution of 0.265 then maize with 0.172. The least contribution was groundnuts with 0.100. In availability of maize among most families has let them to depend on other food crops although farmers still allocate relatively more farm size to maize.

Table 15

Effects of Farm Sizes Under Food Crops on Food Security Scale Index

Food Security Scale Index							
Farm size under food crops	Model Summary	Unstandardized Coefficients		Standardized Coefficients			Significance
Model	R-Square	B	Std. error	Beta	t	Sig.	p-value
1(Constant)	0.101	5.828	0.501		11.63	.000	.045[a]
Maize		0.796	0.481	.172	1.65	.101	
Sweet potatoes		-4.956	2.831	-.274	-1.75	.083	
Bananas		7.129	2.899	.265	2.46	.016	
Groundnuts		1.970	2.908	.100	.677	.500	

a. Predictors: Farm size under groundnuts, farm size under maize, farm size under bananas, farm size under sweet potatoes.

df- degrees of freedom and 95% confidence level

4.5.2 Effects of the type of improved maize variety used on food security

The use of improved maize varieties was measured using H614D, WS403, WS505 and KS-6217. To facilitate regression analysis a dummy variable was created on the use of any one of them by the farmer by coding yes (1) and nonuse coded zero (0).

X_5= H614D, X_6=WS403, X_7=WS505.

The use of KS-6210 had no respondent and therefore removed from the analysis. A general linear regression (Method=Enter) was performed in order to check on multicolinearity. The results of the regression analysis are tabulated in Table 16. The use of the selected improved maize varieties (H614D, WS403 and WS505) contributed 0.014 (1.4%) of the variation in food security index of the households on overall. From a p-value (0.734) the contribution of the model as whole is not statistically significant at significance level of 0.05.

To compare the strength of contribution of each of the selected type of improved maize variety used to the mean values of the food security the standardized coefficients (Beta) value was used. The use of WS403 contributed substantially (0.093) to food security scale with a p-value 0.382. WS505 was second with 0.078 at p-value 0.465 while H614D contributed 0.004 and a p-value of 0.969. When the IMV was changed into a dummy to allow a general regression analysis it indicated that the use of IMV contributed 12.9% to food security. From a p-value (0. 000) the use of the IMV is statistically significant. Therefore the use of improved maize variety has statistically significant effect on food security among SSFs in Kakamega Central Sub-county.

A survey of 1,542 farmers in 6 countries in SSA, including Kenya, found that where farmers had the opportunity to plant new varieties, 91% of the farmers stated that the new variety was at least 50% better yielding than their prior unimproved variety, with 36% stating that it was at least double the yield (O'connor *et al*., 2012).A study in Nigeria revealed that if farmers use improved technologies food insecurity incidence would reduce by 16.27% (Obisesan & Omonona, 2013).

Table 16

Effects of Type of Improved Maize Variety Use on Food Security Index

Food Security Scale Index							
IMV Use	Model Summary	Unstandardized Coefficients		Standardized Coefficients			Significance
Model	R-Square	B	Std. Error	Beta	t	Sig.	p-value
1(Constant)	.014	6.294	.544		11.566	.000	
H614D		-.022	.550	-.004	-.039	.969	.734[a]
WS403		.654	.745	.093	.878	.382	
WS 505		.398	.543	.078	.733	.465	
2.Maize (IMV general)	.129	-4.540	1.218	-.359	-3.729	.000	.000[b]

a. Predictors: Improved Maize Variety Use: WS505, WS403, H614D

b. Predictor: Use of Improved maize Variety. Confidence level 95%

4.5.3 Effects of sugarcane farming on food security

Sugarcane farming was measured by using two moderator variables as:

X_8=Sugar Cane income to food X_9=Farm size under sugarcane

From Table 17 sugarcane income and farm size allocated to sugarcane contributed 0.039 to food security scale index and with a p-0.158 is not statistically significant. From the Beta values, sugarcane income explained 0.229 to food security compared to farm sizes allocated to sugarcane at 0.064. The relationship between sugarcane farm sizes and food security is negative meaning for every increase of one unit of land size under sugarcane there is a 0. 064 decrease in food security. The data provided no evidence that the null hypothesis is false. This means that sugarcane farming has no statistically significant effect on food security among SSFs in Kakamega Central Sub-County. This result is supported by Waswa *et al.*, (2009) that Sugarcane farming, though popular, has had little or no significant positive impact on the livelihoods of small-scale farmers. Similar finding were made by Nah Tiepoh (2012) that about 66 % Liberians could not afford enough grain to feed themselves because

they had devoted the bulk of their land into foreign-owned oil palm or cocoa plantations, and turning farmers and other able-bodied men and women into plantation workers

Table 17

Effects of Sugarcane Farming on Food Security Index

Food Security Scale Index							
Sugarcane Farming	Model Summary	Unstandardized Coefficients		Standardized Coefficients			Significance
			Std.	Beta			p-value
Model	Rsquare	B	Error		t	Sig.	
(Constant)		6.202	.431		14.381	.000	
Farm size	.039	-.167	.331	-.064	-.505	.615	.158[a]
Sugarcane income		5.66*	.000	.229	1.805	.074	

a. Predictor Variable: Sugarcane income to food, farm size under sugarcane

Note: *1x10^{-5} and the unit of measurement is Ksh, 000' Confidence level 95%

4.5.4 Effects farmer's education level on food security

To perform regression analysis education level was changed into dummy variable by labeling 0=No and 1= Yes which was measured by requesting the respondent to choose from the 5 categorical levels of education; 1= No formal education, 2= Primary level, 3 secondary education, 4= College education and 5= University education. Each of the variables was then coded as: No (0) and Yes (1) to the response:

X_{10}=No Formal Education; X_{11}= Primary level; X_{12}= Secondary Level; X_{13}=College Level X_{14}= University Level.

The results of the regression analysis were summarized in Table 16.On overall, farmer education level explained 0.082 (8.2%). With P-value 0.163, farmer education level is not statistically significant to food security at a significance level of 0.05. This means data provided no evidence to reject the null hypothesis that farmer's education level has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county. When all other factors are held constant, Primary education level explained 0.554 food security followed by Secondary education level (0.547), College education level (0.348) and

lastly with no formal education (0.156). University education level explained only (0.132). From the beta values only University level education had a positive relationship which indicates that as education increases food security also increases because educated farmers have a better opportunity to acquire and access information on new technologies and are generally better able to assimilate, to process and use the information (Nata *et al*., 2014; Schroeder *et al*., 2013). This implies that educated farmers are more likely to use IMV. A study by Ali-Olubandwa *et al.,* (2011) in western province revealed that more farmers with higher education (masters- 100%, college/ university-50%, secondary school-46.5%) adopted either three quarters or all the improved agricultural practices passed by extension staff as compared to 28.5% and 30.8% of farmers with primary and no formal education, respectively. Enhanced cognitive skills may raise income levels and employability through better decision-making in the allocation and distribution of resources and an increased marginal productivity. Thus education levels decrease the probability of being in chronic and seasonal food insecure. Literature by Schroeder *et al.*, (2013) reported that among 200 households studied in the Kilifi and Kwale, literacy rate was not significant in the regression model but positively correlated. The study further found that the literacy rate was higher for adopters (75%) than for non-adopters (61%) of improved maize varieties.

Table 18

Effects of Farmer's Education Level on Food Security Scale

Food Security Scale Index							
Farmer Education Level	Model Summary	Unstandardized Coefficients		Standardized Coefficients			Significance
Model	R-square	B	Std. Error	Beta	t	Sig.	p-value
1.Constant	.082	9.33	2.528		3.69	.000	
No formal education		-1.80	2.770	-.156	-.650	.517	
Primary		2.83	2.555	-.554	-1.11	.270	.163[a]
Secondary		-2.96	2.568	-.547	-1.15	.251	
College		-3.06	2.665	-.348	-1.15	.255	
University		3.33	3.576	.132	.93	.354	

a. Predictor Variables: University, No formal education, College, Secondary, Primary Confidence level 95%

Based on the regression analysis the selected factors affecting food security of small scale farmers in the study area can be classified in a decreasing order as in Table 19.

From Table 19 IMV used had the highest (.129) contribution to food security followed by farm size allocated to food crops. Sugarcane farming had the least (.039). This implies that farmers can improve food security status by employing improved technologies in order to improve farm food security.

Table 19

Categorization of Factors Affecting Food Security based on Model Performance

Factor Affecting Food Security		**Model Performance**	
	moderator variable	**(R-Square)**	**(p-value)**
Improved Maize Varieties used	H614D,WS403, WS505 (Dummy variable)	.129	.000
Farm size allocated to food crops	Maize, Sweet potatoes, Bananas, Groundnuts	.121	.045
Farmer education level	No formal education, Primary education, Secondary education, College education University education	.082	.163
Sugarcane farming	Farm size allocated to sugar cane, sugarcane income allocated to food	.035	.158

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The following are the summary, conclusion and recommendations of the study findings on effects of selected factors on food security of small scale farmers. The selected factors were farm sizes, type of seed variety used, sugarcane farming and farmers' education level on food security of small scale farmers.

5.2 Summary

The study revealed that farm size allocated to food crops had a statistically significant effect respondents allocate between .05-1.0 acres to maize. Sweet potatoes had largest contribution of 27.4%, however showed a negative correlation while bananas, maize and groundnuts contributed 26.5%, 17.2% and 10.0% respectively to food security index.

The use of the selected individual improved maize varieties contributed 1.4% of the variation in food security which was not statistically significant at significance level of 0.05. The use of WS403 contributed 9.3% to Food Security Scale; WS505 contributed 7.8% while H614D contributed 4%. The use of IMV generally contributed 12.9% to food security and was statistically significant. None (0%) of the respondents reported having used or even being aware of KS-6217 variety.

Less than half (46.88%) had allocated between 0.1-1.0 acres to sugarcane and only 10.41 % were food secure. The mean sugarcane farm size was 1.26 acres. The mean farmers' sugarcane income allocated to education was Ksh 37093.75. Sugarcane income allocated to food by 63.54% respondents was between Ksh 1-25000. Over half (60.42%) respondents who had allocated between Ksh. 0-25000 to food had only 11.46% food secure while 32.29% were food secure without hunger. Sugarcane income and farm size allocated to sugarcane contributed 3.9% to food security scale index though it was not statistically significant. This means that sugarcane farming has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county. Sugarcane income contributed 22.9% to food security compared to 6.4% contributed by farm sizes allocated to sugarcane.

The majority of the respondents (92.71%) had formal education and only 17. 71% were food secure. Farmer education level explained 8.2% and was not statistically significant to food security at a significance level of 0.05. When all other factors are held constant, university education level contributed 13.2%. Primary education level explained 5.54% food security followed by secondary education level 5.47%, college education level 3.48% then with no formal education 1.56%. University level education had a positive relationship with food security because educated farmers have a better opportunity to acquire and access information on new technologies Higher education level may also raise income levels and employability through better decision-making in the allocation and distribution of resources and an increased marginal productivity. Thus education levels decrease the probability of being in chronic and seasonal food insecure.

5.3 Conclusions

The following are the conclusion of the research findings on effects of farm sizes, type of seed variety used, sugarcane farming and farmers' education level on food security of small scale farmers.

Farm size allocated to food crops has statistically significant effect on food security of small scale farmers in Kakamega Central Sub-county at significance level of 0.05. Bananas, maize and groundnuts had positive correlation with food security index. This means that the more land allocated to a variety of food crops the more food secure the household becomes.

The use of the selected individual improved maize varieties has no statistically significant effect on food security of small scale farmers in Kakamega Central Sub-county at significance level of 0.05. However the general dummy analysis indicated that the use of improved maize variety has statistically significant effect on food security. The use of WS403 and WS505 contributed substantially to food Security Scale In general the use of IMV can improve productivity hence food security.

Sugarcane farming has no statistically significant effect on food security among SSFs in Kakamega Central Sub-county at significance level of 0.05. Sugarcane income and farm size allocated to sugarcane contributed positively to food security scale index. Sugarcane farm sizes and food security are inversely correlated. Sugarcane income can help households to meet other food necessities that cannot be produced in the farm.

Farmer education level is not statistically significant to food security at a significance level of 0.05. University level education had a positive relationship with food security. Educated farmers have better opportunity to acquire access and assimilate information on new technologies that would ultimately lead to food security. Education levels decrease the probability of a household being in chronic and seasonal food insecure categories.

5.4 Recommendations

The following recommendations are based on the research findings:

The government should, through extension policies, continuously encourage diversification into traditional agricultural food crops among farmers. Farmers should purpose to allocate more proportion of their farm to a variety of food crops. This would improve and diversify their diet, reduce risk of crop failure and thus improve their food security status.

Policy makers should always try to intensify dissemination of improved farming technologies which would inevitably increase farm productivity. The agricultural extension officers should continuously coordinate with farmers on the use of current and suitable, high yielding maize varieties that are best suited to the ecological area. This would ultimately improve food security.

Public and private Extension officers should continuously encourage farmers to improve allocation of income to household food security. The sugarcane industry should sensitize and motivate farmers more on the policy of land allocation. Education is necessary to enhance farmer skills in financial management and income prioritization.

The Ministry of Agriculture and Ministry of Education, Science and Technology, should always work with farmers to enhance farmer participation in farmer training in order to improve farmer access to and processing of farming information and technologies. Ministry of agriculture should work together with stockists of farm inputs and research and extension service providers in order to increase the level of farmer awareness on the new and more yielding crop varieties.

This study mainly looked at the physical dimension of household food security as directly experienced by household members and not necessarily the nutritional adequacy of diets. More studies are therefore encouraged on the economic access to and utilization of food by

rural farm families. Contrary to a *priori* expectations, sugar cane and education are statistically insignificant in improving food security. It was therefore expected that these factors should improve the food security position of the household. Further, research is necessary to better understand the relationship between these variables.

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APPENDIX A

FARMER'S QUESTIONNAIRE

Questionnaire No. [ ]

Introduction:

The researcher is a student at Egerton University undertaking a Master's Degree in the Department of Agricultural Extension and Education. The information sought here is mainly for academic purposes. Confidentiality will be strictly observed.

Please give your sincere responses to the questions in this instrument.

SECTION A: GENERAL INFORMATION OF THE RESPONDENT

AI) (LOC) Geographical location of respondent

Division (DIV)…… Location (LOC)……

Sub-location (SUBLOC)……..

A2) Background information of respondent

a) Gender (GEND): 1. Male (.....) or 2. Female- (……..)

b) Marital status (tick the one applicable):

1) Married (.....) 2) Widow (.....) 3) Single (.....)

c) Age in years…….. Year of birth…….. (DD/MM/YYYY)

SECTION B: FACTORS AFFECTING FOOD SECURITY

1. What is the total size of your farm (in acres)? TOTFSIZ (.....)
2. Give the size of your farm (in acres) that is allocated to each of the following crops:

   Maize (MAIZHA) …… sweet potatoes (SWEPOT)…… Bananas (BANA)…… Sugarcane (SUGCAN)……. Sorghum……. Millet……Beans…….. Groundnuts…….Others (specify)…….

3. Which category of seed maize varieties did you plant in the last two planting season? (Write your appropriate answer in the corresponding box). **(MVUSE) write the number that match your answer in the box (**Use=1 Not use=0

Variety	H614D	WS 403	WS 505	KS-H6217	Others (specify)
Long season					
Short season					

4. a) What is the total number of maize bags (90kg) per season did you get from the two seasons in Q3 above?

Short season (SHBAG)…….. Long Season (LSBAG)…….

5. Give the size of your farm (in acres) that is planted with sugarcane. (……acres)
6. What is the estimate income from your last sugarcane payment was allocated to each of the given items?

   1. Education (Ksh……) 2. Food (Ksh……)..3. Other developments (Ksh……)

7. What is your highest level of education? (Tick one applicable to you)

   1=No formal education (.....) 2=Primary (.....) 3=secondary (.....)

   4=College (.....) 5=University (.....)

SECTION C: HOUSEHOLD FOOD SECURITY

8. What is your main source of food? (Tick one applicable to you)

   a). 1.Farm Production (.....) 2) Purchase market (.....)

   b) To what extent has sugarcane growing assisted you in family food security? (Tick one applicable to you) 0=Not at all 2=little extent 3=Great extent(……)

9. Give the number of family members under your support in each of the following age brackets if any. (FAMLSIZ)

   1) 0-10years (.....) 2) 11-18 years (.....) 3) 19-30 years (.....) 4) 31-59 years (.....) 5) Above 60 (.....)

10. How many bags of maize do you need to last one year? BAGMAYS (……)
11. How many bags of maize did you store from your farm for family consumption from last year? STOCK (…….)
12. How many months did the above maize stock last? MONFSEC (…….)
13. The following questions are about the food eaten in your household in the last one year. Please indicate your response in the corresponding Variable column.

Que No.	Question	Response Option	Variable name
1	We always have enough food to eat in the last three months	0=No 1=Yes	ENFOOD (……)
2	We did NOT have enough maize to eat in the last three months	0=Not true 1=true	NOTENFD (……)
3a	I was worried whether our maize would run out before we got money to buy more in the last three months	0= never true 1=often	MAIZSHT (……)

3b	If yes in Q3a how often, sometimes, or never true for you in the last six months?	1=rarely 2=sometimes 3=always	HWOFT (……)
4	In our home the children were not eating enough because we just couldn't afford enough food in the last three months	1=Never true 2=often 3=always	CNOTEN (……)
5a	In the last 3 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?	0=No 1=Yes	ANOENM EL (……)
5b	How often did this happen in the last three months?	1= Only two weeks in a month 2=almost every month 3 =week	AHWOFT (……)
6	In the last 3 months, did any of the children ever not eat for a whole day because there wasn't enough money for food	0=No 1= Yes	EATWDA Y (……)

Respondents name…….Contact……

THANK YOU FOR COOPERATION AND GOD BLESS

APPENDIX B

LETTER OF RESEARCH AUTHORISATION

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OFFICE OF THE DIRECTOR GRADUATE SCHOOL

Ref:..... EM12/2964/11 Date:..... 4th August, 2014 .....

The Secretary,
National Council of Science and Technology,
P. O. Box 30623-00100
NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MS. BEATRICE CHEPKIRUI ROTICH – REG. NO. EM12/2964/11

This is to introduce and confirm to you that the above named student is in the Department Agricultural Education and Extension, Faculty of Education and Community studies, Egerton University.

She is a bona-fide registered Masters student in this University. Her research topic is **"Effects of Selected Factors on Food Security Among Small-Scale Farmers in Kakamega Central Sub-County, Kenya."**

She is at the stage of collecting field data. Please issue her with a research permit to enable her undertake the studies.

DIRECTOR, BOARD OF POST GRADUATE STUDIES * EGERTON UNIVERSITY P.O. Box 536, EGERTON * 11 MAY 2015

Yours faithfully,

Prof. M.A. Okiror
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

MAO/ear