THE IMPACT OF FARM TECHNOLOGIES ON HOUSEHOLD FOOD SECURITY AMONG SMALLHOLDERS IN WESTERN PROVINCE OF KENYA: A GENDERED PERSPECTIVE

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DECLARATION

THIS THESIS IS MY ORIGINAL WORK AND HAS NOT BEEN SUBMITTED FOR A DEGREE IN ANY OTHER UNIVERSITY

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ABSTRACT

The study examined how improved farm technologies affected household food security in two rural districts in Kenya (Busia and Vihiga). The study further explored the gender related constraints that affected household food provisioning mechanisms and how this impacted on the nutritional status of children (between 6 and 60 months) and women in reproductive age (15-49 years) .The data was collected through a socio-economic survey involving a pre-tested structured questionnaire which was administered to 217 and 282 households in Busia and Vihiga respectively. Additionally, 119 mothers and their children were examined for nutritional status using anthropometrics and Body Mass Index (BMI) .The investigation involved the collection of both qualitative and quantitative data that was analyzed using various methodological approaches including descriptive statistics, Principal Component Analysis (PCA), Analysis of Variance (ANOVA) and Simple Regression Analysis.

The most important fertilizer was Di-ammonium phosphate (DAP) used by 49 % of households and combination of Calcium Ammonium Nitrate (CAN) and urea, used by 24 %. The application rate was however below recommended rates (96kg and 37kg per hectare for Vihiga and Busia districts respectively); the same applied to the application rate for farm yard manure. Expenditure on fertilizers not only had a significant effect on maize yield but accounted for 12% of the variation in income from maize sales (Adjusted $R^2 = 0.121$). Likewise, expenditure on seeds had a significant effect on maize yield accounting for 17% of yield variation (Adjusted $R^2 = 0.165$).

There was widespread use of ox-drawn ploughs for land preparation in Busia (52%) as compared to Vihiga (2%) attributed to variation in farm sizes (1.3ha and 0.6ha) for Busia and Vihiga respectively). Although the households that prepared their seedbed using ox ploughs realized higher yields (Busia), this did not reach a statistical significance. There was a minimal use of crop protection technologies both in the fields and after harvest contributing to 25 % loss of food crops and significant loss of income for the households.

When the effect of education level of household head and number of contacts with extension officers on maize yield was analyzed, the results showed a significant effect on maize yield

($p \leq .05$). Likewise, household headship was found to significantly affect the nutritional status of children ($p \leq .05$) but not women ($p \geq .05$). There was a significant difference in nutrition status of children in *de jure* and *de facto* female headed households and *de facto* female headed and male headed households with children in *de facto* female headed households being better nourished.

The Principal Component Analysis (PCA) showed that six variables; age of household head (16.6%), number of children (15%), expenditure on seeds (8.6%), expenditure on fertilizers (7%), quantity of fertilizers (6.3%) and expenditure on tools (5.6%), all totalling 59.6% accounted for the variation in maize yield and therefore household food security.

The food security situation in Vihiga district was relatively better due to a higher production per hectare of maize (503 kg) compared to 420 kg per hectare in Busia, Likewise, annual income from agriculture was Ksh.12, 045 in Vihiga compared to Ksh.9,637 in Busia. This variation was attributed to intensive use of farm inputs, farm diversification including the cultivation of horticultural crops and dairy farming in Vihiga than in Busia. The results also revealed that the number of stunted children was higher in Busia (37%) than in Vihiga (25 %).

The study concluded that the use of farm technologies, particularly hybrid seeds and fertilizers was low among smallholders and contributed to the low agricultural productivity that failed to meet the food security needs of the population in the two districts. In addition, the female-headed households had the potential of increasing production just like mainstream households, if they were supported through capacity building and access to financial and physical capital

The study underscores the importance of promoting intensive use of improved technologies by smallholders through efficient extension service and more friendly credit system as a means of achieving household food security. Improvement of women's access to productive resources is also recommended to ensure a more sustained food production.

DEDICATION

To my beloved sons Mugambi, Makamu and Mukhovi

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TABLE OF CONTENTS

LIST OF PLATES

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ADB	African Development Bank
AFC	Agricultural Finance Corporation of
AJFAND	African Journal of Food, Agriculture and Nutrition Development
ANOVA	Analysis of Variance
ASALs	Arid and Semi -Arid Lands
ATNESA	Animal Traction Network for Eastern and Southern Africa
BMI	Body Mass Index
CAN	Calcium Ammonium Nitrate
CED	Chronic Energy Deficiency
CIAT	International Centre for Tropical Agriculture
CIMMYT	Cento International de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Centre)
CTA	Technical Centre for Agriculture and Rural Cooperation
DAP	Di-ammonium Phosphate
DGES	Department of Geography and Environmental Studies
FAO	Food and Agricultural Organization
FGDs	Focus Group Discussions
GIS	Geographic Information Systems
GLS	Grey Leaf Spot
GoK	Government of Kenya
Ha	Hectare
HAZ	Length/height-for –age Z- scores
HYV	High Yielding Varieties

IADP	Integrated Agricultural Development Programme
ICN	International Conference on Nutrition
ICRA	International Centre for Development oriented Research in Agriculture
ICRAF	International Centre for Research in Agro Forestry (now World Agroforestry Centre)
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
KARI	Kenya Agricultural Research Institute
KEPHIS	Kenya Plant Health Inspection Service
KENDAT	Kenya Network for Draught Animal Technology
Kg	Kilogramme
KSC	Kenya Seed Company
LM1	Low Midland Zone (sugarcane zone)
LM2	Low Midland Zone (Marginal zone)
LM3	Low Midland Zone (Cotton zone)
LM4	Low Midland Zone (Cotton Marginal Zone)
MDG	Millennium Development Goals
MOA	Ministry of Agriculture
MOH	Ministry of Health
MSV	Maize Streak Virus
NCHS	National Center for Health Statistics
NCPB	National Cereals and Produce Board
NGO	Non-governmental Organization
NPAN	National Plan of Action for Nutrition

SEAGA	Socio- Economic and Gender Analysis Programme
SD	Standard Deviation
UNFPA	United Nations Population Fund
UN	United Nations
UNDP	United Nations Development Programme
UNU	United Nations University
USA	United States of America
USAID	United States Agency for International Development
WAZ	Weight- for- age Z- score
WHZ	Weight- for- length/height Z-score
WHO	World Health Organization

CHAPTER 1: INTRODUCTION

1.1 OVERVIEW OF FOOD SECURITY

The UN Food and Agricultural Organization (FAO) estimated that 852 million people worldwide were undernourished in 2000–2002. Amongst these, 815 million were in developing countries, 28 million in the countries with economies in transition, while 9 million were in the industrialized countries (FAO, 2004; FAO, 2005). In 2007, due to the increase in food prices, the number of undernourished persons increased to 923 million people globally (FAO, 2007). Currently, approximately one billion people comprising of one sixth of the world population subsist on less than one dollar per day. Out of this, 162 million people survive on half a dollar per day (USAID, 2009). Majority of the undernourished and poor persons come from smallholder households in Sub Saharan Africa.

Even though the number of undernourished people in developing countries decreased by 9 million during the decade following the World Food Summit baseline period of 1990–1992, a large percentage of people, especially children and women were still undernourished (FAO, 2004). While all the continents have recorded improvement in their economies with significant reduction in the number of the poor, the African continent has continued to grow poorer with the food situation in the continent worsening since 1970.

Poverty is a major cause of food insecurity while food insecurity also perpetuates poverty. Poverty contributes to low food production because the poor cannot afford farm inputs and at the same time, they cannot purchase food to maintain a healthy life. Food insecurity on the other hand, reduces productivity due to ill health associated with inadequate food and poor nutrition. Although the proportion of malnourished individuals in Sub-Saharan Africa has remained in the range of 33%–35% since around 1970, the absolute number of malnourished people in Africa has increased substantially with population growth, from around 88 million in 1970 to an estimate of over 200 million in 1999–2001 (Rosegrant *et al.*, 2005; FAO, 2003). Chronic food insecurity generally arises from inadequate access to resources that affect household ability to produce food and other requirements.

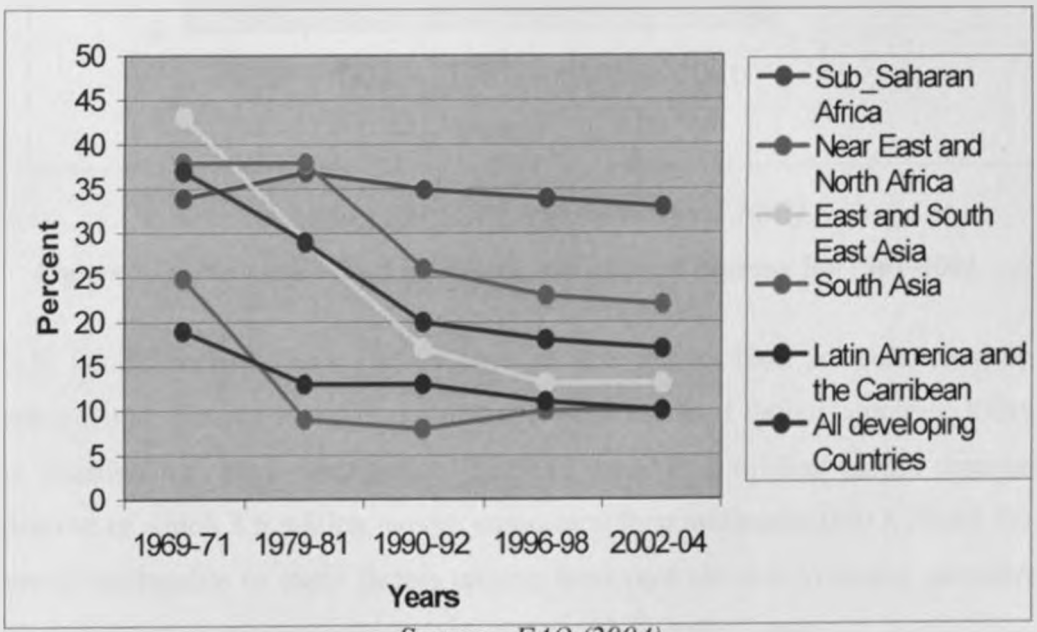
Hunger contributes to poverty hence reduction of the number of hungry people helps to alleviate poverty and promote development. Hunger affects people's health and productivity. A lot of productive time is lost due to diseases, disabilities and pre-mature deaths and this may cost the country billions of Kenya shillings. This *hunger-low productivity-extreme poverty* cycle that populations in Africa find themselves in, requires long-term investment especially in agriculture and other sectors of the economy.

Rural communities in Sub-Saharan Africa are the most affected by food insecurity. These communities form a large share of the world's poor and hungry people. It is apparent that achievement of the Millennium Development Goal (MDG) number one of halving the world's hungry and poor people by the year 2015 must start from the rural areas and from the agricultural sector. Since most of the poor derive their livelihood from agriculture and other related activities, the eradication of poverty and hunger must start from this sector. Before population increase became a global concern, increase in agricultural production was achieved through expansion of arable land. However, arable land is increasingly becoming scarce due to rapid population growth especially in Developing Countries. It is also apparent that such countries cannot sustain food imports due to limited foreign exchange earnings. The use of modern technologies in smallholder agriculture is one of the key areas that have the potential to increase productivity and income for the rural people. Increased productivity in agriculture in the long run will contribute directly to food security together with other benefits such as industrialization, poverty reduction and overall economic development.

Apart from agricultural intensification, sustainable use of natural resources especially land and water, improvement of rural infrastructure, research and communications, improved access to markets and efficient rural institutions such as credit and extension service provision are essential for promoting agricultural growth and improving the general wellbeing of rural communities. Productivity induced agricultural growth has a wider impact on rural areas through the strengthening of off-farm activities and rural employment and wages (FAO, 2004). Even though governments in Sub-Saharan Africa are making efforts to eradicate poverty, there are various groups of people such as children and women that require special attention. Development projects geared towards socio-economic development must consider gender differences in terms

of women's access to income, physical resources and technology. Sustainable economic development will be realized when women's role especially in agriculture will be recognized and supported by relevant policies.

Between 1969 and 1971, Sub Saharan Africa had less undernourished people than East and South/South East Asia (Figure 1.1). East and South East Asia which had 43 % in 1969-97 periods managed to reduce it significantly to 13 % in 2002-2004 periods. This can be explained by aggressive implementation of the Green Revolution technologies that improved the incomes and reduced poverty significantly.

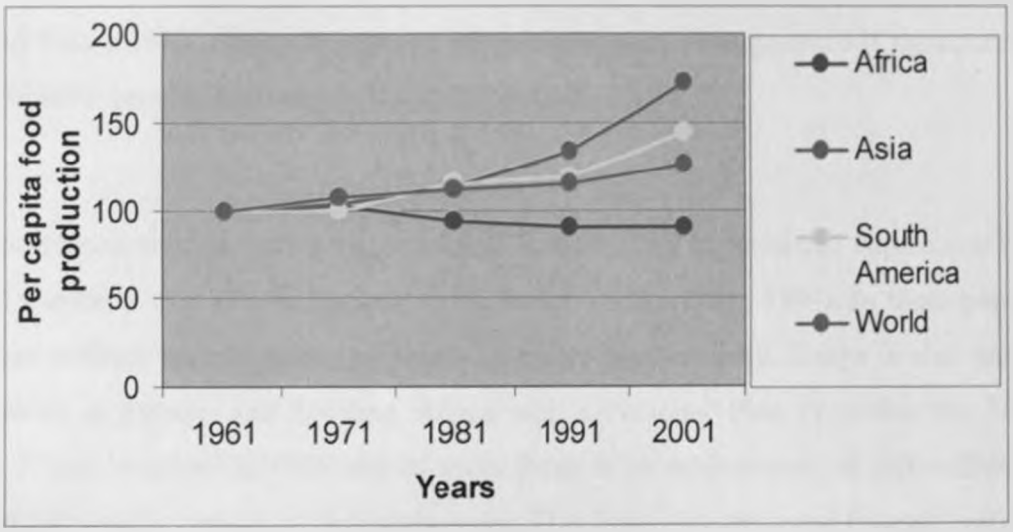


Source: FAO (2004)

Figure 1.1: Percentage of undernourished population in developing regions

In Africa, cereal yields increased by only 72 % in the last 50 years compared to increases of 217 % in Asia from similar starting points (FAO, 2004). Per capita food production in Africa also shows a declining trend (Figure 1.2) while other continents such as Asia have recorded increasing production since 1970s due to intensification of agricultural production. The differences in production can be attributed to many factors among them the low fertilizer use in Sub Saharan Africa averaging 8 kilograms per hectare compared to 101 and 96 kilograms per

hectare in South Asia and East and South East Asia respectively (Morris et al., 2007). Factors contributing to low fertilizer use in Sub Saharan Africa include small market, high transport and handling costs at the port and poor fertilizer dealer network (Morris et al., 2007)



Source: FAO (1976, 1983, 1993, and 2003)

Figure 1.2: Per capita food production in various regions for 1961-2001

The FAO Food Security Index rates Kenya as one of the food insecure countries in the Developing world, placing it at 51st out of 61 low-income food deficit countries. Kenya's food security situation has been described as alarming with 10.5 million people threatened with starvation out of which 3.5 million require emergency food assistance (FAO, 2009). Food crisis in Kenya is attributable to many factors among them post election violence, escalating global food prices and poor weather conditions associated with climate change.

In Kenya, food insecurity is not only a problem of the Arid and Semi Arid Lands (ASALs) but also in humid areas where agricultural potential is high. Kenya continues to import maize and other food stuffs thereby putting pressure on scarce foreign exchange earnings which would otherwise be used to import capital goods to promote industrialisation and help in attaining Vision 2030 (GoK, 2007). Commercial imports of food cannot be sustained because of low export earnings hence the government must adopt vigorous programmes geared towards increasing agricultural production in addition to sustainable management of land and water resources.

The agricultural sector contributes 24% of Kenya's GDP, accounts for 65% of total exports and 18% of total employment in the country (GoK, 2007). Despite its importance in contributing to foreign exchange earnings, national economy and food security, the agricultural sector has not been given the attention that it deserves in terms of resource allocation. Although some progress has been made as is evident from the implementation of Strategy for Revitalizing Agriculture (SRA) and Vision 2030, efforts to improve productivity must be augmented if the country is to realize self sufficiency in food supply (GoK, 2004; GoK, 2007).

Kenya government recognizes the importance of food security in Sessional Papers number 4 of 1981 and number 1 of 1994 on National Food Policy (GoK, 1981; 1994). In these papers, the government outlines various policy measures to ensure food security. Kenya is also one of the few countries in Eastern and Southern Africa with a National Plan of Action for Nutrition (NPAN). It was launched in 1995 and its main focus is on achievement of self-sufficiency in food especially maize which is the staple crop. This could be achieved through agricultural research, extension, availability of hybrid seeds, fertilizers, pesticides, provision of credit, improvement of food marketing and distribution structures. The government has increased its effort especially in encouraging the farmers to adopt modern farming techniques that enhance soil fertility, use of simple labour-saving devices and use of hybrid crop varieties. However, comprehensive data on the extent of use of these technologies among smallholders is scanty.

Despite the government strategies to improve food security, data from various parts of the country show that many households both in rural and urban centres are food poor. Household food poverty data shows a lot of geographical variation. One in every two households in the Coast, Eastern, Western and North Eastern Provinces are classified as absolutely food poor. Western Province is among the humid areas leading in the number of households that are below food poverty line and two districts, Busia and Vihiga, have chronic food poverty problems with over half of the households falling below food poverty line (61 and 60 % respectively). Central is the only province in the country with the lowest prevalence of food poverty (GoK, 1998; GoK, 2003). Wanyama (2003) attributes food poverty in Western Province to the fact that the farmers do not use seeds and fertilizers, fluctuation of prices especially during harvesting season, lack of credit facilities and scarcity of land.

1.2 HOUSEHOLD FOOD SECURITY

At a household level, food security is defined as the state of affairs where all persons in the household have at all times, access to adequate diet for an active and healthy life (UNICEF, 1996; GoK, 1998). Many factors influence food security including poverty, consistent access to food, nutrition, food production, availability of resources and coping strategies. Food availability is crucial to food security but not the only factors; income or resources to produce and purchase the food are equally important (FAO, 1997). The most severely affected during times of low food supply in the household are women (especially expectant and lactating mothers), children and the aged. It is important to note that food insecurity may exist in households where there is plenty of food. This is due to the fact that access to food and its availability at household level does not only depend on production but also on the control of household income and assets. These are determined largely by intra- household dynamics and to some extent inter- household relationships. This involves a complex web of social relationships and trade-offs among competing claims or needs for resources (Horestein, 1989). Traditionally, the women serve their husbands and children first. During times of food scarcity, the women may not have anything left to eat or may reduce their consumption in order to give their children and husbands enough. Likewise, in the study area, extended families are part and parcel of the nuclear family, meaning that the food resources have to be shared between various households.

Attitudes of men and women are different in production strategies. They see the goals of production (production maximization, income maximization, risk avoidance and food security) differently (Palmer and Weeks-Vaghlani, 1987). Men can have profound effect on food security by supporting women access and control over land and financial resources. The increased use of labour saving devices to some extent increases men's participation in activities otherwise perceived to be women's such as planting and weeding. This in the long run helps to improve food production in the household.

Food security issues like food production, food storage, and food utilization are central to women yet women have remained practically invisible to many policy makers. Women have provided for their households for centuries despite unequal access to land, to inputs such as seeds and fertilizers and to information. Given access to resources and human capital, women farmers can

achieve yields equal to or even significantly higher than those of men. FAO (2002a) emphasizes that ownership and secure land tenure are indispensable conditions to improving agricultural activity and supporting the ability and interest of rural women and men to engage in sustainable agriculture. Access and control of land resources by women depend on formal legislation, custom and religion, intra-household power relations, status, economy and education (FAO, 2002a)

Women's multiple roles have been summarized by Horestein (1989) as follows: "*women are farmers, traders, income earners, mothers and family caretakers hence are a critical link in achieving food security. They therefore need better access to credit, labour saving technologies and agriculture and nutrition extension information in addition to grater access to control over income*". The most important role of women is to provide food security for their households. They are able to do this by supplementing household earnings, diversification of household incomes and raising livestock and cultivation of vegetables to augment household assets .The household is able to depend on the vegetables when prices of food crops go up and they can also spend on other foodstuffs in order to improve their diets. Technological development therefore should be geared towards meeting the specific needs of women labourers. Despite their roles as "farm managers", women in Kenya receive less than10 % of credit to small farmers and 1% of total credit to agriculture (Quisumbing, 1994a). If the Kenyan women farmers are accorded the opportunity through credit facilities to obtain the same level of farm inputs as the men, their farm output could increase by more than 20 % (Quisumbing, 1994a). According to Muro (1985), there are many challenges that limit women's productivity and achievement of food security for their households. These include the following:

i. Lack of ownership and control over labour time and produce.
ii. Use of inferior farm implements and lack of knowledge and technology
iii. Inability to join cooperatives and lack of access to credit facilities
iv. Heavy burden of unquantified household chores, which are not even recognized let alone remunerated.

The Green Revolution of the 1960s and 1970s with its packages such as irrigation, High Yielding Varieties (HYV), chemical fertilizers, as well as mechanization, has been very instrumental in

increasing food production especially in Asia where it was most successful. The important aspects of the Green Revolution have been the development of new seed varieties (HYV) for important crops such as maize, wheat and rice (Pearse, 1980). These varieties are more tolerant to climatic vagaries such as drought, heavy rainfall, strong winds and diseases. Some of the seeds mature early and can grow below and above optimum climatic conditions hence ensure food security during periods of scarcity. According to Alston, et al., 1995 (cited in FAO, 1992) the effect of agricultural research on improving the purchasing power of the poor - both by raising their incomes and by lowering the prices of staple food products - is probably the major source of nutritional gains associated with agricultural research. A relatively high proportion of any income gains made by the poor is spent on food, therefore income effects of research-induced supply shifts can have major nutritional implications, particularly if those shifts result from technologies aimed at the poorest producers.

1.3 STATEMENT OF THE RESEARCH PROBLEM

Many rural households in Kenya face chronic food poverty due to a number of reasons including poverty, lack of commercialization of agriculture, small farm sizes and natural factors such as unreliable rainfall and poor soils. Smallholder households face food security challenges related to reduced capacity to produce food as well as lack of affordability. There are many questions with regard to the severity of food insecurity problem for different household types. Other issues of concern are the role of farm intensification on household food security and how national agricultural policies affect household provisioning mechanism. Although it has become clear that women play an important role in providing for food security needs of their households, the link between gender and technology in agriculture has not been adequately studied .There are several studies on food security in Kenya (Kennedy and Cogill, 1988; Horestein, 1989; Kennedy and Peters, 1992; Kennedy, 1989; Kigutha, 1995). None of these studies have explored the link between technology use and food security. Studies done elsewhere in Africa are also silent on this relationship (e.g. Agarwal, 1992; Alderman et al., 2003; Alderman and Garcia, 1993; Braun et al., 1991). Technology related studies have also tended to concentrate on large scale farmers due misconception that small scale farmers are not consumers of farm technologies. This study

set out to investigate the relationship between use of technology and household food security in two contrasting districts in Western Province of Kenya.

The research questions that the study aimed to answer are as follows;

a) What is the current status regarding use of different farm technologies in the study area?
b) Is there a difference in food security among the male-headed and female-headed households?
c) Does the use of modern technology in agriculture affect food security and nutrition?
d) Is there a difference in food security among the farmers who use modern technologies and those that use traditional methods?
e) What factors determine access to productive resources such as land, labour and capital for men and women?
f) What and how do national agricultural policies affect household provisioning mechanisms?
g) Are there differences in food security between Vihiga and Busia?

1.4 OBJECTIVES OF THE STUDY

The broad objective of this study was to find out, using a gendered approach, the impact of modern farm technologies on food security among smallholders in Vihiga and Busia districts of Western Province.

The specific objectives were as follows:

1. To collect baseline data on current status regarding the use of farm technologies among smallholders in Vihiga and Busia districts

2. To evaluate the impact of technology use on food security in different types of households in the study area

3. To assess gender specific constraints that affect the impact of farm technologies on household food security

4. To assess the impact of financial and human capital on household food security

1.5 RESEARCH HYPOTHESES

There are four hypotheses that were tested in this study.

1. H_0: Modern farm technologies have no significant effect on household food security

   H_1: Alternative

2. H_0: There is no significant difference in food security in various types of household.

   H_1: Alternative

3. H_0: The use of modern farm technologies has no significant effect on the nutrition status of women and children.

   H_1: Alternative

4. H_0: Human capital has no significant effect on household food security.

   H_1: Alternative

1.6 JUSTIFICATION AND SIGNIFICANCE OF THE STUDY

Improving food security and people's livelihoods is complex and requires a comprehensive and multidisciplinary approach. Such an approach must include the collection, management and analysis of gender disaggregated data for agriculture and rural development. The biggest constraint to the effective recognition of women's actual roles and responsibilities in agriculture is the scarcity of gender-disaggregated data available to technicians, planners and policy-makers. According to FAO (2003), the first step towards women's empowerment and full participation in food security strategies is the collection and analysis of gender disaggregated data, in order to understand role differences in food and cash crop production as well as men's and women's differential managerial and financial control over production, storage and marketing of agricultural products. Gender disaggregated data at household level investigates who does what, level of access to resources, benefits and deprivation for both men and women. This data is not only important for planning purposes, but also for evaluating and monitoring development programmes. The government in its efforts to reduce inequality has stepped up the mainstreaming of gender issues and concerns in all sectoral plans and has prepared a national

policy document on gender and development (GoK, 2000c). As the country moves towards the realisation of Vision 2030, there is need for empirical data that highlights the role of women in various sectors of the economy and in agriculture in particular, where the majority of labour force comprise of women. Available data on the role of women in enhancing food security is quite scanty in Kenya yet women form the bulk of food producers.

Women's workload has been increasing over the years due to male labour migration into towns in search of job opportunities, the HIV Aids scourge and the recent 'free' primary school education that has seen many children who hitherto supplemented women labour enrolled in schools. Women not only care for HIV Aids patients but also have to perform other chores that were initially performed by children and their husbands. In Sub-Saharan Africa, women head 31% of rural households. The situation is the same in Kenya with Western Province having the highest proportion of poor female households of 37.4 %, followed by Nyanza with 34 % (GoK, 2000b). The problems of female-headed households in rural areas vary according to their degree of access to productive resources. There are various potential consequences of the absence of male labour. This includes declining yields and output shifts in production toward less nutritious crops that require less labour and increased reliance on children's labour .All these have implications on human capital not only to the household but also to the country as a whole. It is against this background that women's access to labour-saving technologies is of particular importance (FAO, 2003)

Most research on use of farm technologies in Kenya has been done on commercial agriculture. Over 80 % of farmers in Kenya are smallholders. It is therefore important to ascertain how technologies have penetrated among them and whether this has impacted negatively or positively on food security and their general welfare. So far no comprehensive study has been done on the relationship between use of farm technology and food security in Kenya.

Data on the intensity of use of technologies is very important because it will help the scientists to define relevant research priorities and programmes to target and fine tune technologies to local conditions and to develop an effective process of promotion and dissemination of technologies (Sands, 1986).

This study on farm technologies and food security in Western Kenya is significant for sustainable development and poverty alleviation. The study will contribute to empowerment of rural women as well as alleviation of poverty in the following ways;

a) It contributes to the understanding of socio-cultural constraints affecting women farmers.

b) It identifies the limitations of farm technologies and suggests possible remedial measures by agricultural research stations and extension agents

c) The study promotes gender sensitivity in rural areas thereby enhancing the nutrition of women and children, which is one of the Millennium Development Goals.

d) It provides a strong stimulus for the improvement of food security policy by providing empirical data on the importance of women in increasing food security.

1.7 SCOPE AND LIMITATIONS

Food security is multifaceted hence the factors that cause food insecurity within the household are diverse. They include factors that affect production, which are both physical and socio-economic in nature. The socio-economic factors include accessibility issues such as income, prices of foodstuffs, proximity to the market and infrastructure development. The physical factors include weather conditions, access to water and soil fertility. Furthermore, nutrition aspects cannot be ignored and these are determined by access to health care, safe drinking water, clean environment and food utilization. It is important to examine all the factors so that intervention measures can be tailored to specific needs. However, because of time and financial constraints this study concentrated on the role of technologies in enhancing food security and gender dynamics.

Likewise many technologies have been developed for production and preservation of food but this study limited itself to farming methods, use of seed varieties specifically hybrid such as the 600 series among them, H632, H622 (Busia and Vihiga), 500 series such as, H511 (Busia) and traditional varieties of maize, use of animal traction, fertilizers, pesticides and storage facilities. The gender variable is emerging as very important in influencing food production in developing

countries hence the study also addressed its implication on food security and use of technologies that are being promoted in the country

The study covered two districts in Western Province namely Busia and Vihiga, and was completed in the duration of four years (2005-2009). The study had the following limitations:

a) The current study excluded farmers who grew cash crops like tea (*Camellia sinensis*), coffee (*Coffea arabica* L.), cotton *(Gossypium herbaceum*) and tobacco (*Nicotiana tabacum* L.) which are dominant in the study area. The study concentrated on resource poor households who cultivate maize as both food and cash crop.
b) This study focused on hybrid and traditional varieties of maize, which was the staple crop for analysis. However, data on other food crops such as sorghum, millet, cassava, and sweet potatoes that are grown in the area and contributes to food security was collected and examined although the emphasis was put on maize.
c) Irrigation farming is a very important technology and especially due to inadequate and unreliable rainfall that always led to crop failure. The researcher collected data on irrigation and but it did not form part of the analysis due to small proportion of households that practised it.
d) Measuring the amount of food produced per household was challenging due to low production and limited land in the study area. Many households consumed food before the actual harvest and the farmers rarely kept records of what they consumed. This study did not include food consumed before harvest in its analysis of consumption and sales.

1.8 OPERATIONAL DEFINITIONS

Absolute poverty line

It is the minimum amount of money necessary to afford an adult equivalent, their basic minimum food and non-food requirements. It is estimated to be Ksh. 1,239 per adult equivalent per month (GoK, 2000a).

Absolute poverty

It is the state of existence in which the overall needs of the individual are not satisfied due to lack of enough purchasing power or means of self provisioning. A person is considered to be in poverty if he or she lacks resources to obtain enough food, clothing, warmth and shelter to maintain a tolerable standard of physical health and efficiency (GoK, 1997)

Activity analysis Examines the activities of the household by season and gender. Gender here includes both female and male adults as well as boys and girls. This involves all production activities including domestic production (collecting firewood, water, childcare, cooking, house construction and repair), non-farm activities like home processing and trade. A diagnosis of activities is important in this study due to the effects that various activities may have on increasing or decreasing food within the households (Feldstein et al, 1989a, Feldstein et al., 1989b).

Agricultural technology

This includes both the technical and biological innovations of the Green Revolution. The technical aspect includes the use of labour saving devices like tractors, threshing machines, and ox-drawn ploughs. Biological innovations include the use of seeds, chemical fertilisers, insecticides and pesticides (Gold, 1999).

Anthropometrics

Use of human body measurements to obtain information about nutrition status of children. (WHO, 1995; Grosh and Glewwe, 2000).

Benefits analysis

It involves the analysis of access to and control of farming output and income among the household members (Feldstein et al, 1989a; Feldstein et al., 1989b).

Body Mass Index

It is a ratio of weight for height often used to estimate body fat. It is obtained by dividing a person's weight (kg) by the square of their height (m). The index was used in the study to estimate nutritional status of women (GoK, 2003).

Dependent variables

Maize yield (kg/ha), nutrition status of children (anthropometrics) and women (Body Mass Index)

***De facto* female-headed unit**

Households where the women are heads of household on temporary basis because their husbands are absent due to labour migration but they have ongoing contact, accompanied by the sending home of remittances (Feldstein et al,1989a; Feldstein et al.,1989b).

***De jure* female-headed unit**

Households where women live without a male partner on a more or less permanent basis and receive no economic support from a male partner except in the form of child maintenance. Included here are single mothers, divorced women, separated women and widows (Feldstein et al., 1989a; Feldstein et al., 1989b).

Farm implements

Refers to devices used on the farm that are pulled behind, pushed or otherwise used by a human, animal or mechanical power to carry out agricultural activities. It includes ploughs, hoes, transport sledges, and carts (Byerlee, 1990).

Farm Mechanization

It is the use of various tools, implements, machines and equipments for agricultural production, crop harvesting and processing on the farm. This study excludes costly machines such as tractors (Mortar and Noor, 2001).

Food accessibility

This refers to affordability and good transport system to the markets for sales and purchases (FAO, 1996).

Food –Energy Intake (FEI)

It is a method that aims at finding a monetary value at which basic needs are met. It sets the minimum food requirement by finding the consumption expenditure level at which food energy intake is just sufficient to meet pre determined average food energy requirements for normal bodily functions. WHO (1986, 2006) and FAO (1996) have set this at 2,250 calories per adult.

Food insecurity

A situation that exists when households lack secure access to sufficient amounts of safe and nutritious food, for normal growth and development and active healthy life. It may be caused by the unavailability of food, insufficient purchasing power or the inappropriate distribution or inadequate use of food within a household. (GoK 2000a; FAO, 1996; GoK, 1998)

Food poverty line

This is the amount of expenditure that would on average meet the recommended daily energy allowance of 2,250 calories per adult (2,250 is the amount of calories per day per adult equivalent recommend by WHO and FAO. In Kenya this has been estimated to be Ksh.927 per month per adult equivalent in rural areas (GoK, 2000b)

Food Security

A situation that exits when all people at all times have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996 ;FAO ,2005).

Gender Analysis

It is the study of different roles of men and women aimed at understanding what they do, what resources they have and what their needs, responsibilities and priorities are (CTA 1999). It looks

at how power relations within a household interrelate with those in the international, state market and community level (Candida et al., 1999).

Gender empowerment

Promoting women participation in decision making processes as well as having their voices heard and the power to put issues on the agenda (Porter and Sweetman, 2005).

Gender

This is a social- cultural construct of society that determines the identity, roles or functions, entitlements and deprivation of women and men in society. It must be differentiated from sex, the biologically determined state of being male or female which defines the biological difference between boys and girls, women and men (GoK, 1999; Candida et al., 1999))

Gender roles

Refers to the distribution of roles and responsibilities between men and women, conditioned by sociological, political and geographical factors (CTA, 1999; Candida et al., 1999)

Gender mainstreaming

It is a process that leads to equality of opportunities between men and women, equal access and control, equal rights and an equal voice .Gender mainstreaming involves ensuring that all general measures and operations openly and actively take into account - during planning, implementation, monitoring and evaluation – their effects on the respective situations of women and men. It also involves the complementary design, implementation, monitoring and evaluation of specific measures and operations to promote equality and to assist women to participate and benefit equally (Porter and Sweetman, 2005).

Green Revolution

Refers to the introduction of varieties of rice, wheat and maize which led to large production increases when other circumstances such as reliable water supply and access to inputs and market were favourable (Mettrick, 1993)

Growth Monitoring

It's a form of nutrition surveillance that involves anthropometrical measurements (weight, height etc) on a continuous basis in order to track a child's progress over time World Bank, 1995).

Hardcore poverty

The hard-core poor are those people who would not meet minimum food calorie requirements even if the concentrated on spending on food (GoK, 2000b)

Household food security

Situation where all persons in the household have at all times physical, economic and social access to adequate and nutritious food that meets their dietary preferences for active and healthy life (FAO, 1996))

Household

A household comprises of a person or group of persons, generally bound by ties of kinship, who normally reside together under a single roof or several roofs within the same compound and who share the community of life, in that they are answerable to the same head and they share a common source of food (GoK,1997) . In this study a household includes those members who are not always present but who supply remittances, goods, and services and occasionally draw from household resources.

Inorganic fertilizers

These are substances derived from chemical processes or mining which are added to the soils to supply essential nutrients for crop growth (Collins Dictionary of Environmental Science, 1999)

Independent (explanatory) variables

Expenditure on fertilizers, seeds, tools of production and pesticides (Ksh /ha) and the number of contacts that household had with extension personnel.

Male-headed household

A family unit in which there is an 'intact' couple and the man is the head of the family (Feldstein et al, 1989a; Feldstein et al., 1989b)

Nutritional Status

The physiological state of an individual that results from the relationship between nutrient intake and the requirements, and from the body's ability to digest, absorb and use these nutrients. In this study a well nourished child is one who is not underweight, stunted or wasted. A woman whose BMI falls within 18.9 to 24.9 is well nourished (G0K, 2003)

Participatory research

It is research undertaken in partnership with farmers who in general are involved in definition of research agenda, the conduct of research, the evaluation of results and the dissemination of findings (Mettrick, 1993).

Relative poverty line

It is the poverty line, which is proportional to the mean or median income or expenditure some studies use two thirds or one third of the mean (GoK, 200b)

Resource analysis

This involves the disintegration of households by gender and age, and access to and control of strategic resources like land; capital and labour is assessed. It is necessary to understand the control of resources on the basis of gender. This is important in the analysis of the constraints to full utilisation of technologies (Feldstein et al., 1989a; Feldstein et al., 1989b)

Smallholders

Smallholders are small-scale farmers operating farms of less than twelve hectares who are socially, economically or culturally marginal. They constitute groups with limited or no access to productive resources, technology and credit and have little or no bargaining power on the market.

Stunting

Low height for age, reflecting a sustained past episode or episodes of under nutrition. (GoK, 2003)

Sustainable agriculture

This is the successful management of agricultural resources to satisfy changing human needs while maintaining the quality of the environment and conserving them for future generation (Gold, 1999).

Transitory food insecurity

It is the temporary decline in household's access to adequate food due to instability in food prices, food production or household incomes (GoK, 2000b)

Underweight

Low weight for age in children and a BMI of less than 18.5 in adults, reflecting a current condition resulting from inadequate food intake, past episodes of under nutrition or poor health condition (GoK,2003).

Variety (cultivars)

Is defined as the assemblage of cultivated plants which is clearly distinguished by any characters (morphological, physiological, cytological, chemical or others) and which when reproduced (sexually or unisexual) retains its distinguishing characters (Feistritzer, 1975).

Wasting

Low Weight for height, generally the result of weight loss associated with a recent period of starvation or disease (GoK, 2003).

Women- headed household

It is a family unit where an adult woman (usually with children) resides without a male partner and she is the head of the household (Fieldstein et al., 1989a).

1.9 SUMMARY OF THE THESIS

The thesis consists of six chapters. **Chapter one** is an introduction of the study. **Chapter two** presents literature review, theoretical and conceptual framework. **Chapter three** provides a description of the study area. In **chapter four** the methods used in collecting and analyzing data are discussed. **Chapter five** presents empirical findings, analysis and discussion of the results. Lastly **chapter six** provides the summary of the study findings, conclusion, and recommendations.

CHAPTER TWO: LITERATURE REVIEW, THEORETICAL AND CONCEPTUAL FRAMEWORKS

2. 1 INTRODUCTION

The main objective of this chapter is to present a critical analysis of the various studies related to the subject while highlighting the gaps that this study sought to fill. The literature review concentrated on key issues of Green Revolution technologies especially the use of hybrid maize, animal traction and fertilizer in relation to their impacts on household food security and the link between gender and food security. The chapter also provides the theoretical underpinnings of the study and conceptual framework

2.2 LITERATURE REVIEW

2.2.1 IMPACT OF GREEN REVOLUTION TECHNOLOGIES

Since time immemorial human beings have made great attempts to improve breeding techniques in order to increase food supply for the ever-increasing population .These improvements have had drastic effects not only on the yields but also on global food security. There is increasing empirical evidence on the production, productivity, income and nutritional impacts of modern agricultural technologies. FAO (2003) data indicate that between 1960 and 2000, production of major food crops increased in all Developing Countries. For instance, wheat yields rose by 208%, rice by 109%, maize 157%, potato 78% and cassava yields rose at 36%. There was however, very little research on many of the crops grown by smallholders in less favourable agro-ecological zones such as sorghum, millet, barley, cassava and pulses during the early decades of the Green Revolution. Nonetheless, since the 1980s modern varieties have been developed for these crops and their yield potential has risen .These crops have a potential of enhancing the food security situation in marginal areas if proper policy machinery are put in place. Policy issues include, among others, according such traditional crops greater emphasis in the same way as staple crop, maize. Apart from the development of High Yielding Varieties

efforts have been made to develop plants with durable resistance to a wide spectrum of insects and diseases, plants that can tolerate a variety of physical stresses, crops that mature early and are drought resistant, and cereal grain with enhanced taste and nutritional qualities (FAO,1992).

The adoption of HYV increased rapidly during the two decades of the Green Revolution, and even more rapidly in the following decades, from 9% in 1970 to 29% in 1980, 46% in 1990 and 63% by 1998 (FAO, 1992). The countries that were able to make the most of the opportunities presented by the Green Revolution include those of Asia such as China and India since they developed strong national capacity in agricultural research. Researchers in these countries were able to make the necessary local adaptations to ensure that the modern varieties suited the needs of their farmers and consumers. National agricultural research capacity was a critical determinant of the availability and accessibility of Green Revolution agricultural technologies.

As the world population increases and land resources become scarce, it is apparent that land intensification through the use of modern crop varieties, better agronomic practices and use of fertilizers will be the main means through which the nutritional needs of the smallholders will be met. The wide spread adoption of modern seed-fertilizer technology contributed to the shift in the food supply function, increasing output and contributing to a fall in real food prices. The reduction of food prices is particularly important for low-income people whose larger share of income is spent on meeting their food requirements. The decline in food prices saw the increase in consumption per capita from 2,280 Kca per person per day in 1960 to 2,800 Kca per person per day in 2007 (FAO, 2007). Consequently the world's undernourished people have declined from 37 % in the 1969-1971 periods to 17 % in 2002-2004 periods (FAO, 2006). Any gains made on reduction of the world hungry and poor people is likely to be lost if the current escalating food prices associated with climate change, increasing fuel prices and demand for food is not checked.

Agricultural research helps in improving the purchasing power of the poor by raising their incomes and lowering the prices of staple food products and as a result, has a positive effect on their nutrition. Adoption of modern seed varieties is usually associated with the use of other technologies such as machinery, land and water management practices, fertilizer use and

integrated pest management. Although many Green Revolution technologies were developed and extended in package form (e.g. new plant varieties plus recommended fertilizer, pesticide and herbicide rates, along with water control measures), many components of these technologies were taken up in piecemeal, often in a stepwise manner. There are evidences from various studies showing that the piecemeal adoption of Green Revolution technologies is due to scarcity of resources and other related constraints (Byerlee, 1990), some of which are socio-cultural in nature. In particular the adoption of modern seed varieties in Africa in general and in Kenya in particular has been piecemeal. The main reason given by the farmers has been the lack of income to purchase other inputs recommended for these varieties (Salasya et al., 1998; Salasya, 2005). This to some extent has led to low adoption of the Green Revolution technologies in Sub Saharan Africa. This is why any future technologies should target the smallholders.

The ineffective nature of extension systems and lack of access to credit facilities by smallholders has also been a big challenge to the successful implementation of the ideals of the Green Revolution (Lastarria-Cornhiel, 1988; Oniango and Kimokoti, 1999; Quisumbing, 1994a). The high potential agricultural areas gained the most from the Green Revolution. These are areas that were not only conducive in terms of physical environment (favourable soils and humid conditions) but also areas where the socio-economic conditions such as extension and credit services were efficient. However, there was a significant spill over to arid and semi-arid lands.

As rice (*Oryza sativa*) became an important crop in Asia feeding millions of people, maize (*Zea mays*) slowly replaced indigenous crops of Africa as a staple crop. Maize has become so important that its availability is an indicator of food security. Maize is however not an indigenous crop to Africa .The crop originated in Central America, particularly in Mexico, from where it spread northwards to Canada and southwards to Argentina (FAO,1992). The oldest maize, about 7,000 years old, was found by archaeologists in Teotihuacan, a valley near Puebla in Mexico, but it is possible that there were other secondary centres of origin in the Americas (FAO, 1992). Most researchers believe that maize developed from *teosinte, Euchlaena mexicana Schrod*, an annual crop that is possibly its closest relative. The closeness of teosinte to maize is suggested by the fact that both have ten chromosomes and are homologous or partially homologous (FAO, 1992).

The survival and dispersal of the oldest maize depended on humans who harvested the seed for the following planting, and on migration from one continent to the other. Maize was introduced into Europe through Spain at the end of the fifteenth century (FAO, 1992; Sauer, 1969) .It then spread through the warmer climates of the Mediterranean and later to northern Europe. Today maize is grown in every suitable agricultural region of the world and a crop of maize is being harvested somewhere around the globe every month of the year.

2.2.2 CONTRIBUTION OF MAIZE TO HUMAN NUTRITION

Food security is not just a matter of food availability but also the nutritional value of the food. Since maize is the staple crop for people in Western province and being a major variable in this study, it is important to consider the nutritional value of the crop and other aspects of the maize crop that affects household food security. Cereals especially maize make up such a large part of diets in Western province and in Kenya in general. Cereal grains cannot be considered only as a source of energy, as they provide significant amounts of protein as well. It is also recognized that cereal grains have a low protein concentration and that protein quality is limited by deficiencies in some essential amino acids, mainly lysine (FAO, 1992). A comparison of the nutritional value of maize protein with the protein quality of eight other cereals is given in Table 2.1. The protein quality of common maize is similar to that of the other cereals except rice. Both opaque-2 maize and the hard-endosperm QPM (Nutricta) have a protein quality not only higher than that of common maize, but also significantly higher than that of other cereal grains (FAO 1992).

Table 2.1 Protein quality of maize and other cereal grains

Cereal	*Protein quality (% casein)*
Common maize	32.1
Opaque-2 maize	96.8
QPM	82.1
Rice	79.3
Wheat	38.7
Oats	59.0
Sorghum	32.5
Barley	58.0
Pearl millet	46.4
Finger millet	35.7
Teff	56.2
Rye	64.8

Source: FAO (1992)

2.2.2.1 Chemical composition of maize

Starch is the major chemical component that makes up the maize kernel (Table 2.2). Starch makes up between 72 to 73 % of the kernel weight (FAO, 1992). Other carbohydrates include simple sugars present as glucose, sucrose and fructose in amounts that vary from 1 to 3 % of the kernel (FAO, 1992). The starch in maize is made up of two glucose polymers: amylose, an essentially linear molecule, and amylopectin, a branched form. The composition of maize starch is genetically controlled. In common maize, with either the dent or flint type of endosperm, amylose makes up 25 to 30 % of the starch and amylopectin makes up 70 to 75 % while waxy maize contains a starch that is 100 % amylopectin (FAO, 1992).

Protein is the next largest chemical component of the maize kernel (Table 2.2). It varies in common varieties from about 8 to 11 % of the kernel weight. The protein in maize kernels is

made up of at least five different fractions. In their scheme, albumins, globulins and non-protein nitrogen amount to about 18 % of total nitrogen, in a distribution of 7 %, 5 % and 6 %, respectively (FAO, 1992). Quality protein maize differs from common maize in the weight distribution of the five protein fractions .The extent of the change is variable and affected by genotype and cultural conditions. The nutritional quality of maize as a food is determined by the amino acid make-up of its protein.

Maize also contains **oil and fatty acids.** The oil content of the maize kernel comes mainly from the germ. Oil content is genetically controlled, with values ranging from 3 to 18 % (FAO, 1992). Maize oil has a low level of saturated fatty acids, i.e. on average 11 % palmitic and 2 % stearic acid (FAO, 1992). On the other hand, it contains relatively high levels of polyunsaturated fatty acids, mainly linoleic acid with an average value of about 24 %. Only very small amounts of linoleic and arachidonic acids have been reported. Furthermore, maize oil is relatively stable since it contains only small amounts of linoleic acid (0.7 %) and high levels of natural antioxidants (FAO, 1992). Maize oil is highly regarded because of its fatty acid distribution, mainly oleic and linoleic acids. In this respect, populations that consume degermed maize benefit less in terms of oil and fatty acids than populations that consume whole-kernel products (FAO, 1992).

After carbohydrates, proteins and fats, **dietary fibre** is the chemical component found in the greatest amounts. The complex carbohydrate content of the maize kernel comes from the pericarp and the tip cap, although it is also provided by the endosperm cell walls and to a smaller extent the germ cell walls. According to FAO (1992) maize bran was composed of 75 % hemicellulose, 25 % cellulose and 0.1 % lignin on a dry-weight basis. Dietary fibre content in dehulled kernels would obviously be lower than that of whole kernels.

Other carbohydrates in maize kernel include **sugars** that range between I and 3 %, with sucrose, the major component, found mostly in the germ. Higher levels of monosaccharides, disaccharides and trisaccharides are present in maturing kernels. At 12 days after pollination the sugar content is relatively high, while starch is low. As the kernel matures, the sugars decline and starch increases. For example, sugars were found to have reached a level of 9.4 % of kernel dry weight in 16-day-old kernels, but the level decreased significantly with age (FAO, 1992) Sucrose

concentration at 15 to 18 days after pollination was between 4 and 8 % of kernel dry weight (FAO, 1992). These relatively high levels of reducing sugar and sucrose are possibly the reason why immature common maize and, even more, sweet maize are so well liked by people (FAO, 1992).

Maize also contains some **minerals** that are essential for the body. The most abundant mineral is phosphorus, found as phytate of potassium and magnesium. All of the phosphorus is found in the embryo, with values in common maize of about 0.90 % and about 0.92 % in opaque-2 maize. As with most cereal grains, maize is low in calcium content and also low in trace minerals (FAO, 1992).

There are two **fat-soluble vitamins** in maize kernel namely provitamin A, or carotenoids, and vitamin E. Carotenoids are found mainly in yellow maize, in amounts that may be genetically controlled, while white maize has little or no carotenoid content. Most of the carotenoids are found in the hard endosperm of the kernel and only small amounts in the germ. The betacarotene content is an important source of vitamin A, but unfortunately yellow maize is not consumed by humans as much as white maize (FAO, 1992). Watson (1962) reported values of 4.8 mg per kg in maize at harvest, which decreased to 1.0 mg per kg after 36 months of storage. The same loss took place with xanthophylls. Recent studies have shown that improving the protein quality of maize increases the conversion of beta-carotene to vitamin A (FAO, 1992)

Water-soluble vitamins are found mainly in the aleurone layer of the maize kernel, followed by the germ and endosperm. Variable amounts of thiamine and riboflavin have been reported. The content is affected by the environment and cultural practices rather than by genetic make-up. Variability between varieties has, however, been reported for both vitamins. The water-soluble vitamin nicotinic acid has attracted much research because of its association with niacin deficiency or pellagra, which is prevalent in populations consuming high amounts of maize .As with other vitamins, niacin content varies among varieties, with average values of about 20 µg per gram (FAO 1992). A feature peculiar to niacin is that it is bound and therefore not available to the animal organism. Some processing techniques hydrolyze niacin, thereby making it available. The association of maize intake and pellagra is a result of the low levels of niacin in the grain, although experimental evidence has shown that amino acid imbalances, such as the

ratio of leucine to isoleucine, and the availability of tryptophan are also important. Maize has no vitamin B12, and the mature kernel contains only small amounts of ascorbic acid, if any. Other vitamins such as choline, folic acid and pantothenic acid are found in very low concentrations.

Table 2.2: Chemical composition of main parts of maize kernels (%)

Chemical component	*Pericarp*	*Endosperm*
Protein	3.7	8.0
Ether extract	1.0	0.8
Crude fibre	86.7	2.7
Ash	0.8	0.3
Starch	7.3	87.6
Sugar	0.34	0.62

Source: Watson (1987) in FAO (1992)

2.2.3 HISTORY OF DRAUGHT ANIMAL TECHNOLOGY

Use of animal power for crop production has not been in use in Sub Saharan Africa for a long time. Animal power was introduced in the 1920s but its use became more widespread in the 1950s and after (Starkey et al., 1992). In West Africa countries such as; The Gambia, Burkina Faso, Cameroon, Nigeria and Senegal animal traction has been promoted by companies and projects in the cultivation of various crops such as cotton and groundnuts (Starkey et al., 1992). Both oxen and cows are commonly used for crop production (ploughing and ridging) while donkeys are used for transport. In The Sahelian zones camels are commonly used for ploughing. In Southern Africa, countries such as Zambia, Malawi, Namibia, Botswana and Mozambique have had a long history of use of animal traction (Starkey et al., 1992). Oxen and cows are used for ploughing, ridging and to a small extent for weeding. The mouldboard plough is the dominant implement.

The colonial settlers introduced animal traction technology in Kenya in early 20th Century. Most of the tools used were imported from Europe and Asia and to some extent this undermined the

African blacksmith. There was introduction of tractors in white farms in 1940s. However the promotion of tractor mechanization for smallholders failed due to resource constraint (Oluoch_Kosura, 1984). Other factors that contributed to the failure of tractor mechanization programme included; inadequate foreign exchange to buy tractors, poor infrastructure, lack of maintenance facilities and inadequate technical know-how for the farmers. Even the introduction of cost effective tractors like ENTI from Netherlands did not solve the problems.

In 1970s the government of Kenya realised that animal draught power was more effective for smallholders and begun to encourage farmers to use them in agriculture to increase production. The government encouraged the Jua Kali sector to produce local animal drawn farm implements that could be affordable to farmers. The other strategy was the expansion of village polytechnics in order to develop capacity in carpentry and blacksmithing. Since oxen were the most important animals used, their breeding for oxenization programme became important. The smallholders had serious financial problems and therefore a good credit provision system was essential in order to enable them to buy oxen and implements. Use of animal traction is now widespread in many parts of Kenya both for transport (donkey) and ploughing (Oxen) (Starkey et al., 1992).

Generally the use of animal power has been dominated by male. One of the possible explanations is the fact that cattle are usually owned and controlled by men and animal traction operations tend to be performed by men and boys (Starkey et al., 1992). As more and more men migrate to urban areas and as many households become female headed or female managed this cost effective technology has to spread to women folks if increase in agricultural production has to be achieved. The use of animal drawn weeders could help reduce women's work load if men can embrace this farm activity that traditionally falls within women's domain. Likewise, women access to draft animals can reduce their work load of carrying water, wood and harvested crop, thereby increasing the time available to care for the nutritional needs of their children and households in general.

2.2.4 FARM TECHNOLOGIES IN KENYA AND WESTERN PROVINCE

In Kenya, there was piecemeal introduction of Green Revolution technologies by the colonial government geared towards increasing productivity of export crops. The agricultural policies during the colonial period were aimed at the cultivation of cash crops in order to provide raw materials for the agro-based industries in Britain. Many cash crops were introduced in the country such as coffee (*Coffea arabica*), tea (*Camellia sinensis*), cotton *(Gossypium herbaceum)*, pyrethrum (*Chrysanthemum cineraaiaefolium*), and sugarcane (*Saccharum afficinarium*) among others. The technologies introduced during this time did not have the smallholder's interests but rather the large-scale farmers who happened to be white settlers. This however changed after the Swynnerton Plan (Swynnerton, 1954), which called for various programs to modernise small-scale agriculture. This formed the beginning of maize breeding in the country including Western Province.

Various extension agencies, research stations, land adjudication and consolidation programs were set up in the country between 1954 and 1963 in order to introduce farm technologies for the smallholders. There were however, low adoption rates due to poverty and these technologies only benefited the few rich farmers. Other hindrances were high level of illiteracy, poor access to information, high prices of inputs, poor managerial skills and poor infrastructure. After independence there were even more vigorous plans to assist smallholders to improve production in order to ensure self-sufficiency in food production.

Maize, the American Indian word for corn, literally means, "*that which sustains life*". It is, after wheat and rice, the most important cereal grain in the world, providing nutrients for humans and animals (FAO, 1992). In Kenya maize is an important staple crop for both rural and urban households. It is cultivated by over 80 % of rural households and provides 70 % of the energy and 50 % of protein for rural households (Kliest, 1985; GoK, 2000a). Maize accounts for 40–45 % of total calorie intake in Kenyan population (Kliest, 1985). In Western province maize is such an important crop to the extent that it is referred to as '*food*'.

Hybrid maize was introduced in Western Province in early 20th century from the Kilimanjaro region of Tanzania (Moock, 1973). This maize variety was known locally as *magego*. Germans who had already settled in Tanzania also introduced some yellow maize that also spread to Western Province of Kenya. In 1920s during the British rule, white maize (known locally as *amalavu*) returned to the area and was preferred by the locals than yellow maize. Maize became very popular in the region and it slowly replaced millet and sorghum, which had been staple food crops.

Hybrid maize cultivation started in 1956 after establishment of Kenya Seed Company (KSC) and a breeding station in Kitale (Ogada, 1969). Hybrid maize is produced by crossing different varieties in two steps, thus reaching a new variety, which contains the genetic qualities of in-breed lines (Rundquist, 1984). Hybrid seeds require strict adherence to recommended agronomic practices to ensure good yield such as use of fertilizers, timely planting and weeding and use of fresh seeds every season. Likewise deep ploughing is necessary in order to keep weeds away. This explains the reason why the cultivation of hybrid maize has to be accompanied by other technologies. High maize yield results from factor combination resulting from good husbandry, hybrid maize seed and fertilizers (Rundquist, 1984; Acland, 1971).

The purpose of breeding is to increase maize yield as well as develop hybrid varieties suitable for different ecological zones in the country. In 1959 germplasm was brought in from different Central American sources and in 1961 a variety called Kitale Synthetic II was released (Rundquist, 1984). A second breeding program at Kitale introduced classical hybrid in 1964 that had a higher yield potential. In 1965 another station was opened in Embu in order to produce a cross between the late maturing Kitale type and early maturing Katumani types for the Arid and Semi Arid Lands (ASALS). As a result Hybrid 511 was released in 1973 for Eastern Province and Coast composite variety released for Coast region (Rundquist, 1984). Various varieties have since then been released for different ecological zones

According to Gilbert (1995), the introduction of hybrid maize varieties increased production at the expense of grazing land in marginal areas like Machakos. In high potential areas like Western Kenya, increased maize yields enabled farmers to shift resources to more profitable crops especially coffee, tea and horticultural crops while still meeting their food production objectives. Today there are 46 registered seed companies in Kenya dealing with maize, wheat, barley, oats, sorghum, sunflower, pulses, vegetable and horticultural seeds (KEPHIS, 2004). The main ones being Kenya Seed Company established in 1956 and KARI established in 1979 through Science and Technology Act. Currently 14,600 hectares are under seed production (GoK, 2002). Various seed varieties have been developed that are tolerant to drought, Maize Streak Virus (MSV), Grey Leaf Spot (GLS), northern leaf blight, good standability, resistant to ear rot and early maturing among other attributes (KEPHIS, 2004).

Other researches have been in protein enhancement in maize through the breeding of high lyciene germplasm by KARI and CIMMYT (Gilbert, 1995). It is hoped that this process will improve the nutrition of smallholders especially in communities where maize gruel is used for weaning infants. There are differences in the chemical composition of the main parts of the maize kernel which are important to the body. The seed coat or pericarp is characterized by a high crude fibre content of about 87 %, which is constituted mainly of hemicellulose (67 %), cellulose (23 %) and lignin (0.1 %) (Burge and Duensing, 1989). On the other hand, the endosperm contains a high level of starch (87.6 %) and protein levels of about 8 %. Crude fat content in the endosperm is relatively low. Finally, a high crude fat content characterizes the germ, averaging about 33 %. The germ also contains a relatively high level of protein (18.4 %) and minerals.

The development of germplasm that is resistant to pests and diseases and striga has been ongoing and will go along way in improving food security. This is based on the premise that almost half of the crop is usually destroyed by diseases and pests especially the stem borer. It should be noted however, that strengthening the maize seed supply systems and provision of credit and extension services is important if these innovations have to benefit the farmers.

The farmers consider various traits of seeds before they plant them and there are many factors that affect the adoption and intensity of use of farm inputs including hybrid seeds. Gerhart (1975) observed that the adoption rate of small farmers for hybrid maize in Western Kenya was 90 to 100 %. The mean lag-time between farmers hearing of new seed and using it was only 1.60 months. However, in Central province, Hesselmark (1975) found out a rapid adoption rate. Farmers were also found to be very selective in adoption of other components of recommended package for example planting in rows and weeding more than once. They did not use fertilizers as recommended but were still able to obtain higher yields with the use of hybrid seeds alone. Gerhart (1975)'s study observed that farmers who had more education, high social status, large units of operation and favourable attitudes towards credit were early adopters of hybrid maize. It was further established that 35 % of the farmers surveyed had received extension visit in the previous year while 25 % had personally attended a maize demonstration farm. Although extension service provision was successful at this time, some problems such as untrained field staff, lack of administrative backup, poor promotion policy, and low morale were observed. Other problems that needed attention included poorly staffed farmer training centres and academic approach in farmer training. Generally, in the late 1970s many smallholders were growing hybrid seeds and the extension service was excellent as observed by Gerhart (1975). We sought to establish whether the situation was still the same in this region under new agricultural policies and increased globalisation.

Breeding of hybrid maize has been coupled with other technologies that are essential for a good harvest. These include mechanization, soil nutrient management, moisture management, better agronomic practices like timely planting, proper plant population and intercropping. It also includes pest management (weeds, stem borers and storage pests) and post harvest technologies (Gilbert, 1995). The use of mechanization in small farms in Kenya has not been effective. The tractor hire services programme introduced in 1970s was not successful in Western Province (Oluoch-Kosura, 1983). This was due to the fact that there were only 25 tractors for hire in the entire province, the process of hiring was cumbersome and favourable to high-income households and the farmers found it uneconomical (Oluoch-Kosura, 1983). As a result ox-drawn ploughs and use of hand hoes have become major methods of land preparation in the province (Wangila, 1990)

In a study of small household production and consumption behaviour in Kenya, Ayako (1985), established that the smallholders planted local, HYV seeds, used fertilizers, hired labour, and yet they were not able to generate a reasonable amount of surplus for the market. This was attributable to high prices of inputs that made the farmers to use them only in small amounts and other non-price agricultural policy incentives. This study however did not have a gender bias, neither did it analyse the food security situation in the households. It should be understood however that, the way in which farm households respond to new technologies vary from household to household and from one region to the other. The response is structured by the multiple goals they have to meet, resource availability, factor of production endowments, social organization of the household and the perception of riskness of the new technology or economic opportunity (Sands, 1986). The farmers allocated certain qualities and quantities of inputs to production process in order to meet all household goals. For households to adopt more profitable and sustainable technologies there was need to raise their level of liquidity (Sanders, 1995; Salasya et al., 1998; Salasya, 2005). This could be done by diversifying off-farm employment and improving access to credit facilities for smallholders. In Tanzania, Nkonya and Mwangi (2004) observed that due to financial constraints, farmers recycled open pollinated maize varieties (OPV) and hybrids without substantial yield loss.

The level of production, food insecurity and poverty in general are determined by the ownership and control of productive assets such as land, labour and capital (IFAD, 2001). In many societies in Kenya, productive resources are unevenly distributed among different social and economic groups and this affects the ability of individuals within households to produce goods and services that are essential for life sustenance (Bacho, 2004). The uses of resources depend on intra household variables for example the intra-household division of labour and dependency relationships. Food production is also determined by decision making within the households on the allocation of resources to various activities and farm inputs.

In a study in Eastern Kenya, Franzel (1984), found that farmers had rejected Katumani maize variety (early maturing) because they were not impressed with the yield performance, ability to be stored and culinary qualities. In Western Province, maize is not planted alone but it is intercropped with beans or other pulses. This has the advantage of enhancing soil fertility

although it affects the total population of maize plant in the fields hence affecting the yield. Kenya Seed Company (KSC) recommends 45,000 to 53,000 plants per hectare depending on the variety. For the farmer, intercropping has another advantage of assuring the household of food, in the short run because the crops mature at different times of the year. It is also a strategy against risk related to pests and diseases and climatic variations.

There are several studies which have been carried out in Kenya on adoption of farm technologies especially the use of fertilizers (Karanja, 1999; Salasya et al., 1998; Salasya, 2005). Most of these studies show low use of fertilizers by smallholders. This is despite the fact that studies have shown that use of fertilizers especially on staple crop, maize is profitable for the farmer (Karanja et al., 1999). Likewise studies done in Zambia show that use of farm technologies had a positive correlation with food security at household level (Celis and Bliven, 1991).

The current study underscores the heterogeneous nature of households in rural areas in terms of resource endowment and decision making process. This affects the way resources are allocated by either men or women and determines the choices of crops and technologies with great ramifications on household food security. To understand access and control of resources within a household and how this impacts on food security cannot be complete without the use of gender analysis. Bamire et al., (2005) support the effect of diversity in households on decision making and overall welfare.

2.2.5 WOMEN AND FOOD SECURITY

Women in Africa still have to bear the burden of feeding their households with meagre resources at their disposal. They face economic, socio-cultural and legal barriers that constrain their capacity to produce adequate food and participate in activities that enhance their income for improvement of standard of living of their households (Oniango and Kimokoti, 1999). Even though both men and women farmers do not have access to adequate resources in Africa, women's access is even more limited due to cultural, traditional and sociological factors. Women have little access to the benefits of research and innovation, especially in the domain of food crops, which, in spite of ensuring food security at the household and community level, have a

low priority in crop improvement research and among policy makers (FAO, 2002) .In addition, women farmers' roles and needs are often ignored when devising technology that may cause labour displacement or increased workload on the side of women (FAO, 2002).

Nutrition security of women is essential in building a strong nation. This is due to women's important reproductive and productive roles as well as being caretakers for their households. In addition the nutritional status of children depends on the well being of their mothers. Many of the health problems that affect women in their reproductive age began in childhood and adolescence (World Bank, 1997). For instance stunting which is a problem of malnutrition during childhood contributed to complications during child birth and the likelihood of getting underweight babies (World Bank, 1993).

Women in reproductive years, especially during pregnancy and lactation, had specific nutrient requirements which determined both their own nutritional status and that of their children. Women faced multitude of health risks some of which originated from childhood and adolescence. According to World Bank (1994) 450 million adult women in Developing countries were stunted as a result of childhood protein energy deficiency. Each year 7 million infants died within a week of birth and more that 20 million low birth weight babies were born (UNICEF, 1992; UNICEF, 2000). Conditions necessary for good nutrition were access to adequate food, adequate care for children and women, access to basic health services and a healthy environment (GoK, 1998). Women like men required access to productive resources to enhance their ability to provide for their households. The need for data on the differences between males and females, in terms of access to food and other resources as well as nutritional status of vulnerable groups was fundamental in order to assist in the evaluation and monitoring of progress in the achievement of national food security and nutritional goals.

Improving women's health and nutrition contributes to sustainable economic development since women made up over 50 % of the population and women health had a widespread effect on themselves, households, communities and the nation. Due to their reproductive roles women's poor health and nutrition affected many generations.

There were many determinants of women health status. They included biological factors, socio-economic factors and health and nutrition services. This study concentrated on the socio-economic and cultural factors that increased the vulnerability of women to health problems resulting from under or over nutrition. Women's disadvantaged social position often related to economic value of household chores, control and access to resources helped perpetuate poor health and continued cycle of poverty (World Bank, 1997). Further more, women were generally paid less than men for same quantity and quality of work. This was common not only in the agricultural sector but in other sectors of the economy. This constrained women's ability to meet their nutritional needs that of their households and to actively participate in activities that enhanced the welfare of their communities. Women in reproductive age especially during pregnancy and lactation needed adequate food to meet the high energy in addition to other roles of farming, carrying water, fuel wood and foodstuffs.

The problems of female-headed households in rural areas vary according to their degree of access to productive resources. This is why information about men's and women's relative access to, and control over, resources is critical in the development of food security strategies. Under most systems of customary law in Africa, women do not own or inherit land partly due to the perception that women are part of the wealth of the community or they are themselves regarded as property. Access to land by women is through their husbands, fathers, brothers, uncles and sons (Kameri-Mbote, 2005). This ignores both the existence of female-headed households and the rights of married women to a joint share. In Sub-Saharan Africa, women head 31% of rural households, while in Latin America and the Caribbean and Asia, women head 17 % and 14 %, respectively (FAO, 2002). In Kenya women head 38.9, 44, and 55 % of households in Western province, Nyanza province and Siaya district respectively (GoK, 1999). While there are different types of female-headed households, in almost all countries female-headed households are concentrated among the poorer strata of society and often have lower income than male-headed households. The absence of male labour from the households leads to serious repercussions on food security. This does not only lead to decline in yields but also result in the shifts in production towards less nutritious crops requiring less labour. It also affects the improvement of human capital through increased reliance on child labour, which, in turn. has further implications

not only to the household's future income and welfare but also to the country's human resource development.

Ownership and secure tenure are indispensable conditions to improving agricultural activity and supporting the ability and interest of rural women and men to engage in sustainable agriculture. According to FAO, (2002) access to land depends on formal legislation, custom and religion, intra-household power relations and status, economy and education. All these aspects can easily be streamlined by good agricultural policies so that both men and women from poor households are not disfranchised in land issues.

Women lack of access to credit is still a major hindrance to increased productivity in agriculture .The national legislation and customary law do not allow women to share land property rights along with their husbands neither do female heads of household have land entitlement. This means that they cannot provide the collateral required by lending institutions. In a study in Vihiga and Kiambu districts, Salasya (2005) observed that lack of collateral and unfavourable repayment conditions was a major constraint in obtaining credit. The study revealed that 17 % of the farmers interviewed obtained credit from private moneylenders who charged exorbitant interest rates (.Salasya *et al.*, 1998; Salasya, 2005). If women were given the same level of inputs as men in Kenya, maize, beans and cowpeas production would increase by 22 % (Quisumbing, 1996). Likewise a year of primary school education for women in Kenya would boost maize yield by 24 % (Quisumbing, 1996; Udry et al, 1995). According to FAO (2005), a study in 63 countries revealed that improvement in women's education made the single largest contribution to the decline in malnutrition during 1970-95, period accounting for 43 % of the total progress.

The limited access by women to credit means that they cannot buy technological inputs such as modern seeds, fertilisers and pesticides (Quisumbing, 1996). In Sub Saharan Africa, women farmers receive only 10 % of loans granted to smallholders and less that 1 % of the total credit advanced to the agricultural sector (FAO, 2005). Women are also rarely members of co-operatives, which often distribute government-subsidised inputs to small farmers. In addition, they lack the cash income needed to purchase inputs even when they are subsidised (FAO, 2002). Apart from access to credit and other productive resources, women also have limited access to extension services. Achieving agricultural development goals of efficiency,

sustainability and equity is hindered by the predominant practice of directing extension and training resources primarily to men. FAO (1989) global survey showed that women received only five per cent of all agricultural extension services worldwide. In Kenya the extension service programme was biased towards male farmers and therefore women farmers did not benefit from the knowledge and skills that result from this service. Saito and Weidemann (1990) observed that extension services had always been targeted exclusively at men with the assumption that the benefits would trickle down to women. The services were also designed to benefit men related farm activities especially the cultivation of cash crops. Such lack of access to information undermined women's ability to maintain environmental quality and the sustainable use of resources such as land, water and forests that supports livelihoods of the rural communities.

Extension services designed for women need to understand the constraints women face, the traditional culture in the specific regions, financial and human resources available and institutional organization (Saito, 1992). Good extension and technical service programme is very important for efficient use of farm technologies by both men and women. Saito and Spurling (1992) have observed that male farmers in Sub-Saharan Africa have greater contact with extension services than female farmers. Likewise in El Salvador male-headed households have significantly higher access to technical assistance than female-headed households (Lastarria-Cornhiel, 1988). Many studies indicate that a combination of factors limit women's access to extension services such as cultural restrictions that prevent male extension officers from meeting women farmers, many responsibilities that make it difficult for women to attend meetings away from home and very few trained women extension officers (Saito and Spurling, 1992).

In Kenya the competence and motivation of junior extension officers has also been an issue. In a study of decision-making process amongst extension officers in Ikolomani and Lugari, Chitere (1980) found that junior officers were incompetent and less motivated to effectively perform their duties. This was due to problems such as lack of promotion, transportation and insufficient delegation of authority. They were unable to interpret decisions made by their seniors to local conditions. Extension activities did not also take into account farmer's preference, market availability, price fluctuations, poor roads and cost of land preparation. In Chitere's (1980) study, 90 % of farmers in Lugari were found to be efficient in managing their crops to the standards set

by extension officers. On the contrary, only 35 % of farmers in Ikolomani followed the instructions of the officers. As a result production in Lugari was higher (10-12 bags per acre) than in Ikolomani (4-5 bags per acre). The low production in Ikolomani which borders Vihiga district to the north was attributed to consumption of maize before harvest, rotting at the time of harvest, damage by birds, ants, vermin, pests, rodents, and armyworms. Other contributors were late planting, inadequate use of fertilizers and pesticides, low plant population and inadequate storage facilities. Various factors such as exposure to radio and newspapers, attendance of demonstration and field days, visits to farmer training centres, large farm sizes and high income contributed to variation in utilization of extension service information. The inefficiency of extension service system and Farmer Training Centres was also observed by Motoro (1997) in a study of North Maragoli. Mutoro's (1997) study observed that extension agents were too few, they lacked adequate training, were poorly equipped and targeted affluent farmers. The Farmer Training Centres (FTC) on the other hand, were poorly equipped and under staffed (Mutoro, 1997)

There is also the assumption that women hardly make decisions about farm activities hence they do not require extension service. On the contrary, there are many *de jure* and *de facto* households units in Kenya where the women are major decision makers. Given the traditionally limited role of women in decision-making processes at the household, village and national levels in most cultures, their needs, interests and constraints are often not reflected in policy-making processes and laws which are important for poverty reduction, food security and environmental sustainability (FAO, 2002). The causes of women's exclusion from decision-making processes are closely linked to their additional reproductive roles and their household workload, which account for an important share of their time. Studies in Bangladesh, Ethiopia Indonesia and South Africa show that women resources within the household though meagre played an important role in household decision making especially in allocation of household expenditure to education and children's clothing and reducing the rate of illness for girls (Quisumbing and Maluccio, 2000; Quisumbing and De la Briere, 2000).

In Northern Cameroon, women were actively involved in decision-making in agriculture when their husbands were absent than when they were present (Jones, 1983). The women were

however constrained by lack of access to technologies to improve productivity on their fields. Cash crops such as rice that were under men were cultivated using modern technologies while food crops such as sorghum were cultivated using hand labour. There was also distinct division of labour in households that greatly affected production of rice. Rice production was a government project and well paying. The husbands therefore had to pay for the wife's labour on the rice fields. Women accepted to work on the male crop, only if they received some payment from their partners. This illustrates the fact that resource allocation in small farm households is a complex bargaining process between wives and husbands. Technology adoption may depend on consensus between numerous decision makers each with their own goals, priorities and motivations (Sands, 1986). Jones (1983)'s study emphasized that intra-household relations played an important role in determining production among smallholders.

Likewise in Burkina Faso, men and women have separate plots where they grew either same crop or different crops with the later having more labour and using more fertilizers. The differences in the use of inputs made the yield on women's plots to be 20-40 % lower than that on male farms. If the inputs used on male farms were shifted to women plots then agricultural output could increase by 10-20 % (Quisumbing, 1996; Udry et al., 1995; Alderman *et al.*, 1995).

As a result of lack of access and control of productive resources by women, the nutrition of children and other household members suffers. Malnutrition is a serious problem in Developing countries affecting nearly one third of all children under five years of age (Rosegrant et al., 2006). More than half of children die due to diseases associated with underweight and those who survive into adulthood are more likely to suffer from chronic illness, disability and sometimes reduced physical and intellectual productivity. Even though factors that contribute to under nutrition are many and varied unsatisfactory food intake and severe and repeated infections are the most important (UNICEF, 1998).

In Kenya the first nationwide rural nutrition survey was conducted in February and March 1977 by the Central Bureau of Statistics (CBS) covering 1,400 children between one year and 4 years (GoK, 1977). The survey identified factors influencing nutrition in the country such as growing of cash crops, declining farm sizes, income and literacy level. The second national survey was

done in October 1978 to January 1979 involving 3,525 children aged between 6 months and 6 years both in rural and urban areas. The third survey was done between June and September 1982, which found the prevalence of malnutrition in children to be protein-energy malnutrition (protein calorie malnutrition) caused by lack of food (GoK, 1983). Since then Kenya has continued to carry out demographic and health surveys the most recent being in 2003 (GoK, 2003). Inadequate food among other factors such as poor access to health facilities have always been recognized as underlying factors that lead to under nutrition. All the surveys agree that malnutrition is a problem of access and not supply of food hence an analysis of access to and control of resources that affect household provisioning mechanisms is a step towards identifying solutions to malnutrition in Kenya.

Women's education significantly helps to reduce malnutrition. In a study to determine the factors that reduced malnutrition by 15 % between 1970 and 1995, Smith and Haddad (2000), observed that increase in women's education accounted for 43 % of total reduction while improvement in women status accounted for 12 %. Improvement in food availability contributed 26 % to the rate of reduction of child malnutrition. In a study in Botswana, Salah *et al.,* (2006) observed that maternal education and income had a positive effect on nutritional status of children under three years. There was also a difference in nutrition according to gender with girls having better nutrition than boys. This was unlike in Tanzania where Mbago and Namfua, (1991) in a study of urban areas found that boys under four years had better nutrition than girls of the same age.

Lawal *et al.,* (2004) in a study in Oyo state of Nigeria, observed that there was limited participation of women in food security programmes due to lack of motivation by programme agencies, time constraint, high cost of inputs and lack of formal education. In fact education was found to be important in influencing the participation level of women in activities directed towards improving the food and nutrition status of family members. The study found nutrition status of children to be positively and significantly related to the participation of women in programme activities. Many studies therefore concur that improvement of the socio-economic status of women helps to improve the nutrition status of not only children but also other members of the household (Mbago and Namfua, 1991; Madzingira, 1995; Salah et al., 2006, Smith and Haddad, 2000; Smith et al., 2003; Lawal et al., 2004). In Egypt increasing the education level of mothers from none or less than primary to completion of primary school reduced the proportion

of people below the poverty line to 33.7 % (Datt and Joliffe, 1998). In Mozambique increasing the number of adult females that have completed primary school in each household by one, led to 23.2 % decrease in population of people living below poverty line (Datt et al., 1999)

Farm technologies have different effect on women depending on the socio-cultural characteristics of the region where they are introduced. In the Philippines the introduction of mechanical threshers relieved both men and women of threshing and substantially speeded the threshing process. Labour released by new technology enabled the farmers to grow more rice. This created employment for women farmers in transplanting, weeding and harvesting of rice. The benefits outweighed the small cost of reduced opportunities for manual labour (Paris and Pingai, 1994). In Bangladesh however, Paris and Pingai, (1994) observed that the substitution of a mechanical rice mill for a traditional threshing implement had a negative effect on poor and landless women who had previously earned income by providing hand-pounding services. The negative effect was due to the fact that Bangladesh women were restricted from leaving their homesteads for alternative employment.

Kumar (1988), in a study in Zambia established that additional supplies of food are necessary for labour productivity and increased demand for labour by small farmers. The study also indicates that adequate food supply, indirectly influence the decision by small farmers to adopt modern technology. In Kakamega district, which is bordering the study area, Rukandema (1977), observed very low labour productivity among smallholders due to predominance of hand hoe as a tool for land preparation. The output per unit of labour for 1975 maize yield was 4.7 bags (423 kilograms), and 2.7 bags (243 kilograms) in Muyenga and Shitoli sub locations in Idakho location respectively. The study attributed this to low food supply at a time when energy requirement for agricultural work is greatest. The farmers were living in absolute poverty with average per capita annual income of 40 to 42 US dollars .As a result of lack of compliance with technologies, traditional farming tools such as hand hoe, *pangas* and shovels were common. There were however, a few farmers who hired ox-ploughs and tractors for seedbed preparation. Farmers whose basic needs of food and non-food items had not been met found it difficult to spend the little income they had on purchase of farm inputs.

A study in Zambia (Siandwazi et al., 1991; Celis et al., 1991) identified different conditions of food consumption and nutrition status between households that used high-level technology (hybrid maize) and those that used low level technology (local maize) in Zambia. The study observed that the nutritional status of children was different in women headed and male-headed households. In low technology adoption areas, pre-school children from female-headed households had better nutrition than their counterparts in male-headed households. This was attributed to active involvement of women in decision-making especially those related to consumption. However in high technology areas pre- school children had poor nutrition in female-headed households than male-headed households. This was probably associated with the high income associated with technology use which was under the control of men. Siandwazi, et al., (1991) emphasized that in general child nutrition varied with adoption of new technology but it worsened in female-headed households. This is due to the fact that several factors affected child nutrition and not only availability of food. They included healthy environment, diseases, education, maternal care, and role of mothers in household decision-making, access to resources and the amount of work the mothers performed. The study generalised regions in Zambia by categorizing them into two groups, low adopters and high adopters (of hybrid maize). Even though a particular area may adopt technologies there may be differences within individual households. The study by Siandwazi (1991) also did not analyse the nutritional status of women, a component that has been included in the current study. The importance of storage facilities was also included in the current study. Siandwazi (1991) found that women were more involved in agricultural decision making in low adoption areas. This probably explained why the areas were lagging behind in farm technologies because the women did not have resources to modernise their farms. The study by Siandwazi (1991) did not show whether these women belonged to 'de-jure' or 'de-facto' households.

Omosa (1998), focused on the interplay between historical processes, state interventions and household food security in Kisii district. She observed that many households had no access to food in the district despite it being a high agricultural potential area. This was attributed to lack of purchasing power, household relations determined by social structures as well as technical and cultural transformation that have characterized the community over time. The study concentrated

on the coping mechanisms employed by rural households in meeting day-to-day food requirements. The core of the study was to establish the production and consumption patterns of smallholders and what made households to feel food secure. Analysis of calorie intake and nutrition status of household members was not in the scope of Omosa's (1998) study and was therefore incorporated in the current study.

An analysis of the methods of land preparation for maize on small farms in Western Province, observed increased use of ox drawn ploughs, from 25 % in 1977 to 43 % in 1981 (Oluoch-Kosura,1983). The study established that the farmers who used ox- ploughs attained higher maize yield as compared to those who used hand hoes. The use of tractors was very restricted in the area due to limited number of tractors available for hire and the cost associated with their use. The use of fertilizers was also found to be unprofitable in the fields where planting and weeding was delayed. Timeliness of planting and weeding were very important factors influencing the overall yield of maize. Using production function and analysis of variance, the study documented in details the various tools used in land preparation in the province and the effect on crop yield .The study concentrated on production of maize and did not analyse the consumption behaviour and expenditure of the households (Oluoch-Kosura, 1983). The study incorporated these aspects in order to establish the food security situation within the households. Oluoch-Kosura (1983) used samples of farmers who were under the Integrated Agricultural Development Program (IADP). This was limiting due to the fact that IADP selected farmers who belonged to cooperative societies meaning that they were likely to have more access to information and credit facilities as compared to the rest of the farmers in the province. The smallholders who belong to cooperatives are also most likely to grow cash crops.

The proposed study sought to fill the gaps in research indicated above as well as improve the understanding of the link between farm technology food security and gender.

2.3 THEORETICAL FRAMEWORK

There are many approaches to the food insecurity problem. Two economists, Reutlinger and Selowsky (1976, cited in Sen, 1995) published an influential monograph on *Malnutrition and Poverty.* They challenged the view held by scholars in early 1970s that a higher rate of economic growth, food production and market forces brings about improvement in nutrition in the Developing Countries. Their argument was that even though the economy of a country may grow, this may not translate into the wellbeing of the majority of the population unless there is equitable distribution of resources in a country. They emphasized the fact that food insecurity was caused by poverty. Many poor people suffered from malnutrition because of lack of affordability.

According to Seavoy (1989) many households suffer from food insecurity due to lack of transformation from subsistence to commercial farming. Seavoy asserted that subsistence farmers, even though they may embrace Green Revolution technology, they may continue to suffer from hunger in the same way as those peasants who do not use any technology. Seavoy's (1989) view regards commercialization of subsistence farming as the key solution to food insecurity problems. It should be understood however, that the adoption of technologies alone might not pave way for better nutrition and the general welfare of the household unless the role of women in household decision-making process is addressed. This is due to the important role that women play as food producers and care givers for their households.

In 1986, the World Bank issued food security policy paper entitled *Poverty and Hunger.* In this paper, food security was defined as *access by all people at all times to enough food for active healthy life.* The World Bank has recognized two key issues to food security namely, availability and accessibility (and nutrition) which are the core of this study. The World Food Conference of 1974, the International Conference on Nutrition (ICN) of 1992 and World Food Summit of 1996 all emphasized the fact that access to adequate food is a basic human right (GoK, 1998; FAO, 1996). In the Greater Horn of Africa, the per capita calorie availability of 1,950 Kcal per capita per day is less than the WHO minimum of 2,100 calories required for survival and 2,250 calories essential for a healthy life (FAO 1996a). One untapped source of agricultural growth to help

meet the food security needs of these countries lies in reducing the bias against women in agriculture.

The theoretical framework adopted in this study is the entitlement approach as advanced by Amatya Sen (Sen, 1986). Sen (1981; 1986; 1990a; 1995) used the *entitlements approach* to explain the causes of food insecurity in developing countries. This approach emphasizes the fact that what people own determines their food security situation. Sen (1986) argued that people suffer from hunger because of lack of entitlements, in other words because of poverty. Entitlements include the right to own what one grows on the farm (production based entitlements), the sale of one's labour in order to earn income to purchase food (own labour entitlements), and the right to own what is given by others (inheritance and transfer entitlements) (Sen, 1981; 1986; 1990a; 1995). The people who suffer from food insecurity more are the poorest in society who include the landless, subsistence farmers, peasant farmers, pastoralists, unemployed, refugees, squatters, fisher folks, salaried employees and self employed in agriculture (Kiros 1995; FAO 1981; World Bank 1980). Sen moved away from the notion of hunger as a failure of food production and slow economic growth, he retained the idea of breakdown or collapse of a person's entitlements. Sen did not consider the possibility that people may not have access to food because of a break down of social and economic systems that may continue to marginalize certain groups of people in society. His entitlements approach excludes instances of deliberate starvation by political elites for purposes of gaining political control of impoverished citizens. Entitlement to resources within the household may depend on many factors but the most important is gender. Gender is a socio-cultural construct of the society that determines the identity, rules or functions, entitlements and deprivation of women and men in the society. It must be differentiated from sex, the biologically determined state of being male or female which defines the biological difference between girls and boys, men and women (GoK, 1999).

Gathering information on who does what, level of access to resources for both men and women, benefits and deprivation for both as imposed by society helps in appreciating the dynamics of entitlements within the household and how this affects peoples access to food. Information is collected on the activities that household members engage in as well as how productive assets are controlled and accessed by household members. Such information is used in the analysis of

factors and trends influencing activities and access and control of resources (Candida et al., 1999; FAO, 2004). Women may not have access or control over benefits accruing from agriculture thereby reducing their level of income to access food (production based entitlements). Kenyan societies are patriarchal hence women may not have access to inheritance or transfer entitlements since land resources are transferred to the sons by their fathers. Through gender analysis access to and control over productive resources such as land, equipment, labor, capital and credit, and education, and training is analyzed. This enables planners to consider whether the innovation being introduced in agriculture could undermine access to productive resources, or if it could change the balance of power between men and women regarding control over resources.

When women have limited access to income or land, they may be unable to join groups, which provide production inputs and commercial opportunities, or to become independent commercial producers. In some subgroups, men may also suffer the same disadvantage. This analysis considers the structural and socio-cultural factors that influence the gender patterns of activity and access and control in the study area. The factors that are considered include; demographic factors (including household composition and household headship), general economic conditions (such as poverty levels, inflation rates, income distribution, internal terms of trade, and infrastructure), cultural and religious factors, education levels and gender participation rates and political, institutional, and legal factors (FAO, 2004; Candida et al., 1999).

The analysis considers the policies and programs that affect women's participation in modern agriculture. The community norms and beliefs that influence women's participation in modern agriculture are also investigated as well as the laws or regulations that could affect women's utilization and access to the benefits of modern agriculture. The end result of this is to recommend gender-sensitive research in agriculture, technology design, implementation and monitoring and post-evaluation.

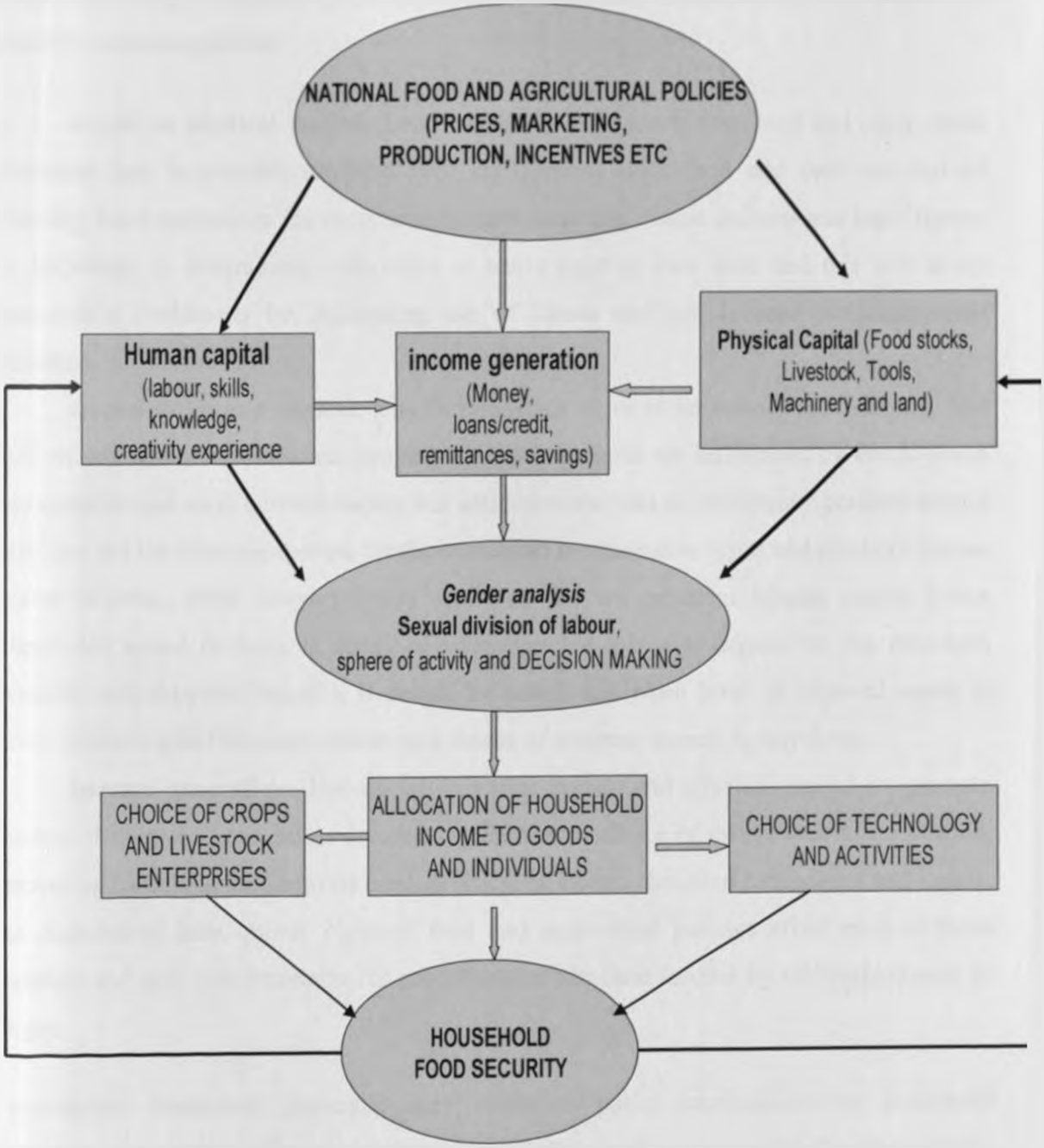
Food insecurity is an extreme manifestation of poverty which may be a result of cumulative and cyclical interdependence of deprivation. According to Myrdal (1957 cited in Bradshaw,2006) in his theory of cumulative causation, poverty may become prevalent in a region due to lack of employment which reduces consumption and spending on education and training which in turn reduces people's potential to earn income to improve their wellbeing. When households have

limited resources to invest in agriculture, the end result is low productivity that prevents them from participating in cash economy. Lack of participation in cash economy reduces households to subsistence economies that perpetuate poverty and food insecurity.

On the other hand, poverty may be caused by breakdown of social, political, and economic systems that make people to have limited access to opportunities and resources with which to achieve income and wellbeing. Literature on poverty (Yoon and Hirschl, 2003 and Jencks, 1996 cited in Bradshaw, 2006), suggest that the economic system is structured in such a way that certain groups of people in society lag behind no matter how competent they may be. People may be discriminated against by socio-economic and political system on the basis of gender, disability, religion and race. Such groups may have limited opportunities regardless of personal capabilities. One of the strategies to deal with such inequalities is to create and develop institutions which ensure equal access of disadvantaged groups. Such institutions in agriculture and in rural setting include those that provide credit and technical advice to farmers. Increasing access to job opportunities, expanding safety nets for the poor, and supporting programmes to increase agricultural productivity are important steps towards poverty reduction and improvement of the wellbeing of women and those under their care.

2.4 CONCEPTUAL FRAMEWORK

The conceptual framework of this study is shown in Figure 2.1. The key issues in this study are policy implication on physical and human capital, income generation and its affects on intra household access and control of resources, sphere of activity and decision making process. These factors affect household provisioning mechanisms as well as determine preference in intra-household investment in technology, health and nutrition. The resources available to the household as well as the exogenic factors such as climate and infrastructure determine the choices of food crops to be grown and animals to be raised as well as decisions on choices and intensity of use of various technologies. All these will affect the amount of food produced by the household, how much food they can buy or borrow and finally the food security situation in the household. This in turn provides the basis for an intergenerational transfer and exchange of resources and the start of the process all over again (IFPRI, 1995; Kumar, 1994; Dwyer, 1983) (Figure 2.1).



Source: Author

Figure 2.1: Conceptual framework

There are three major components of household provisioning mechanisms all of which are influenced by national policies.

a) **Access to physical capital:** Land ownership or rights to own land and other assets determine how households establish their entitlements since food and cash are derived primarily from agriculture for most smallholders in Kenya. Socio cultural and legal factors are important in determining who owns or has a right to own land and this will affect household's livelihoods by influencing use of labour and real income availability and allocation.

b) **Access to human capital:** It is an important factor in household provisioning. The level of education, nutrition and health within a household are influenced by employment opportunities and socio cultural factors that influence who can or who cannot perform certain activities and the returns expected for the household by alternative types and levels of human capital (Kumar, 1994; Dwyer, 1983). Children too are potential human capital hence households invest in them in terms of education but this will depend on the resources available and expected benefits. It should be noted that when level of physical assets is lower, human capital becomes crucial as a means of securing income to buy food.

c) **Income generation:** Households combine human and physical capital to generate income. Within the households decisions are made on choice of crops, area to be planted, amount of household labour to be used, division of labour, choice of technology and inputs, and disposal of farm output. National food and agricultural policies affect each of these variables and may also determine the production of non-farm income by self-employment or wages.

The conceptual framework presented here examines policy implications on household provisioning mechanisms and use of technologies. Policies affect socio-cultural and economic variables, which in turn influence household income and division of labour. Likewise policies can also influence preference functions involved in the allocation of household resources for certain technologies for instance availability of information may influence the preferences of certain inputs in regions where they are better known as opposed to areas where households are not familiar with them.

Gender analysis was emphasized in this study because of its strength in understanding intra household dynamics especially on resource allocation, income generation and distribution and decision-making. Feldstein (1989) defines gender analysis as "*getting information about women and men, about who is included and who is left out, who makes the decisions and who sets the agenda, how resources are allocated and who benefits*".

Gender analysis recognizes that women's and men's lives and experiences, needs issues and priorities are different. This affects the way they allocate resources to food production and to nutrition needs of those under their care. In addition, women's lives are not all the same; the interests that women have in common may be determined as much by their social position or their ethnic identity as by the fact that they are women. Women from different ethnic groups may have different needs determined by the socio-cultural setting, age, income levels, marital status and employment status. This means that different strategies may be necessary to achieve equitable outcomes for women and men in different situations and surroundings.

The study recognizes that a household is not undifferentiated grouping of people but rather quite diverse in terms of production, consumption and resource allocation. The heterogeneous nature of households affects the utilization and allocation of resources to various inputs and activities and decision making which in the long run impinge on household food security. Some of the questions addressed in gender analysis include: who produces what goods and services, what resources are available, who has access to or control of the resources, and who benefits.

Decisions on food acquisition and use do not benefit all the members in a household. Studies have shown that men control the supply of staple food and sometimes the money to purchase food during time of scarcity. This affects food supply to women and children (Kennedy and Cogill, 1987).

Gender analysis entails assessing the contributions that all members of a household make to the economy. In this study it's the contributions made to food security. Decision making by farmers is influenced by gender roles, inter (between) and intra (within) household relations. Limited land ownership by women due to customary laws, lack of access to credit and other services are

some of the problems that hinder women's full participation in food production. This to some extent has negative effect on ensuring food security at household level.

Gender has proved to be the most useful category to split up the farm household and analyze the intra-household behaviour (Cloud, 1988). It helps in understanding intra-household relations and decision-making and how this affects the farmer's use of various farming techniques. The primary task of gender analysis involves dismantling of households based on distribution of power and access to resources, before roles, relationships and activities of individual households can be examined (Sage, 1993). It is now becoming clear that households structures are different within a community. These emerge as a response to stages in the life cycle, population movements, or differences in asset holding, residence or cultural traditions. These different structures within a household may have different resources and face different incentives. This knowledge is important in understanding how resources and incentives are organized and might be mobilized for changes in farm production (Feldstein et al., 1989).

Food availability and accessibility together with the nutritional status of household members will determine the efforts that will be put on income generation, human capital development and acquisition of physical assets such as land. A household that is not food secure will think about ways of meeting its day-to-day food requirements. It is only after the basic needs of food have been met that investments can be made in other aspects of life.

CHAPTER THREE: THE STUDY AREA

3.1 INTRODUCTION

This chapter presents a detailed description of the location, area, physiographic, agro-ecological and socio –economic characteristics of the study area. Emphasis is placed on those aspects of the study area that relate to food production, poverty and food security.

3.2 LOCATION AND EXTENT

3.2.1 General

The study area is in Western Province of Kenya. Western Province lies between latitude 0^{o} and 1^{0} 02' North and longitude 33^{0} 54' East and 34^{0} 39'East .The province is within the Kenyan Lake Victoria Basin, at the western border with Uganda. It covers a land area of 8,360 square kilometres (CBS, 2006). Western Province comprised of eight districts namely Busia, Kakamega, Vihiga, Bungoma, Butere- Mumias, Lugari, Mt.Elgon and Teso (GoK, 1999). Two districts were selected for this study, namely Busia and Vihiga. In 2007, the government created new districts in the country including in Western Province. Busia district was split into three districts namely Samia, Budalangi, and Busia while Vihiga district was split into three districts to form Emuhaya, Hamisi and Vihiga. The study was conducted using the old administrative boundaries.

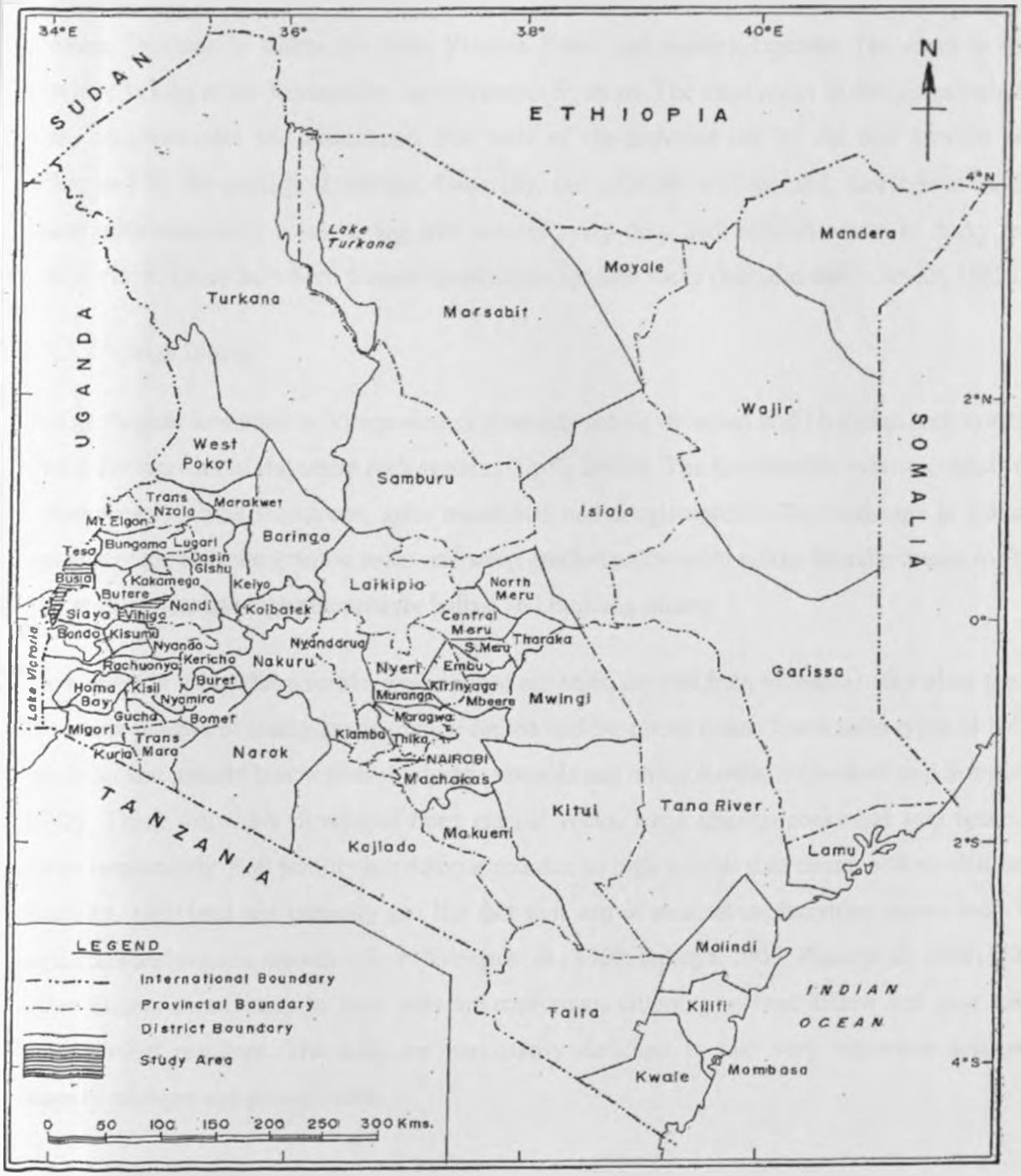
3.2.2 Vihiga district

Vihiga district lies between latitude 0^{0} and 0^{o} 15' North and between longitude 34^{o} 30' East and 35^{o} 0' East (GoK, 2002a). It is on the southernmost tip of western province and was carved out of Kakamega district in 1991 .The district covers a land area of 563 square kilometres making it the smallest rural district in Kenya.

3.2.3 Busia district

Busia lies on latitude 0^{o} 1'South and 0^{o} 33'North and at longitude 33^{o} 54' East (GoK, 2002b). It borders Teso and Bungoma to the North, Kakamega district to the east, Busia district of Uganda

to the West and Lake Victoria to the south. The district occupies an area of 1,261 square kilometres, out of which 137 square kilometres are under Lake Victoria.



Source: GoK (2002a)

Figure 3.1: Map of Kenya showing the location of the study area

3.3 PHYSICAL ENVIRONMENT

3.3.1 Geology and Soils

3.3.1.1 General

Western Province is within the Lake Victoria Basin and borders Uganda. The rocks in the province belong to the Kavirondian and Nyanzian Systems. The main rocks in this series include grits, conglomerates and mudstones. The soils of the province and of the two districts are influenced by the geological settings. Generally, the soils are well drained, dark brown sandy loams with some hilly areas having well drained, very deep dark reddish brown to dusky red friable clays. These have been formed mostly from igneous rocks (Jaetzold and Schmedt, 1982).

3.3.1.2 Vihiga District

The geological formation in Vihiga district is mainly the Kavirondian and Nyanzian rock system with a few parches of Basement rock systems (GoK, 2002a). The Kavirondian system consists of young rocks such as sandstones, grits, mudstones and conglomerates. The landscape in Vihiga has numerous resistant granitic rocks and steep gradients (the word *vihiga* literally means rock). The rock system has high potential for ballast and building stones.

Most areas in Vihiga have fertile, well-drained red soils, derived from volcanic rocks while there are a few parches of loamy sands from sediment and basement rocks. Three main types of soils are dominant namely humic acrisols, dystric nitosols and orthic ferralsols (Jaetzold and Schmidt, 1982). These soils have developed from granitic rocks, basic igneous rocks and acid igneous rocks respectively. Soil fertility has deteriorated due to high rainfall that causes soil erosion and leaching, high land use intensity and the fact that use of nutrient replenishing inputs such as fertilizers and organic manure is low (Salasya et al., 1998; Salasya, 2005; Place et al., 2005). The other factors contributing to poor soils are continuous cropping without fallow and poor land management practices. The soils are particularly deficient in two very important nutrients namely nitrogen and phosphorous

3.3.1.3 Busia District

Busia district consists mainly of precambrian gneisses and granites while some areas are made up of basement rock systems with few patches of volcanic outcrops such as Samia hills. The

soils in Busia are as varied as the geological structure. They are moderately deep, rocky and stony and consisting of well drained red clays with low natural fertility. Nambale and Butula divisions have well drained deep brownish and sandy loams with moderate water holding capacity (GoK, 2002b). Busia municipality and Samia hills consists of well-drained friable clays with low natural fertility while Budalangi and parts of Funyula divisions that border Lake Victoria have poorly drained clay type of soils prone to flooding (GoK, 2002b). Sandy soils that have developed on beach ridges occur along the lake while soils of Yala swamp have very high to moderate organic matter. The poor soils in the district are a major challenge and require better choice of crops such as intercropping of cereals with legumes and continuous nutrient replenishment (Jaetzold and Schmidt, 1982).

3.3.2 Physiography and drainage

3.3.2.1 General

Western Province forms part of the undulating plains of the Lake Victoria Basin. It has diverse physical landscape with hills in northern Bungoma and lowlands bordering Lake Victoria. The highest point in the province is Mt. Elgon at 4321 metres above sea level. The province is drained by mainly rivers Nzoia and Yala and their distributaries all of which are fed by Mt Elgon watershed.

3.3.2 .2 Vihiga District

Vihiga district lies in highland area on the eastern fringes of the Rift Valley in Lake Victoria Basin. The altitude ranges from 1300 –1500 meters above sea level (GOK, 2002a). The district comprises of rugged granitic hills like the Bunyore, Maragoli and Nyangori hills that are about 1950 metres high with streams flowing from northeast-southeast direction and draining into Lake Victoria. The district has four permanent rivers with the major ones being Esalwa and Yala

3.3.2.3 Busia District

Busia district is characterized by undulating terrain with higher lands intersected by numerous valleys (Jaetzold and Schmidt, 1982). The lowland and highland topography ranges between 1130m on the shores of Lake Victoria to 1375m in the central part. Butula and Nambale

divisions are characterized by plains while the southern part particularly Matayos, Funyula and northern part of Budalangi divisions are hilly (GoK, 2002b). Samia hills and the Yala swamp form important physical landmarks in the southern part of the district. The district is drained by two main rivers namely Nzoia and Sio both of which drain into Lake Victoria.

3.3.3 Climate and Vegetation

3.3.3.1 General

Western Province experiences tropical climate with a few areas that fall under equatorial climate such as the Kakamega forest. The amount and distribution of rainfall in the province is closely associated with altitude. The rainfall is high in the hilly areas of Vihiga, Bungoma and Mt. Elgon decreasing sharply towards the lowlands of Busia as one approaches Lake Victoria. The rainfall ranges from .760mm to 2000mm per annum with a lot of variations due to relief and distance from the Lake Victoria. While the mean annual temperatures range between 23^0 C to 32^o C. Bungoma and Vihiga are generally cooler due to high relief while the lowland district of Busia is the warmest. The rainfall in the province is influenced by westerly winds from Lake Victoria which converge with the south-east trade winds causing warm air to rise and consequently resulting into heavy showers especially in the afternoons (Jaetzold and Schmidt, 1982).

The vegetation of the province is greatly influenced by soil distribution, relief and human settlement. Other factors that have either reduced or modified natural vegetation include arable agriculture, burning, building and construction and grazing. Kakamega forest is the only surviving rainforest in the province. It covers an area of 238 square kilometres of which less that half is indigenous forest. Mt. Elgon is also forested and a protected area. These forests and many remnants of forests in the province are threatened by encroachment by human activities and hence great effort is required to preserve them in order to sustain these vital ecosystems and the life forms that they support.

3.3.3.2 Vihiga District

Vihiga district experiences warm and humid equatorial climate with rainfall fairly well distributed throughout the year. The rainfall pattern is bimodal and ranges from 1800 to 2000mm per annum, with an annual mean of 1900mm (Jaetzold and Schmidt, 1982; GoK, 2002a). The

rainfall in the district is both convectional and orographic due to the effect of Lake Victoria and numerous hills. The rainfall is adequate for the production of a wide range of crops. The long rains fall between March and June while the short rains are between August and November .The rainfall allows for two cropping seasons in a year. Generally, the district is humid with a moisture availability of over 80% (Jaetzold and Schmidt, 1982).

Vihiga district had only 4 % forest cover in 2001 (GoK, 2002a). The forests remnants are Kaimosi and Kabiri which are extensions of the larger Kakamega forest. The dominant tree species include Elgon teak, Celtic and Cordia (Mutoro, 1997). Exotic trees such as the Eucalyptus are the dominant tree species grown on the farms and are the major source of timber and wood fuel in the district.

3.3.3.3 Busia District

Busia has two rainy seasons, the long rains (March to May) and the short rains (August to October). December, February, June and July are characterised by dry spells. The mean annual rainfall ranges between 760 and 1500 mm. In both the short and long rains there is 60% reliability (Jaetzold and Schmidt, 1982). The mean annual air temperatures range between 26° and 32° C (Jaetzold and Schmidt, 1982; GoK, 2002b). The driest parts of the district are found in parts of Funyula and Budalangi divisions near the lake shores which receive 760-1015mm of rainfall. As a result of high temperatures, the district experiences high evaporation rates of 1800-2000mm per year (GoK, 2002b).

Most of the natural forests have been cleared to pave way for settlement and agriculture. Busia has some remnant of forests that cover 579 hectares mostly in Budalangi division (GoK, 2002b).

3.3.4 Agro ecological zones

3.3.4.1 General

Western Province is relatively wet except near Lake Victoria where the rainfall is scanty. The province mainly fall under Upper and Lower Midland Zones (UM and LM). The upper midland zones cover parts of Vihiga, Bungoma, Mt. Elgon, Kakamega and Lugari while Lower Midland zones cover mostly Busia, Butere-Mumias, Teso and parts of Kakamega districts. The Upper

Midland zones can mainly support tea and coffee as cash crops and a wide range of food crops while the lower midland zones can support mainly sugarcane where the soils are well drained and cotton in poorly drained soils closer to the lake .Many types of food crops can also be grown in this zone.

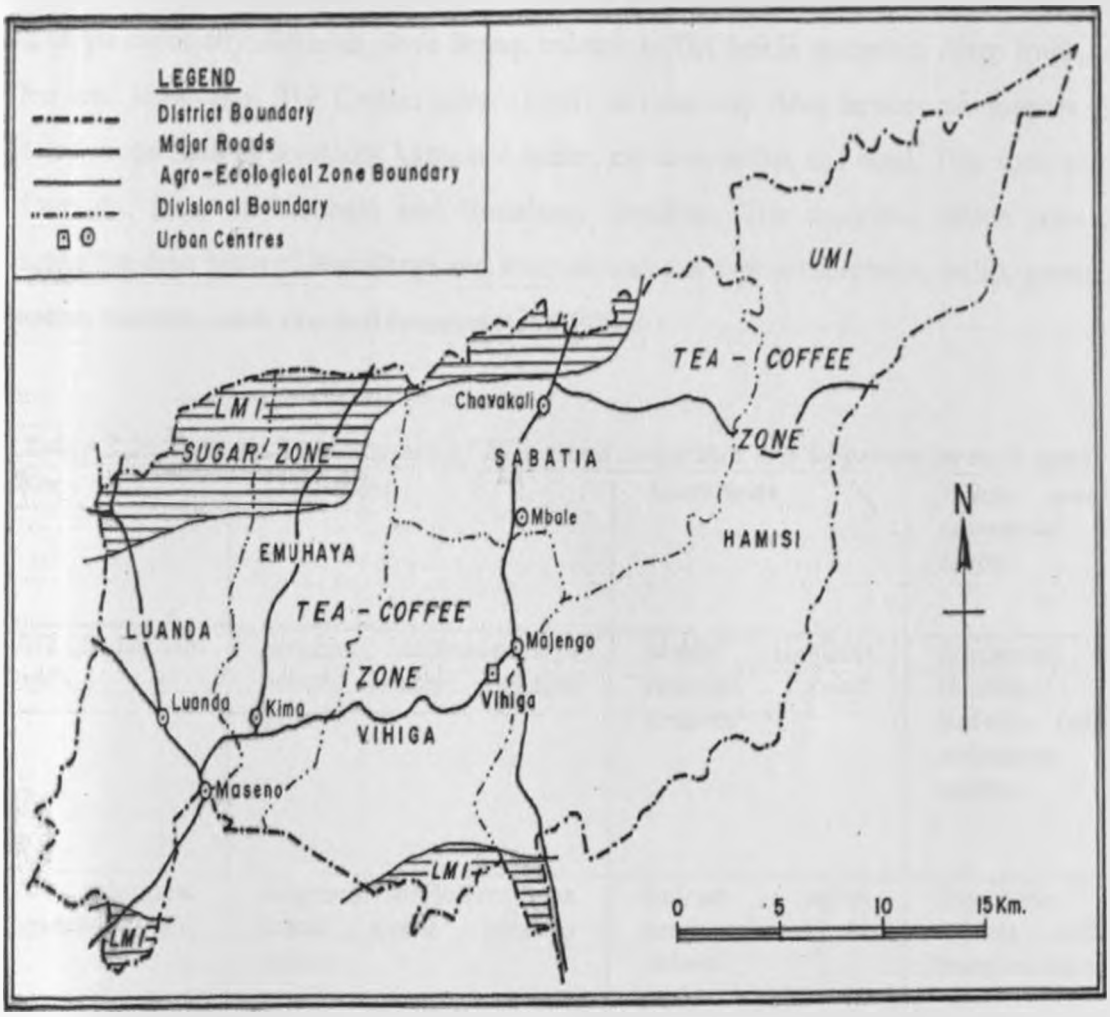
3.3.4.2 Vihiga District

Vihiga district has two main agro-ecological zones both of which are classified as humid receiving over 1500mm of rainfall (Table 3.1) (Figure 3.2) (Jaetzold and Schmidt, 1982). They are Upper Midland Zone (UM1) and Lower Midland Zone (LM1). The Tea-Coffee (UM1) zone has well drained soils with good potential for crops such as tea, coffee, maize, beans, groundnuts, bananas, and a variety of horticultural crops (Jaetzold and Schmidt, 1982). This zone covers 90% of the district and comprises of Central Sabatia, Vihiga and Tiriki divisions (Figure 3.2). The Sugarcane zone (LM1) which covers only 5% of the district contains red loamy sand soils derived from sediments and basement rocks and can support maize, beans, sorghum, millet and cassava. This mostly covers Emuhaya division (Figure 3.2). Maize is the staple food crop while tea is the main cash crop in the district. Farmers also keep livestock, including cattle, poultry, sheep and goats. Indigenous zebus are the most common cattle species with a few cross and exotic breeds. Dairy farming is dominant in Vihiga, Sabatia and Tiriki. However, poor breeds, poor husbandry, lack of capital and inadequate management of pests diseases limit milk production. Every farm household also keeps poultry due to its significance in the culture of the people in Western Province (GoK, 2002a).

Table 3.1: Agro-ecological zones of Vihiga and crops that can be grown in each zone

Zone	Area in Square km	Location	Classification	Land use
UM I Tea-Coffee zone	447	Central parts of Vihiga, Sabatia Tiriki East and West	Humid	Maize, beans, millet, sorghum tea, coffee fruits
LM I Sugar Zone)	94	Western parts of Emuhaya	Humid	Maize, beans millet, sugarcane

Source: *Source: Jaetzold and Schmidt (1982)*



Source: *Jaetzold and Schmidt (1982)*

Figure 3.2 Agro-ecological zones of Vihiga district

3.3.4.3 Busia District

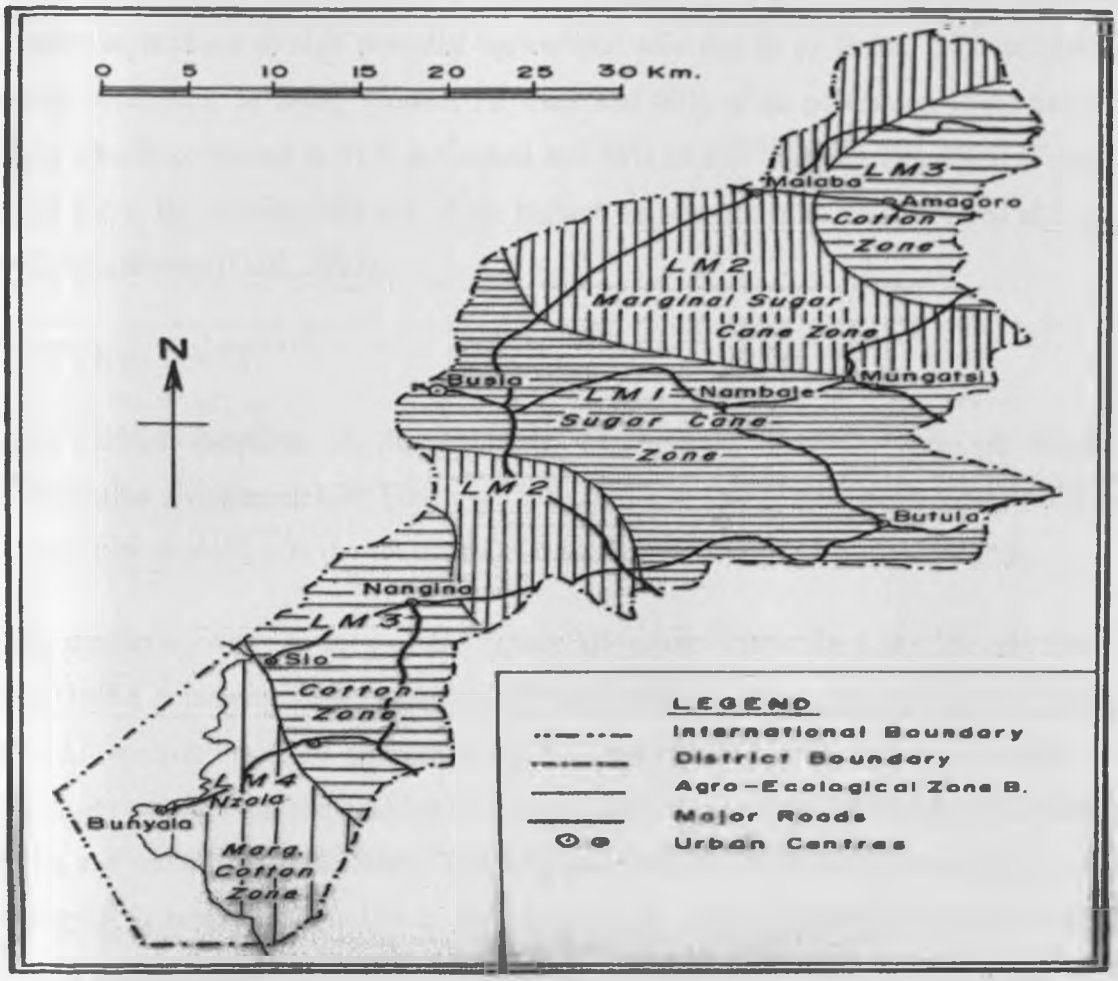
Busia district is found in the Low Midland (LM) zone. There are four agro-ecological zones that make up the district, namely, LM1 (Sugarcane zone), LM2 (Marginal zone), LM3 (Cotton zone), and LM4 (marginal cotton zone) (Table 3.2) (Figure 3.3) (Jaetzold and Schmidt, 1982). The Low Midland Zone one (sugarcane zone) can support food crops such as sorghum, sunflower, maize, cowpeas sorghum bananas and beans. Cash crops that can do well in the zone include; sugarcane and robusta coffee. This zone covers Butula, and Nambale divisions of the district. The marginal

sugar zone (LM2) covers parts of Butula, Nambale and Funyula and can support a wide range of food crops especially sorghum, soya beans, bulrush millet, beans mangoes, citrus fruits, robusta coffee and sugarcane. The Cotton Zone (LM3) is relatively drier hence can support drought resistant crops such as sorghum, katumani maize, cassava, millet and sisal. This zone comprises of Funyula, parts of Nambale and Budalangi divisions. The marginal cotton zone (LM4) occupies the drier parts of Budalangi and Funyula and can support sorghum, millet, green, grams cowpeas, cassava, sisal, rice and bananas (GoK,2002b).

Table 3.2: Agro-ecological zones of Busia and crops that can be grown in each zone

Zone	*Long rains*	*Short rains*	*Whole season (perennial crops)*
LM1 (Sugarcane zone)	Sorghum, sunflower, Soya beans, sweet potatoes maize	Maize sorghum cowpeas sweet potatoes	Sugarcane, Bananas, Robusta coffee avocadoes, cassava
LM2 (Marginal sugarcane zone)	Sorghum sunflower Soya beans sweet potatoes onions	Bulrush millet sorghum beans kale onions	Sugarcane robusta coffee mangoes citrus
LM3 (Cotton zone)	Maize Katumani sorghum millet beans cow peas	Simsim green grams	Cassava sisal rice bananas vegetables
LM4 (marginal cotton zone)	Sorghum, millet green grams cowpeas	-	Cassava sisal rice bananas vegetables

Source: Jaetzold and Schmidt (1982)



Source: *Jaetzold and Schmidt, 1982*

Figure 3.3 Agro-ecological zones of Busia district

3.4 HUMAN ENVIRONMENT

3.4.1 Population and demographic characteristics

3.4. 1.1 General

With a population of 36 million, Kenya is the most densely populated country in East Africa (UNFPA, 2007). However, like many countries in Sub Saharan Africa, about 50% of Kenya's population live below poverty line (CBS, 2003)

Western Province is mainly composed of the Luyia tribe. It covers a land area of 8,264 square kilometres with an average population density of 406 persons per square kilometres (GoK,

1999). It is one of the provinces that suffer from chronic food poverty despite the fact that it is classified as medium to high potential agricultural area due to its fertile soils and favourable climatic conditions. In 2003, Western Province had 60% of its population living below rural poverty line as compared to 31% in Central and 48% in Rift Valley (CBS, 2003) (Figure 3.4). Further more, the province has one of the highest percentages of stunted children after Eastern and Coast province (GoK, 2003).

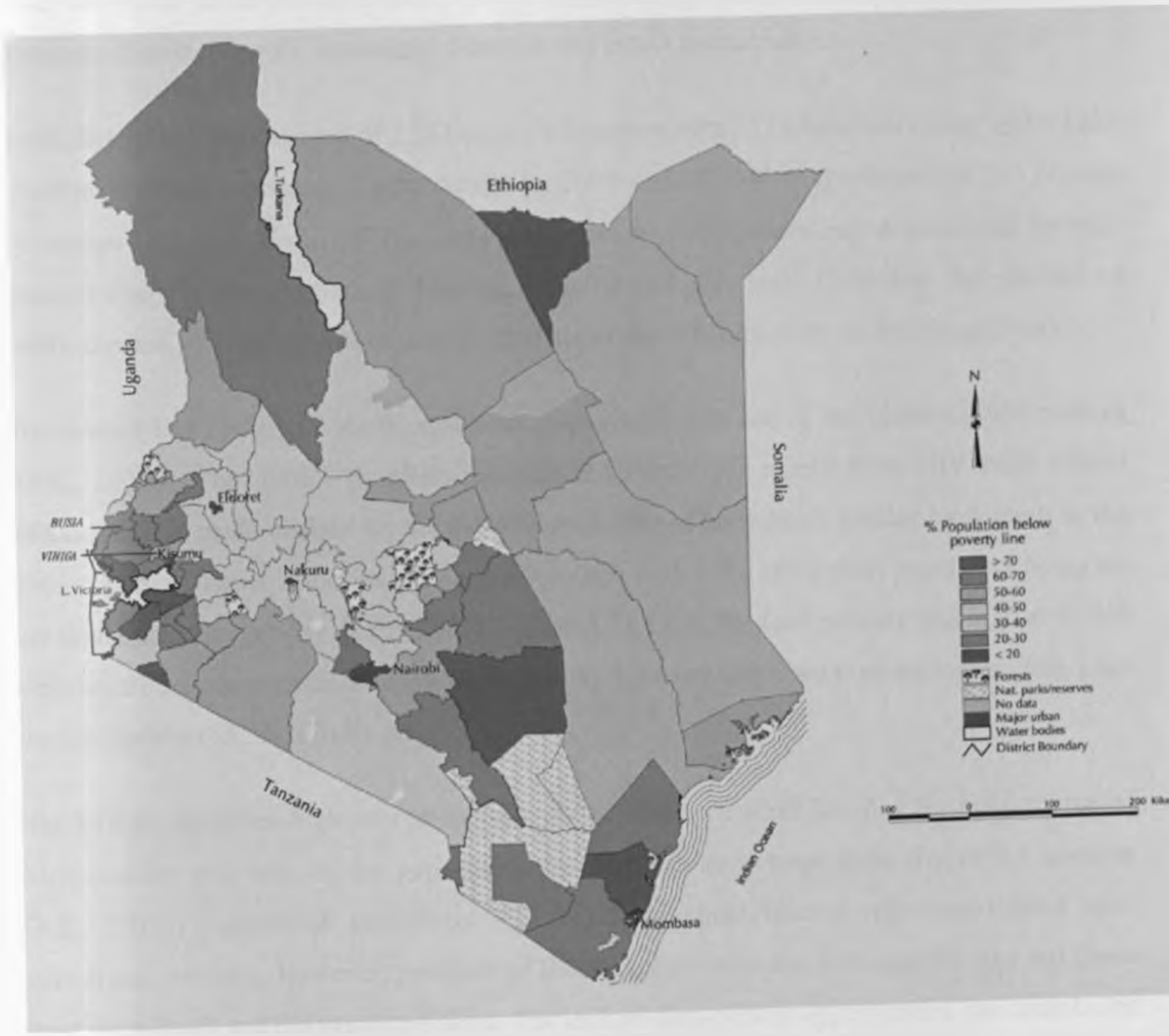
3.4.1.2 Vihiga District

Vihiga district comprises of the Abatiriki, Abamaragoli and Abanyore sub tribes. The administrative divisions include Emuhaya, Sabatia, Tiriki East, Tiriki West, Vihiga and Luanda. This however changed with the formation of new districts in 2007 after the fieldwork.

Vihiga district occupies an area of 563 square kilometres within the Lake Victoria basin. The district had a population of 498,883 in 1999 and with population density of 886 persons per square kilometers. Projected population in 2005 was 595,180 with an average density of 975 persons per square kilometer making it the most densely populated district in the country after Nairobi and Mombasa (GoK, 2005) .The settlement pattern varies with rainfall distribution and topography. It ranges from 1,179 to 682 persons per square kilometer in Sabatia and Tiriki divisions respectively. The population is mostly comprised of youthful population; 59% are under 20 years of age while 71.1 % falls below 30 years (GoK, 2005). The average household has 4.7 persons living on an average of 0.5 hectare of land, creating a very high dependency on agriculture (GoK, 2001). The fertility rate of 5.5% is among the highest recorded in the country with an annual population growth rate of 3.3% (GoK, 2002a).

Vihiga district has high incidences of malnutrition among children under five years. The situation was worse in Emuhaya division. Vihiga had more than half (58%) of the population living below rural poverty line - an indication of the inability of large proportion of people in the district to meet their food security needs (Figure 3.5). Despite the fact that literacy levels are high (86.7% for male and 77.7 % for female), unemployment is widespread and it's attributed to landlessness and inadequate non-farm activities. There are only two factories in the district; a milk processing and tea factory all of which are found in Sabatia division. Other sources of

income include remittances which contribute 20-22% of livelihood and livestock production accounting for 15-19% of household income (GoK, 2002a)



Source: Modified from CBS (2003)

Figure 3.4: Map of Kenya showing district boundaries and population below poverty line

3.4.1.3 Busia District

Busia district hosts the Abasamia, Abanyala, Abamarachi and Abakhayo, which together with other sub-tribes in the province make up the larger Luhyia tribe. The administrative units are, Nambale, Butula, Funyula, Budalangi, Matayos and Busia municipality.

Busia district occupies an area of 1,261 square kilometres with 137 kilometres square under Lake Victoria. Population estimate for the district for 2005 was 485,047 with a density of 385 persons per square kilometre (GoK, 2002b). The population was low in Budalangi division and the hilly areas of Funyula due to frequent flooding, droughts and poor soils .Data from the ministry of health showed very high levels of malnutrition in the districts especially in Budalangi division.

The district had 33 % HIV Aids prevalence rate, which was one of the highest in the country (GoK, 2002b). The district hospitals recorded ten deaths per month from HIV Aids related infections. This could explain for the increasing number of households headed by widows in the district. Busia District is the poorest in the Province with 67% of its rural population living on less than one dollar per day (CBS, 2003) (Figure 3.5). Likewise food poverty was high at 61.4% while hard core poverty was 50.64% (GoK, 2002b). Literacy levels are high for males (76%) but low for females (55.3%) (GoK, 2002b).

Like Vihiga, Busia has high rate of unemployment with agriculture forming the main source of livelihood for over 80% of the population who cultivate an average farm size of 2.5 hectares (GoK, 2002b). Agriculture contributes 35.4 % of household income with very limited non-agricultural activities. However, residents of Budalangi division that live near the lake and those along river Nzoia and Sio practice fishing. The lack of employment opportunities has contributed to male labour migration contributing to many households managed by women. The number of female headed households in Busia district was 27,522 (GoK, 2002b). Out- migration also contributes to constraints on labour supply especially during the peak seasons.

Source: Modified from CBS, 2003

Figure 3.5: Population below poverty line in Western Province

3.4.2 Land Tenure and Land use characteristics

3.4. 2.1 General

The land tenure system is an important aspect of food production. It determines farm size distribution and land use patterns. Communities in Western Province are patriarchal hence sons inherit the land from their fathers. Although women provide over 50 % of labour on family farms, and they literally manage the farms and make minimal decisions regarding production (GoK, 1999; Mikalitsa, 1996). They have to get farm inputs through their husbands who are away most of the year. In addition, women have very limited access to credit facilities due to lack of collateral. This is unlike Central province where more women own property, especially land, hence they have access to credit facilities. It is one of the provinces in Kenya with the lowest number of households below food poverty line probably due to proximity to Nairobi, women's active role in household decision making and their access and control of productive resources such as land. The majority of households in Western Province are smallholders. Maize (*Zea Mays)*, which is a staple crop, had the largest acreage (10 %) followed by sugarcane (*Saccharum Officinarum*) (6 %).

The cultivation of hybrid maize, use of fertilizers and ox drawn ploughs is not new in Western Province having been in use for many decades (Rundquist 1984; Oluoch-Kosura, 1981; Rukandema, 1977; Wangila, 1990; GoK, 2000b). The main farming constraint is declining soil fertility with little replenishment. Other constraints are low farm income, low yields, small and declining farm sizes. Infrastructure in the Province is poor with most areas having earth roads that become impassable during the rainy season .Good transport network is very essential in enhancing food security. Efficient transport system facilitates access to market to purchase both farm inputs and food and non-food items. Smallholders cannot modernize their farms if access to major inputs is difficult and expensive due to poor network of distributional nodes.

3.4.2.2 Vihiga District

The high and bi- modal rainfall pattern and relatively good soils in Vihiga allows for cultivation of a wide range of crops with two harvests in a year. However, the district faces serious problems of dwindling farm sizes and deteriorating soil fertility. Vihiga district is not self-sufficient in

food production. The district is a net buyer of cereals from neighbouring districts such as Tranzoia, Bungoma and Nandi. Cereal production was 38,077MT compared to annual demand of 85,705 MT (MoA, 2005). The main cash crops in the district are tea and horticultural crops while food crops include maize, beans, millet and sorghum.

3.4.2.3 Busia District

The high agricultural potential parts of the districts are found in Nambale, Matayos and Butula divisions while the medium potential areas are found around Lake Victoria and cover the entire parts of Budalangi and Funyula divisions. Budalangi division is susceptible to floods which cause loss of lives and property and is responsible for waterborne diseases, loss of biodiversity and high prevalence of poverty in the division. Before the collapse of the cotton industry in the country, cotton was the major cash crop in Busia district. Fishing is the main source of livelihood in the division with some agricultural activities especially the cultivation of rice under irrigation.

Table 3.3: Summary characteristics of Busia and Vihiga districts

Characteristics	Vihiga	Busia
Altitude (m)	1550	1250
Average annual rainfall (mm)	1900	1500
Average temperature (^{0}c)	20.3	26
Population density (persons/km^2)	886	330
Average farm size (ha)	0.5	2.5
Average household size	4.7	4.5
Landform	Rolling with small catchment areas	Generally plain with isolated hills
General land use	Maize, beans, bananas Vegetables, tea horticultural crops, local zebu and semi intensive dairying	Maize, beans, sorghum, cassava, cotton, local zebu
Soil fertility	moderate	Moderate to poor
Livestock trends	Low but stable	Low but stable
Cash opportunities, access to market	Medium to good	medium

Source: Jaetzold and Schmidt (1982); GoK (2002a, 2002b)

3.5 JUSTIFICATION FOR THE SELECTION OF STUDY AREA

Two districts, namely Busia and Vihiga, were selected for this study because of several reasons. The two districts were some of the poorest in Kenya and in Western Province (Figure 3.4). More than half of the population live below poverty line (CBS, 2003) in addition to more than half of the households living below food poverty line. Vihiga district has very high population density compared to Busia district. Households in Vihiga district mainly rely on agriculture as a source of livelihood while Busia relies on fishing and agricultural activities. Vihiga district is purely agricultural with the highest population density in the province and in the country (Salasya,

2005; GoK, 2001). The farm sizes in Vihiga district were smaller averaging 0.5 hectares (Salasya, 2005; GoK, 2001) while those in Busia averaged 2.5 hectares. The topography in Vihiga is fairly undulating with granitic rock outcrops that further worsened the problem of land availability for agriculture. However, Busia district is fairly flat with a few isolated hills. The two districts had also been under the government crop improvement programmes since the 1970s.

Given the above profiles regarding the two districts, it was therefore found necessary to find out the relationship between farm technologies and household food security, taking into account the important role that gender plays in food production. The postulate was that availability of farm technologies and credit facilities particularly to women in the study areas contributes to food security.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.1 INTRODUCTION

This chapter is a detailed presentation of methods that were use to collect and analyse data. In addition, the sampling techniques employed in the study are discussed.

4.2 STUDY DESIGN, SAMPLE SIZE AND SAMPLING PROCEDURE

This was a comparative study between two districts in Western Province namely, Busia and Vihiga. The two districts have contrasting physiographic, ecological and socio-economic characteristics. However, they are both affected by food poverty. A sample size of 499 households was selected in the ratios of 217 and 282 in Busia and Vihiga respectively. In the determination of the sample size, various factors were considered including the precision required, confidence level and the resources that were available for the study. A large sample size was necessary to allow for both socio-economic and nutritional survey from the same respondents.

The principal objective of a sampling procedure is to secure a sample, which, subject to limitations of size, will reproduce the characteristics of the population, especially those of immediate interest to the researcher (Mwangi and Mbeche, 2004). The sampling procedure employed in this study was multi-stage stratified random sampling. This method was appropriate in cases where the research covers a larger geographical area, as was the case for this study. In stratified sampling the population was divided into several strata; districts, sex, and farm technologies. Each stratum was more homogeneous than the total population. Stratification was useful when a population was characterized as heterogeneous but consisted of a number of homogeneous sub populations or strata (Mwangi and Mbeche, 2004).

Multi stage random sampling takes place in stages. In the first stage, Western Province was purposely selected out of the eight provinces in the country. The researcher was interested in the province having conducted a similar study leading to a master's degree in 1996. Familiarity with the study area made the fieldwork exercise not only less costly but also quicker. The province has one of the highest percentages of people afflicted with food poverty despite having been under the government crop improvement programme for several decades and receives ample rainfall with suitable soils for crop production

In the second stage there was selection of districts within Western Province .The two districts were compared since they were contrasting in terms of physical, social and economic characteristics yet they had common problems of chronic food insecurity.

Finally, the third stage involved random selection of households within the districts using the lowest administrative unit, the sub location. Five divisions were randomly selected from each district for the study. They included; Luanda, Emuhaya, Vihiga, Sabatia and Tiriki East in Vihiga and Matayos, Funyula, Butula, Marachi and Nambale in Busia (Table 4.1).

At the fourth stage, a stratified random sampling technique was used to select farmers and households to be included in the formal survey. The households were subdivided into two main groups according to whether they grew traditional or hybrid varieties of maize. Households that grew traditional varieties of maize were classified as indigenous while those that grew hybrid maize were categorized as modern households. The classification was on the basis of the proportion of land put under either hybrid of traditional varieties. In total, 44.3% of the households who cultivated hybrid seeds were classified as modern while 55.7% that cultivated traditional varieties were classified as indigenous. The study assumed that farmers who grew hybrid maize also used other technologies such as fertilisers since hybrid maize was very responsive to proper soil nutrient management (basal and top dressing) and certain agronomic practices such as timely planting, weed management, spacing and plant density among others. Since the study had a gender bias, the households were further classified as; male headed, *de facto* female headed and *de jure* female headed. *De facto* female-headed households are those where women are heads temporarily because their husbands are away while in *de jure* female

headed households, the women are recognised as heads of the households and they do not receive any remittances from male partner except for maintenance of the children. They included households headed by widows, divorced and single women.

Purposive sampling was undertaken for participatory methodologies such as Focus Group Discussions. Purposive sampling was non-probability sampling where the items were selected deliberately by the researcher.

4.2.1 Selection of households to be interviewed

In both Vihiga and Busia, transects were used to select the specific households to be included in the sample for interview. The sub locations, which are the lowest administrative units, were the basic sampling units. Using sketch maps of the sub locations and with the help of village elders, various landmarks such as schools, markets, shopping centres and churches were identified and given numbers ranging from 1 to 9. After this, transects were drawn on the sub location maps using the landmark numbers that had been chosen randomly. For example if 1 and 4 was chosen, it meant that the transect ran from landmark 1 to landmark 4 and consequently systematic sampling was used along these transects where every 10th household on both sides (left and right) of the transect was interviewed. On average three to five transects were required to complete the total number of households per sub location. Table 4.1 shows how the households were distributed in the divisions. Sub locations with high population density had more households included in the sample.

Table 4.1 Number of households interviewed from each division in Vihiga and Busia districts

VIHIGA		*BUSIA*	
Divisions	***No. of households***	***Divisions***	***No. of households***
Luanda	59	Matayos	50
Emuhaya	57	Funyula	39
Sabatia	58	Butula	38
Tiriki East	45	Marachi	31
Vihiga	63	Nambale	59
Total	**282**	Total	**217**

Source: Household survey data, 2006-2007

4. 3 DATA COLLECTION METHODS

4.3.1 Secondary data

The secondary data were obtained from sources such as Ministry of Agriculture reports at the national provincial and district level, various libraries such as Central Bureau of Statistics (CBS), Food and Agricultural Organization (FAO), International Centre for Research in Agro Forestry (ICRAF), World Bank, Non-Governmental Organizations (NGOs) and universities which continued throughout the study.

4.3.2 Primary data

A pilot survey of farm households in the two districts was conducted with the aim of testing the research tools in February 2006. Thereafter, data collection (qualitative and quantitative) was done in both districts between March 2006 and March 2007.

Pre-tested semi-structured questionnaires were completed through the interview of household heads; however in their absence senior members of the households were used. In cases where all were not available no replacement was done. The main data sets were on household characteristics in terms of age, gender, education level, occupation as well as socio-economic profiles such as farm sizes, land tenure system, credit availability, efficiency of extension system, resource availability, control and access of resources by household members, and nutrition and health characteristics of household members especially children and women (Appendices 1) (Grosh and Glewwe, 2000). Other important data was on production and consumption particularly of staple crop, maize and expenditure on farm inputs such as labour, seeds, fertilizers and production tools.

Key informant interviews were used to collect data from administrative leaders, officials of women groups, credit providers, extension officers, stockists of farm inputs, government officers and other stakeholders in agriculture. Data from key informants was on aspects such as types of seed varieties grown in the province in general and in the districts in particular, fertilizers, production trends, methods used in dissemination of the technologies among others.

Observation formed an integral part of data collection due to the nature of the study. A transect walk through the farm provided insights into the differences between household members, farm technologies being used and living conditions in general. It also helped to cross check the verbal data that was collected through interviews, questionnaires and FGDs. During the transect walk the researcher was accompanied by some members of the household, through this interaction was able to gain insights in intra household relations. This acted as a listening survey that allowed deeper understanding of social relations, attitudes, norms and taboos about production and gender-based ownership and control of assets.

4.3.2.1 Nutritional status of children

In addition to the socio-economic survey, analysis of nutritional status of women and children was undertaken. Anthropometrical measurements (weights and heights) were taken for all the children between 6 and 60 months, using wooden board (lengths and heights) and a scale (weight) .The weight and height were recorded on record sheet that had details about the name, age and gender of the child (Appendix II a). Likewise the mothers of the children were measured for their heights and weights and other information recorded (Appendix II b). Only the children and women who belonged to the same households were examined for nutrition status.

The best way to evaluate the nutritional status of a child was to compare the child's growth indices with a set of cut –off points in the standard normal distribution of well-nourished children that were associated with adequate growth (Salah et al., 2006; UNICEF, 1998; Lawal, 2004;WHO,1983,1983;UN,1986;*www.who.int/nutrition/en;www.who.int/childgrowth/training/measuring-part1.pdf).* The results were compared with the US National Centre for Health Statistics (NCHS) standards since no comparable Kenyan or African standards have been developed. These revealed the numbers of stunted, wasted and underweight children. Three variables were measured; weight- for- height/length index measured degree of **wasting,** height -for -age index measured the degree of **stunting** and weight -for -age measured the degree of **underweight**.

EPI Info software (version 5) was used for data entry and analysis. A total number of 199 children were examined for various indices namely; WHZ (wasting), HAZ (stunting) and WAZ (underweight).Cut of points were used to grade both over and under nutrition. Each of the indicators was expressed in standard deviations (Z-scores) from mean of the reference population which was the U.S National Centre for Health Statistics (NCHS). A Z-score of below -3 indicated severe conditions of either stunting, underweight or wasting. Between -3 and -2 was moderate to mild conditions while above -1 indicated normal or well nourished children (Table 4.2) (World Bank, 1995; *http://www.who.int/nutrition/en).*

There are various methods used to collect nutrition data for children. One can use Gomez height for age, Waterlow height for age and weight for height or use of upper arm circumference. We

chose to use Waterlow criteria because they incorporate both weight and height of a child which was more sensitive to child wasting and depicted acuteness of nutritional disorder (WHO, 1986). Weight showed the current state of the body's store of energy while height summed up the past history of body's growth (*http://www.who.int/nutrition/en*).

The weight was measured using a scale (with maximum 25 kg) while height was taken using wooden board. Children below 2 years who were unable to stand were measured their recumbent length while those above 2 years their height was taken while standing in an upright position. Standing height was about 0.7cm less than recumbent length (WHO, 2006). If a child was less that 2 years old and couldn't lie down, their height was measured and 0.7cm added to convert to length (WHO, 2006). If a child aged 2 years couldn't stand recumbent length was taken and 0.7cm was subtracted to convert to height (WHO, 2006) (*http:// www.who.int/gdgmwho/p-child_pdf).* For purposes of weight, the children who were unable to stand on the bathroom scale, the mother's weight was subtracted from total weight of mother and child to obtain the child's weight.

Table 4.2 Waterlow classification system

Z-score	*Nutritional status*
Less than –3	Severely undernourished
–3 to –2	Moderately undernourished
–2 to –1	Mildly undernourished
–1 to 3	Adequately nourished

Source: World Bank (1995), Alawia and Grobler (1991)

4.3.2.2 Nutritional Status of women

Diagnosis of Chronic Energy Deficiency (CED) was used to measure the nutritional status of women (Appendix IIb). This was done through measuring body weight in relation to height

expressed as Body Mass Index (BMI). This was derived by dividing weight in Kilograms by square of height in metres and was applied on women in reproductive age (15-49 years) and particularly to those who had children between 6 and 60 months. We used the Salter bathroom scale with an accuracy of 100g (±100grams). For height, adjustable wooden measuring board specially designed for use in the field (accurate to nearest 0.1centimetres) was used. According to WHO standards the scale had the following characteristics all of which were considered;

i. It was solidly build and durable
ii. Was electronic (digital reading)
iii. Measured up to 150 kg
iv. Measured to a precision of 0.1kg (100g)
v. Allowed tarred weighing (the scale could be set to zero with the person being weighed still standing on it)

Information on women's age, height and weight was collected using a record sheet and later the data was analysed in Statistical Package for Social Sciences (SPSS) .A BMI under 16 indicated severe Chronic Energy Deficiency; 16-18.0 indicated moderate CED while between 18 and 24.9 indicated normal. Women with BMI of 25 and above were classified as overweight.

The weight of a woman alone was an indicator of the overall health and nutrition status. Women with weight less than 40kg had high risk of giving birth to underweight babies and other delivery related complications that were fatal (GoK, 1998). Height on the other hand was a measure of past nutritional status (under nutrition in childhood) or it was as a result of genetics. On average women in Kenya between 15 and 49 ages were observed to have BMI of 23. Index of 18.5 was the cut-off where 25 and above indicated obesity or overweight while below 18.5 indicated underweight, below 16 was severe thinness. Western province has Mean BMI of 22.1 (GoK, 2003) while 145cm was cut off height for women with the mean height of 159cm. The study sought to find out the extent to which women height and weight deviated from the average in the province and the nation. Only women who were included in the household survey together with their children were examined for BMI .Women whose children were outside the age group were not examined for nutritional status. Likewise children whose mothers were not present were not examined.

4.3.2.3 Focus Group Discussions

Focus group discussions are the most important participatory methodology used in this study. In total 3 FGDs were conducted in each district. Each F.G.D constituted 10 farmers purposively selected from the sample. The F.G.D had male only groups, female only groups and mixed groups. The FGD guide was developed using the main themes of the research especially those related to gender dynamics such as gender roles and gender related constraints affecting use of technologies. The group discussions had the advantages of allowing information to be collected quickly and economically, the collection of accurate information and interaction between the researcher and the respondents (Mwanje, 2001b). The tool also helped us to understand a topic holistically rather that through its separate parts. Data therefore was detailed, descriptive and highly contextual.

Participatory methodologies helped in understanding the households' motivations, constraints and strategies. It was recognised that the households had different opportunities or followed different strategies due to differences in factor endowments and environments, the multiple goals that they had to meet, their perception of the riskness involved in different enterprises and the social factors that determined intra household relationships (Sands, 1986; Mettrick, 1993). The purpose of participatory methodologies was to gather information from a larger number of people at the same time. This helped in gathering details that were overlooked in the semi-structured interviews. Participatory methodology proved to be a useful method of collecting information from respondents who would otherwise be shy during interviews. Participatory methodology was useful in gathering data from a wide range of people within a community, including the poorest and the uneducated in addition to creating awareness that facilitates change.

During the FGDs the following activities were undertaken;

a) Seasonal diagrams

These diagrams or calendars showed changes that affected households, communities or regions within a year. They included climate, crops, labour availability, demand, and prices. The

diagrams highlighted times of constraints and opportunity. In this study the diagrams included traditional and hybrid maize growth cycle and seasonal labour demand (Appendix 4a and b).

b) Socio-cultural profiles

These detailed descriptions of social and cultural dimensions that, in combinations with technical, economic and environmental dimensions served as a basis for design and preparation of policy (Mettrick, 1993). They included data on type of community, demographic characteristics, economy, livelihood, land tenure, natural resource control, social organization that affected access to power and resources, conflict resolution mechanisms, values and perception (Mettrick, 1993). This helped to understand whether the technologies adopted in the area were culturally and socially appropriate and sustainable.

c) Analysis of tasks

This was important in understanding the distribution of activities according to gender. The farmwomen's productive and reproductive roles were analysed through this method. Daily calendar for men and women was developed using this tool (Tables 5.21 and 5.22, Appendix IVa and IV b).

4.2 STUDY VARIABLES

a) Level of education of household head

This was measured in terms of the level of education the household head had attained (primary, secondary, university) Exposure to education increased the ability of the household head to make decision on various technologies, better agronomic practices and the nutrition of the household members. The level of education attained by the household head was grouped into six groups namely; no education, non-formal education, primary education college (post -secondary) and university education.

b) Age and gender of household head

The age determined production through the experience the farmers gain. However, younger farmers were most likely to be more innovative, practise better land management methods and

adopt new technologies than older farmers. Female-headed households were assumed to have fewer resources and therefore more vulnerable to food insecurity and under nutrition than male-headed households. Household head was the person who had the decision-making authority over the allocation of household resources

c) Farm size

The land was considered the most important resource among the smallholders and it was assumed that the larger the farm size the higher the production and the more food secure the household would be. Farm size was measured in acres and then converted into hectares for easier comparisons with other studies.

d) Access to credit and extension services

Financial constraint was the most important hindrance to higher productivity hence access to credit facilities would help the farmers to afford farm inputs and other technologies necessary for improving food security. This was measured in terms of the quantity of credit that the farmers had received and whether or not it was used for production or consumption purposes as well as access to credit provision facility (bank, cooperative).

Access to extension service be it government or private sector oriented was crucial in proper utilization of technologies. This was measured in terms of the number of physical contact the farmers had with extension officers and the nature of advice that was given. Physical contact with extension officer included either the farmer visiting agriculture training centre or an extension officer visiting the farmer on the farm. The assumption was that the higher the number of contact with extension officer the higher the likelihood of efficient use of technologies.

e) Weight of food received in the household

All the food either through own production, purchases, or donations was measured in kilograms.

f) Household income (Ksh)

The gross household income was calculated in Kenya shillings as the sum of the value of marketed output, wage (off-farm) income, dairy income, poultry income and value of livestock sold.

g) Household expenditure (Ksh.)

Household expenditure was calculated by adding the sums of monies spent on purchase of seeds, hired labour, fertilizers, sprays, hiring of ox-ploughs, loan repayment and food.

h) Yield of hybrid maize (Kg)

Yield of hybrid maize was measured in physical terms (Kg) and value (Ksh.).

i) Seeds and fertilizer input (Kg)

Seeds and fertilizer input was measured in physical units (Kg) as well as value (Ksh.).

j) Household food consumption (Ksh)

Household food consumption is the difference between the value of total production and the value of marketed surplus.

4.5 STATISTICAL ANALYSIS OF DATA

4.5.1 Descriptive statistics

Descriptive statistics such as frequency tables and measures of central tendency and variance were useful in exploring the data in order to determine its reliability and suitability for other statistical tools and also to summarise baseline data. Frequency distribution showed the distribution (or the count) of individual scores in a sample for a specific variable. A frequency table indicated 'how many times' each response occurred. Cross tabulation produced two-way or multi-way tables that showed the frequency responses and the relationship among two or more variables.

4.5.2 Simple Regression analysis

Simple regression analysis was employed to find the relationship between the different technologies and food security and between the different types of households and food security.

The formula used was as follows (Mugenda and Mugenda, 2003);

$Y=ß_o+X_1+E$ **(1)**

Where;

Y = the dependent variable

$ß_o$ = the constant or intercept

$ß_1$ = the slope or change in **Y** given one unit change in X_1

X_1 = the independent variable

E = the error term

The formula was used to yield a coefficient of determination or R^2 which refers to the amount of variation explained by the independent variable (Mugenda and Mugenda, 2003).

4.5.3 Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) technique was used in to measure the effect of expenditure on farm inputs on maize yield comparing different households that use different varieties of fertilizers, HYV seeds and other technologies as well as between two districts, Busia and Vihiga. The basic principle of ANOVA was to test for differences among the means of populations by examining the amount of variation **within** each of the samples relative to the amount of variation **between** the samples.

Analysis of Variance (ANOVA) was used to compare two or more means to see if there were any reliable differences among them (Tabachnick and Fidell 2001). ANOVA technique was used in comparing impact of technology on maize yield. . The total amount of variation in a set of data was broken down into two types, that amount which was attributed to chance and that amount that which was as a result of specified causes (Harnet and Murphy, 1975). An F ratio was calculated and represented the variance between the groups divided by the variance within the

groups. A large F ratio would indicate more variability between the groups (caused by the independent variable), than there was within each group (referred to as the error term).

The null hypothesis was that $\mu_1 = \mu_2 = ... = \mu_k$ as estimated from $y_1=y_2=...=y_k$ with **k** equals to the number of means being compared (Tabachnick and Fidell 2001; Mugenda and Mugenda, 2003). There were two types of ANOVA namely one-way between/within groups ANOVA and two-way between/within groups ANOVA. One way between groups ANOVA was used when there was one independent (grouping) variable with three or more levels (groups) and one dependent continuous variable. Two-way ANOVA means that there were two independent variables (expenditure on fertilizer and household types) and one dependent variable (maize production).The advantage of using this tool was that it was possible to test the 'main' effect for each independent variable and also explore the possibility of an 'interaction effect' (Tabachnick and Fidell, 2001; Coakes and Steed, 2003; Mugenda and Mugenda, 2003).

Two-way between groups ANOVA was also used to test the impact of two independent variables (household type and main tool of production) and one dependent variable (maize production).This technique allowed us to measure whether there was significant difference in maize produced in different households (male headed, *de jure* female headed, *de facto* female headed), production in relation to main tool of production (hoe, wheelbarrow, ox plough) and joint effect between the two independent variables.

Steps in ANOVA

The following steps were followed in one -way (or single factor) ANOVA;

i. We obtained the mean of each sample as follows

$$\bar{X}_1 \bar{X}_2 \bar{X}_3 ..... \bar{X}_k \qquad (2)$$

Where there are k samples

ii. We worked out the mean of the sample means as follows:

$$X = \frac{\bar{X}_1 + \bar{X}_2 + \bar{X}_3 ..... + \bar{X}_k}{\text{Number of samples } (K)} \qquad (3)$$

iii. The fourth step involved taking the deviation of the sample means from the mean of the sample means and calculating the square of such deviations which may be multiplied by the number of items in the corresponding sample and then their total obtained. This is known as the Sum of Squares (SS) between the samples.

$$\text{SS between} = n_1 (X_1 . \overline{X})^2 + n_2 (X_2 . \overline{X})^2 + \ldots (X_k . \overline{X}) \qquad \textbf{(4)}$$

iv. The results of step four above were divided by the degrees of freedom between the samples to obtain variance or mean squares (MS) between the samples;

$$\text{MS between} = \frac{\text{SS between}}{\text{K-1}} \qquad \textbf{(5)}$$

K-1 is degrees of freedom between samples

v. We obtained the deviations of the values of the sample items for all the samples from corresponding means of samples and calculated the squares of such deviations and then obtained their total. This sum of squares is known as the sum of squares for variance within samples (SS within).

$$\text{SS within} = \Sigma(X_{1i} - \overline{X}_1)^2 + \Sigma(X_{2i} - \overline{X}_2)^2 + \ldots + \Sigma(X_{ki} - \overline{X}_k)^2 \qquad \textbf{(6)}$$

$$i = 1, 2, 3\ldots$$

vi. The result of step six above is divided by the degrees of freedom within samples to obtain the variance or mean squares (MS) within samples.

$$\frac{\text{MS within SS within}}{\text{(n-k)}} \qquad \textbf{(7)}$$

Where n-k represent degrees of freedom within samples,

n =total number of items in all the samples i.e $n_1 + n_{2+\ldots} + n_k$

k=Number of samples

vii. This step involves the calculation of the sum squares of deviations for total variance as follows

SS for total variance =SS between +SS within **(8)**

viii. Finally we calculated the F-ratio as follows

$$\text{F- Ratio} = \frac{\text{MS between}}{\text{MS within}} \quad \textbf{(9)}$$

Where MS is mean of squares

The ratio is used to make judgements whether the difference among the samples means are significant. If the value of F is less than the table value the difference is taken as insignificant (Kothari, 2001; Mwanje and Gotu, 2001)

4.5.4 Factor Analysis

Factor Analysis, a multivariate technique was used to resolve a large set of measured variables in terms of relatively few categories known as factors. The technique was used to analyse the various variables that determined the choice of various farm technologies and the factors that made some households to be or not to be food secure. The mathematical basis of factor analysis concerned a data matrix (score matrix) symbolised as **S**. The matrix contained scores of **N** persons of **k** measures. A factor is any linear combination of variables in a data matrix (Kothari, 1990; Pallat, 2003; Tabachnick and Fidell, 2001).

Factor Analysis (Pallant, 2001: Tabachnick and Fidell, 2001: Mwanje, 2001a), in this study was important given the complex nature of the factors that caused food insecurity. Factor Analysis is a multivariate statistical technique commonly used in social sciences and physical sciences. The technique is widely used in agricultural studies where production is determined by many variables .The technique seeks to resolve a large set of measured variables in terms of relatively few categories known as *factors.* In this study the technique was used to analyze the various variables that determined the choice of various farm technologies and the factors that made some households to be or not to be food secure.

Factor Analysis summarizes data using a small set of 'factors' or 'components'. There are two related techniques in factor analysis namely Principal Components Analysis (PCA) and Factor Analysis (FA) (Tabachnick and Fidell, 2001; Franfort-Nachmais and Nachmias 1996). Although both techniques produce a small number of linear combinations of the original variables that account for variability in the pattern of correlations, PCA was used because of its strength in providing an empirical summary of the data set. In this study exploratory approach of factor analysis was used in order to explore the inter- relationships among a set of variables

The **Kaiser method** one of the methods of PCA developed by Kaiser in 1959 was used in this study. The method assumed that all principal components with Eigen values greater or equal to one were significant. The other method known as the **Scree method**, which would have been used in finding the appropriate number of orthogonal vectors of practical significance in the factoring was not employed. The latter method would have assumed that the component variance approached some constant value when components would measure random errors. The other methods would have been the use of **logarithm of Eigen values** and **sampling error of the Eigen values**.

The following steps were involved in PCA in Kaiser Method (Kothari, 1990);

(a) Correlation coefficients between the pairs of k variables was worked out and arranged in form of a correlation matrix. The sum of coefficients in each column was obtained. This was referred to as U_{jl} and when U_{jl} was normalised it become V_{jl} This was done by

squaring and summing the column sums in U_{j1} and then dividing each element in U_{j1} by the square root of the sum of squares (known as normalising the factor). Then the elements in V_{j1} were accumulatively multiplied by the first row in the matrix in order to obtain the first element in the new vector U_{j2}. The process was repeated until the principal first factor was derived.

(b) To obtain factor B (second principal component) we sought solutions for V_b and the actual factor loadings for second component, B. The same procedure was done as above. This procedure was also used to obtain other principal component factors.

(c) A decision was made on the number of principal components to retain in the study using the Kaiser method.

(d) The principal components that were extracted and retained were rotated to enhance the interpretability of the factors.

(e) Communality (h^2) was worked out and it showed how much of each variable was accounted for by the underlying factors taken together.

(f) The variables were then regressed against each factor loadings and the resulting regression coefficients was used to generate what were known as factor scores that were then used in further analysis.

Nineteen (19) variables that affected production of maize which in this study was an important indicator of food security, were subjected to Principal Component Analysis using SPSS (Table 5.22). Before performing the PCA, it was important to test the suitability of the data for factor analysis by examining the strength of correlation using evidence of coefficiencies greater than .3. Apart from the coefficiencies, two statistical measures namely Bartlett's test of sphericity (Bartlett, 1954 cited in Tabachnick and Fidell, 1996) and the Kaiser –Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974 cited in Tabachnick and Fidell, 1996) were used. On checking the data using the Kaiser –Meyer-Olkin (KMO) value was found in this study to be 0.662 which is slightly above the recommended value of .6 and the Bartlett's test of Sphericity reached statistical significance supporting the factorability of the correlation matrix. The scale was also checked for internal consistency through reliability analysis. According to Tabachnick and Fidell (1996), the scales for factor analysis had a good internal consistency with a cronbach alpha coefficient reported of 0.744

4.5.5 Qualitative data analysis methods

Most of the qualitative data was obtained through participatory methodologies .The qualitative data were summarised in charts and diagrams showing resource allocation, daily calendar for men and women and division of labour according to gender.

4.6 ETHICAL CONSIDERATIONS

This study involved human subjects hence effort was made to uphold the well being, values and dignity of the respondents. Various underlying ethical principles were followed. Such principles included; formal approval from relevant authorities, informed consent of respondents and confidentiality of information provided.

CHAPTER FIVE: PRESENTATION OF RESULTS AND DISCUSION

5.1 INTRODUCTION

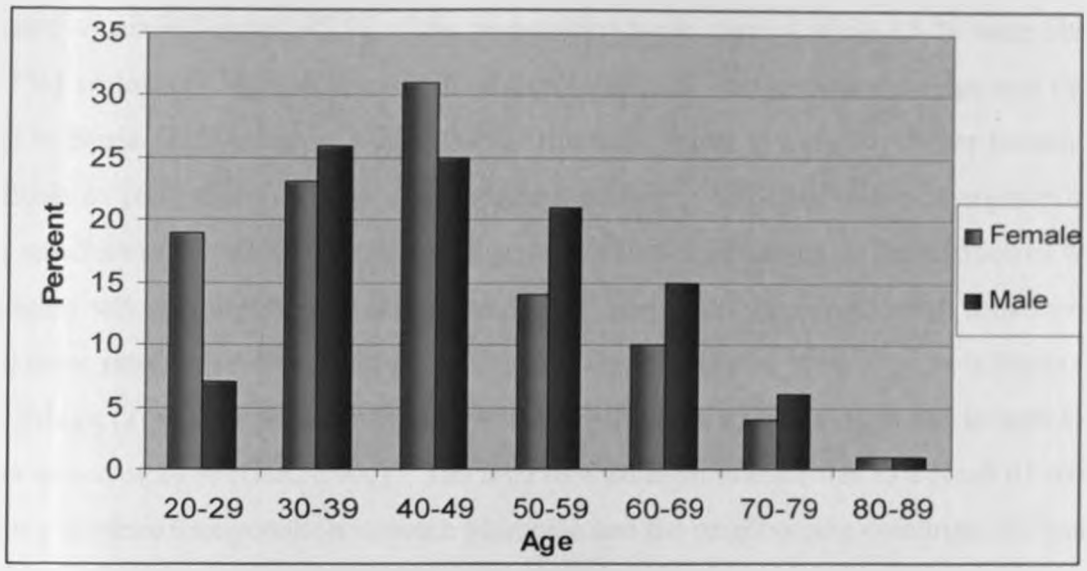
The chapter is divided into five sections namely, current status of technology use, impact of technology on food security in different households, gender specific constraints influencing technology use and food security and role of financial and human capital on household food security. Discussions and conclusions on the findings of the study are also provided.

5.2 CHARACTERISTICS OF HOUSEHOLDS IN BUSIA AND VIHIGA DISTRICTS

This section provides the general characteristics of the study area which gives a framework for the presentation of the results on specific objectives in the subsequent sections.

5.2.1 Household characteristics

Figure 5.1 presents results of age of household heads. The household heads in the two districts fell in the 20-89 age brackets with a mean age of 44 years. Majority of the respondents fell within 40-49 age brackets and comprised of more females than males (Figure 5.1). The limited number of households heads below 40 years of age is an indication of the high rate of migration of the young people to urban areas.



Source: Household survey data, 2006-2007

Figure 5.1: Age of household heads

Women respondents formed the majority at 57 % while male respondents comprised of 43 %. Women formed larger percentage of farm labourers due to high rate of migration of men to urban centres in search of jobs. There was variation in gender characteristics where Busia district had more females (62.7 %) than males (37.3 %) while in Vihiga, the difference between females and males was not large (52.5 and 47.5% respectively) (Table 5.1).Even though majority of the men lived away, they visited their household on weekly, monthly and yearly basis depending on need and financial capability. They also sent remittances that were used for both consumption and agricultural production.

Table 5.1: Gender of respondents

District		**Number of households**	***Percentage of household***
Busia	Female	136	62.7
	Male	81	37.3
	Total	*217*	100.0
Vihiga	Female	148	52.5
	Male	134	47.5
	Total	*282*	100.0

Source: Household survey data, 2006-2007

With regard to marital status, 85 % of the respondents were married while 15 % were either single (3 %) widows (9 %) widowers or divorced (Table 5.2). Polygamous marriage was more prevalent in Busia (25 %) than in Vihiga (9 %). This contributed to a slightly larger household size in Busia as compared to Vihiga. Polygamous marriage in Busia led to the emergence of a complex structure of household control and access to resources depending on the position of wife (among other wives), number of children and their gender, with those with more sons having access to more resources such as land for cultivation. There were also more widows in Busia (11 %) than Vihiga (7 %). The high percentage of widows in Busia could be attributed to high HIV Aids prevalence of 20 % (GoK, 2000). The high HIV Aids prevalence was as a result of cross-border long distance transportation between Mombasa and the neighbouring countries of Uganda and Rwanda (Amuhaya and Opondo,2003; GoK,2000).

Table 5.2: Marital status of respondents

District	*Marital status*	*Frequency*	Percent
Busia	Single	6	2.8
	Married monogamous	128	59.0
	Married polygamous	55	25.3
	Widow	25	11.5
	Widower	1	.5
	Divorced	2	.9
	Total	**217**	**100.0**
Vihiga	Single	11	3.9
	Married monogamous	218	77.3
	Married polygamous	25	8.9
	Widow	20	7.1
	Widower	6	2.1
	Divorced	2	.7
	Total	**282**	**100.00**

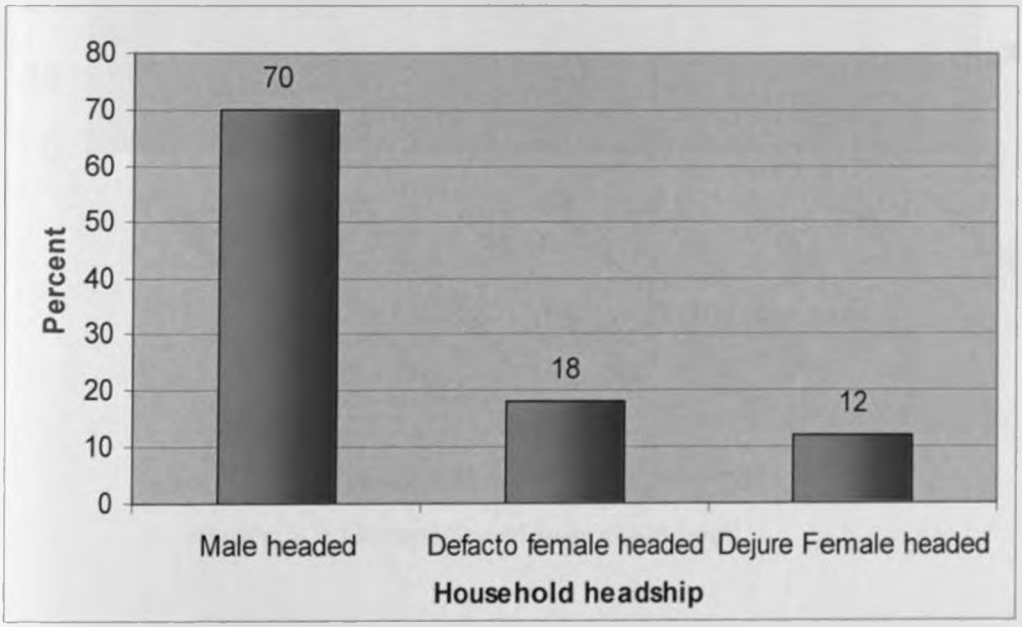
Source: Household survey data, 2006-2007

The average household size was 4.9 in the two districts. However Busia had a higher household size of 6 while Vihiga had 4.7. This included all family members, unmarried daughters, sons,

their wives and children living in same compound and eating from one pot. The households lived on 1.3 and 0.65 hectares of land in Busia and Vihiga respectively.

A large household size may perpetuate poverty due to competition over resources especially land. There is however, a potential for increase in human capital in form of labour as well as income if investment is made in education of the household members. Likewise, in polygamous households such as those in Busia, married women are most likely to be poor as compared to those in monogamous households.

From Figure 5.2 we see that majority of households were headed by men (70 %), 12 % *de jure* female-headed households while 18 % were *de facto* female -headed households (Figure 5.2).



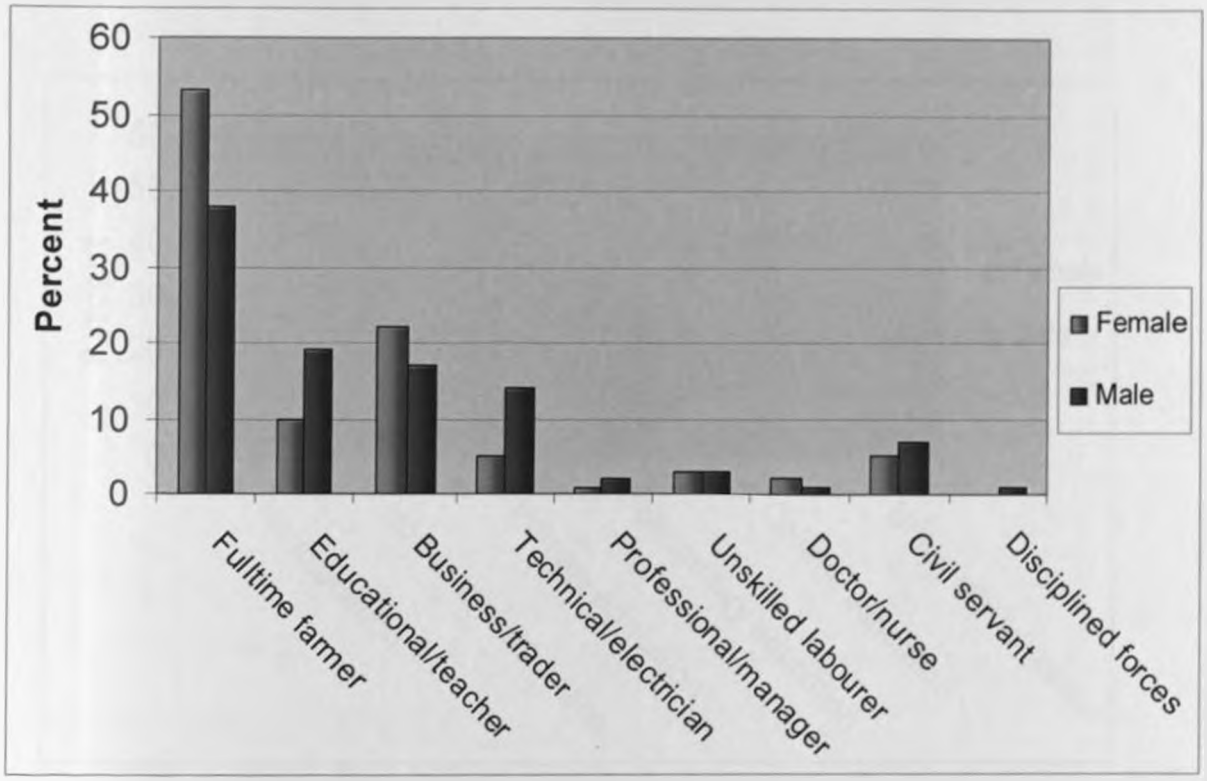
Source: Household survey data, 2006-2007

Figure 5.2: Household headship

5.2.2 Occupation of household head

Over 50 % of the women in the survey were fulltime farmers and more women than men were traders. Majority of men were teachers, technicians and civil servants (Figure 5.3). This not only signified the predominance of women as food producers for their households and the nation but also the discrepancy in education levels attained by men and women. Men were more likely to have attained higher education levels than women hence most of them were employed in formal

sector while women, due to low education levels, concentrated on informal sector and agriculture.



Source: Household survey data, 2006-2007

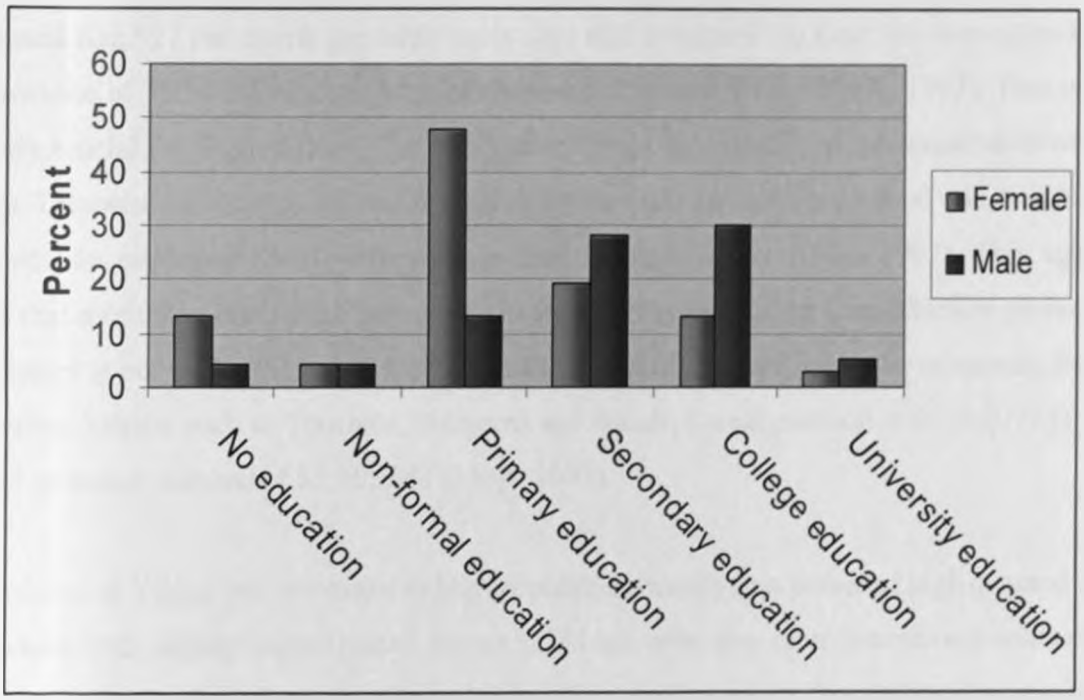
Figure 5.3: Occupation of household head

5.2.3 Education of household head

Farmer's education played important role in food production and interpretation of information for purposes of agricultural production. Education of household head affected decision making ability and influenced future investment decisions in agriculture. Education also improves the household wellbeing through the opportunities that it provides for employment as well as access to important information that may be of benefit to the household.

From Figure 5.4 we observe that majority (40 %) of household heads had primary education, 23 % had secondary and 21 % college education. Only 3 % of the household heads had attained university education. There was geographical variation in education with Busia having more

household heads with either no education or limited non-formal education (19 %) while Vihiga had only 8 and 4 % respectively in the same category. Likewise there was gender disparity in education level with more women than men having no education. While majority of women had primary level education, men had secondary, college level and university education (Figure 5.4)



Source: Household survey data, 2006-2007

Figure 5.4: Education level of household head according to gender

5.2.4 Household income

5.2.4.1 Income from farming

The households in Western province practice crop and animal husbandry both for subsistence and income generation. The main cash crops were maize, tea, cotton and horticultural crops such as fruits (bananas, pawpaw, avocadoes, passion fruits, mangoes) and vegetables (kales, cow peas, tomatoes, onions and indigenous vegetables). Cotton and sugarcane were major cash crops in Busia and tea in Vihiga, all being grown by smallholders. However, as indicated in chapter one the study excluded households that grew such cash crops. Households kept cattle and poultry as a

source of income to meet other household needs such as paying school fees, building houses and for meeting social obligations. Table 5.3 indicates the mean income derived from agriculture. Households in Busia earned a mean annual income of Ksh. 9,637 while those in Vihiga obtained slightly higher income of Ksh. 12,045. This accounted for Ksh.803 and Ksh. 1003.75 per month for Busia and Vihiga respectively. Income from crop production alone averaged Ksh.3, 627 per annum in Busia and Ksh. 4,250 per annum in Vihiga district. This income was much less than the estimated Ksh.927 per month per adult equivalent that is required to meet the recommended daily allowance of 2,250 calories per adult per household in rural Kenya (GoK, 1997). This was particularly crucial for Busia district. The implication is that the majority of the households were food poor. Likewise, in order to afford an adult equivalent of basic minimum food and non-food requirement, an estimated Ksh.1, 239 was required in rural Kenya (GoK, 1997). This again indicates that more than half of the population in the study area suffered from absolute poverty. Vihiga district is not self-sufficient in food production. The district is a net buyer of cereals from neighbouring districts such as Tranzoia, Bungoma and Nandi. Cereal production is 38,077MT as compared to annual demand of 85,705 MT (MoA, 2005).

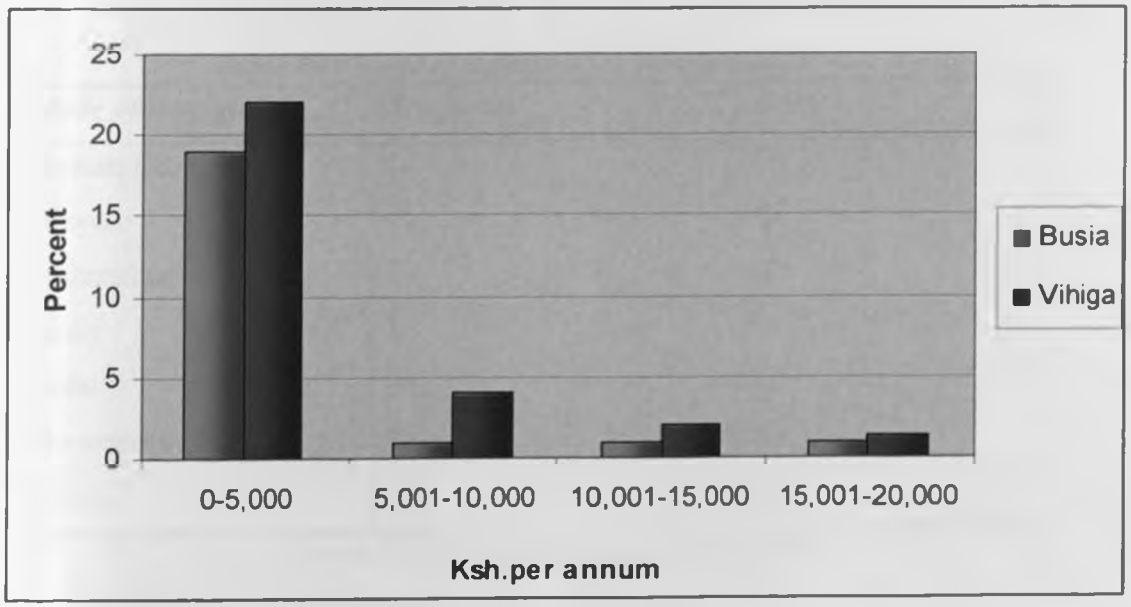
Higher income in Vihiga was attributed to high population density that provided high demand for farm produce with slightly higher prices. Farms in Vihiga were also more intensively cultivated due to land scarcity than those in Busia. High value crops such as horticultural crops and vegetables were also more widely grown due to more wet conditions and ready market as compared to Busia where some divisions such as Funyula and Budalangi were generally dry.

Table 5.3: Average income from agriculture (N=499)

Districts	*Crop production (Ksh/annum)*	*Animal husbandry (Ksh/annum)*	*Total mean income (Ksh/annum)*
Busia	3,627	6,010	9,637
Vihiga	4,250	7,795	12,045
Total	7,877	13,805	21,682

Source: Household survey data. 2006-2007

Figure 5.5 indicates that majority of households in Busia (19 %) earned below Ksh 5000 per annum while in Vihiga a slightly higher percentage of 22 % earned the same amount. More households in Vihiga (6.7 %) attained crop income of between Ksh.5000 and Ksh. 20,000 as compared to Busia (3.6 %). The small proportion of the households who reported to have received some income from crop sales is a clear indication of the subsistence nature of production in the study area.



Source: Household survey data. 2006-2007

Figure 5.5: Annual mean incomes from crop sales

According to Table 5.4 majority of households (75 %) sold their farm produce to the nearest market while 25 % sold through middle persons. Table 4.5 indicates that human transport was used by 59 % of the households while 35 % used bicycles. This was despite the markets being very far (2.1 km and 1.5 km for Busia and Vihiga respectively). The predominant use of human transport in the two districts could be attributed to poor state of infrastructure that increases the cost of travel coupled with high levels of poverty that affects affordability.

Table 5.4: Marketing of farm products

Methods used to dispose off fa produce	*Frequency*	**Percent**
Local market	103	20.6
Middle person	34	6.8
Total	137	27.5
No response	362	72.5
Total	499	100.0

Source: Household survey data, 2006-2007

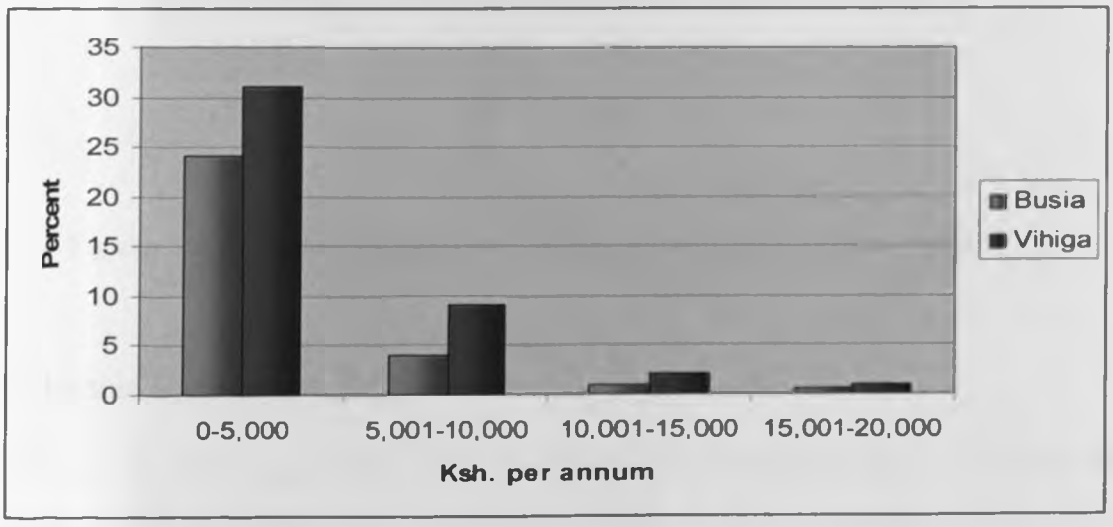
Table 5.5: Mode of transport for farm produce

Mode of transport	*Frequency*	*percent*
Human transport	80	16.0
Bicycle	47	9.4
Matatu/bus	7	1.4
Lorry	3	.7
Total	137	27.5
No response	362	72.5
Total	499	100.0

Source: Household survey data, 2006-2007

5.2.4.2 Income from animal husbandry

Animal husbandry was observed to be an important economic activity in the two districts. Households practised mixed farming in order to ensure availability of food throughout the year. Livestock such as cattle, goats, sheep and poultry were a form of investment which the households fell back on as source of income for production, consumption, children's education, including emergencies like funerals as well as cultural obligations for example paying dowry. A large percentage (83 %) of households kept cattle while all the households had some poultry due to its importance in the culture of the local people. Less than half (37 %) of the households in the survey had received income from livestock husbandry. Livestock income averaged Ksh. 6,010 per annum in Busia and Ksh.7, 795 in Vihiga. In Vihiga, livestock production accounted for 15-20 % of the household income and only 10 % in Busia. High income in Vihiga was attributed to dairy farming where zero grazing was practiced due to limited land resources. This was particularly an important activity in Vihiga, Sabatia and Tiriki divisions. However, in Busia open grazing was common and large percentage of land area received unreliable rainfall with long dry spells thereby limiting dairying in some areas. In both districts animal husbandry was affected by such constraints as poor breeds, inadequate capital, poor husbandry and inadequate management of diseases and pests.

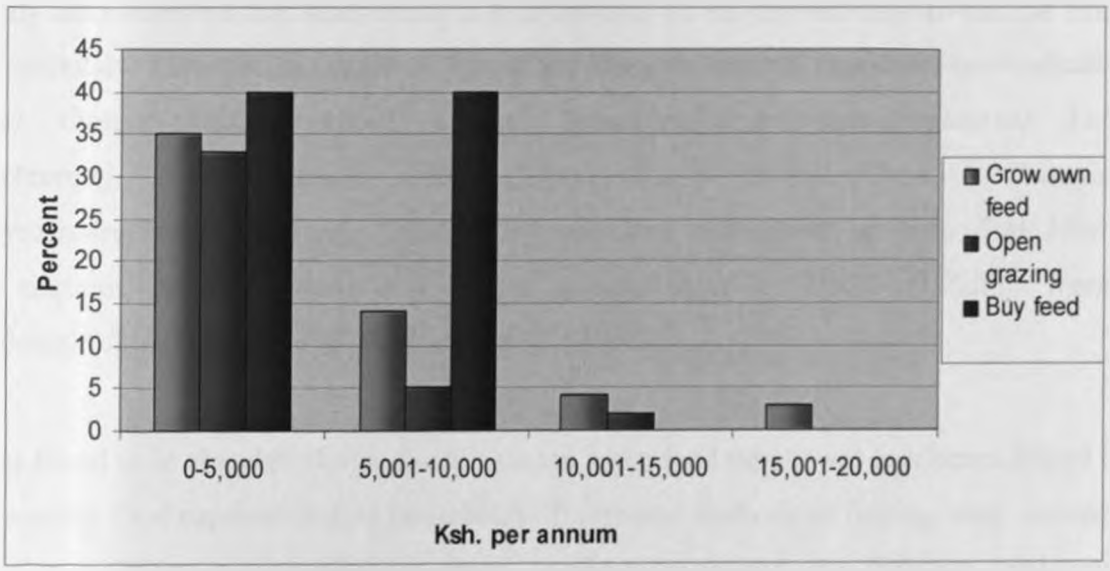


Source: Household survey data, 2006-2007

Figure 5.6: Annual income from animal husbandry

According to Figure 5.6 majority of households in the two districts received an average of less than Ksh.5000 from livestock. Similar to crop income, livestock income was also higher in Vihiga than in Busia. Figure 5.7 shows variation of income in relation to sources of animal feed, those who grew own food (an indication of higher intensity of production) received higher income than those households where open grazing was practiced. Poultry and their products such as eggs were sold as well as consumed at home.

Insects were found to be major sources of protein in Busia unlike Vihiga. They included *monge* (white ants) *agoro, otaro and onyoso* (termite varieties). They were trapped by farmers and sold to earn income.



Source: Household survey data, 2006-2007

Figure 5.7: Relationship between feeding method and livestock income

5.2.4.3 Income from off farm activities

According to the survey, proximity of the two districts to major towns such as Kisumu, Busia, Kakamega and Mbale meant that many residents sought off farm employment. There were also other activities such as masonry, trade, service sector (such as cyclists locally referred to as *boda boda*) which provided income to the locals. There was a high incidence of emigration in the two

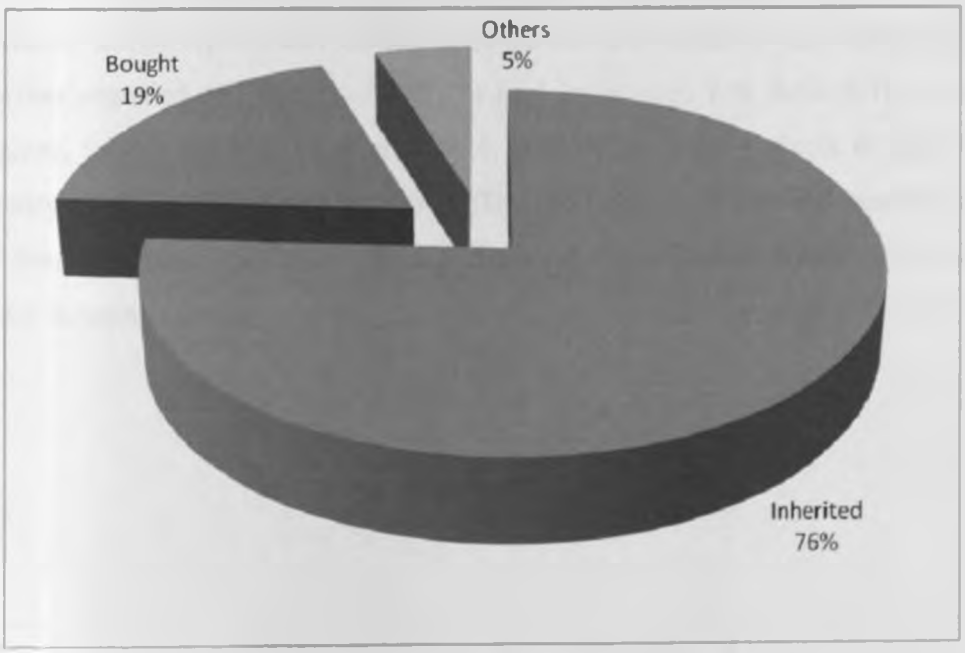
districts with 18 % of the households being *de facto* female headed. The study found out that due to land scarcity many households in Vihiga looked for livelihood off-farm especially in trading activities in district headquarters and markets such as Mbale and Chavakali. The tea factory located at Mudete market along Kaimosi-Chavakali road and the milk processing factory also absorb some labourers. There was also wage labour on the farms especially tea picking from the smallholder farms. High intensity of trading activities in Vihiga district was evidenced by very short distances to nearest shops/markets (1.5 km) as compared to 2.1 km in Busia. This was because of limited off- farm activities in Busia district. However, those who lived near Busia town and markets such as Bumala, Mundika, Matayos, Nambale and Sio port engaged in trade such as selling of fish, vegetables and household items. Remittances from relatives were also a major source of income accounting for 20-25 of total household income in both districts.

The study also observed that households in Bunyala and Samia derived their livelihood from fishing activities. Fish species caught on Samia and Bunyala beaches included *Fuani-odhadho* (Barbus), *Osoga* (Alestes), *Mumi* (Clarias), *Omena* (Engraulicypris argenteus) ,*Fulu* (Haplochromis), *Ningu* (Labeo), *Okoto* (Synondontis), *Otik-seu* (Bagrus), *Snoutfish* (Mormyrus),*Sire*(Schilbe Mystus), *Kamongo* (Protopterus) *aethiopicus or lung fish) Mbuta* (Lates niloticus *or Nile perch) and Tilapia species such as Opato* (T.Zillii), *Ngege* (T.esculenta),*Mbiru* (T.Variabilis) *and Nyamani* (T.nilotica).

Fish was found to be abundant during the wet season when food supply was low hence helped in supplementing food requirements of households. Traditional methods of fishing were common such as use of fishing baskets (*ikhafwa, esiwu, omukono, olukhwire)* and fish trap *(olukhwiri)* (K'okul, 1991). Modern methods of fishing that were slowly replacing the traditional methods included use of motorised boats, hook lines and nets. An important feature in fishing activities at the beaches was the absence of fisherwomen. Women were engaged in fish handling, processing and selling.

5.2.5 Land tenure

Land tenure security is very vital in encouraging investment in agriculture. The government land demarcation programmes immediately after independence in 1970s played a significant role in allocating land to individual households in this region hence many households own their pieces of land which have been passed on from generation to generation. The household survey revealed that 76 % of land in the study area was acquired through inheritance while 19 % was bought (Figure 5.8). This is consistent with studies in other parts of Africa where land is past on from parents to their sons (Bamire et al., 2005).There were however serious problems of land fragmentation in the region due to customary practice of passing on land from fathers to sons. Even though land fragmentation was a problem in all agricultural districts, high potential agricultural areas such as Vihiga had very small uneconomical farm units that could hardly sustain the households without supplementary income from off- farm sources.

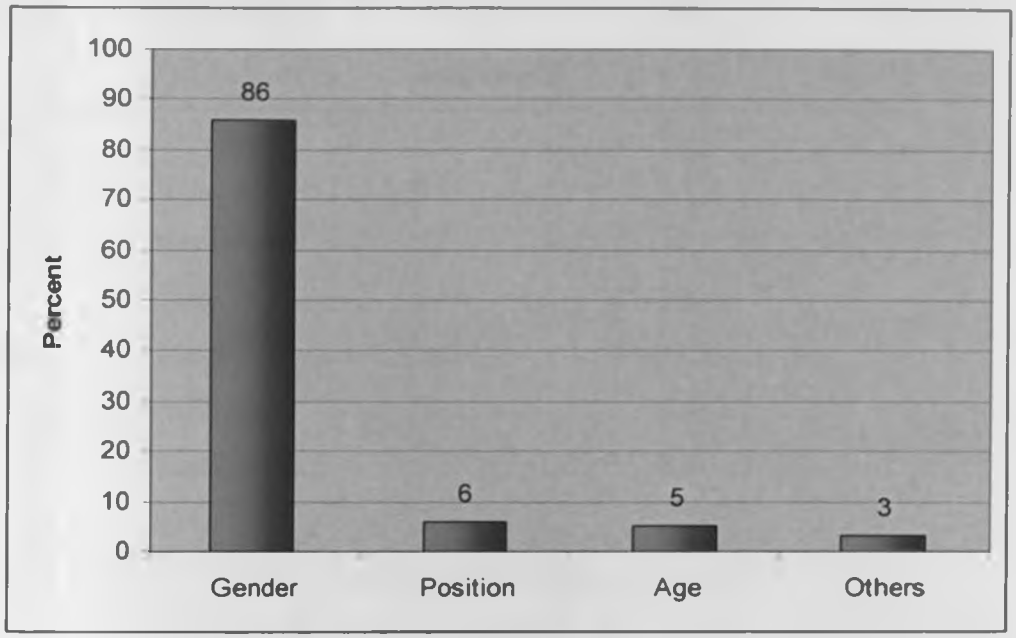


Source: Household survey data, 2006-2007

Figure 5.8: Methods of land acquisition

This household survey indicated that 71 % of household heads had title deeds for their parcels of land however, some of the titles were still in the names of their grand fathers who had since died .This made it difficult to acquire credit since title deeds were major collateral required by banks and other financial institutions. Various reasons were given for lack of title deeds. They included long and time consuming process and high cost to the smallholders. The mean land size in the study area was small, 1.3 and 0.6 hectares for Busia and Vihiga respectively. Salasya (2005), found land size in Vihiga to be 0.5 hectares and 0.7 hectares for Kiambu. These were some of the most densely populated rural districts in Kenya. This therefore created a lot of pressure on agricultural land. Land was particularly scarce in Vihiga due to the rocky nature of the landscape coupled with high population density.

This survey revealed that the main criteria for allocating land was gender (88 %) followed by position and age (Figure 5.9). Ownership rights were passed from fathers to their sons while there were cases where land was allocated according to position and age of the household member. Majority (78 %) of land was owned by husbands while wives owned only 9 % of land. Under most systems of customary law in Africa, women were not supposed to own or inherit land partly due to the perception that women were part of the wealth of the community or they were themselves regarded as property. Access to land by women was through their husbands, fathers, brothers, uncles and sons (Kameri-Mbote, 2005). The lack of access to land inhibited women's ability to provide for their households. The few women who owned land did not have title deeds. Some widows who inherited land from their late husbands had their title deeds confiscated by in-laws.



Source: Household survey data, 2006-2007

Figure 5.9: Criteria used in allocating land

5.2.6 Farming activities

According to household survey there were two cropping seasons that coincided with bimodal rainfall regimes in which long rains fell between March and May and short rains between October and December .There were also intervening middle rains between June and August. The food crops included maize (*Zea mays*), sorghum (*Sorghum vulgare*), finger millet (*Eleusine coracana*), sweet potatoes (*Ipomea batatas*) and yams (*Discorea spp*). Maize was considered a staple crop in the two districts. Maize was the main crop in Vihiga grown by 99 % of the households while in Busia only 85 % of the households grew maize since sorghum and cassava were important crops forming large part of the staple crops (Table 5.6).

Table 5.6: Main staple crops grown in the two districts

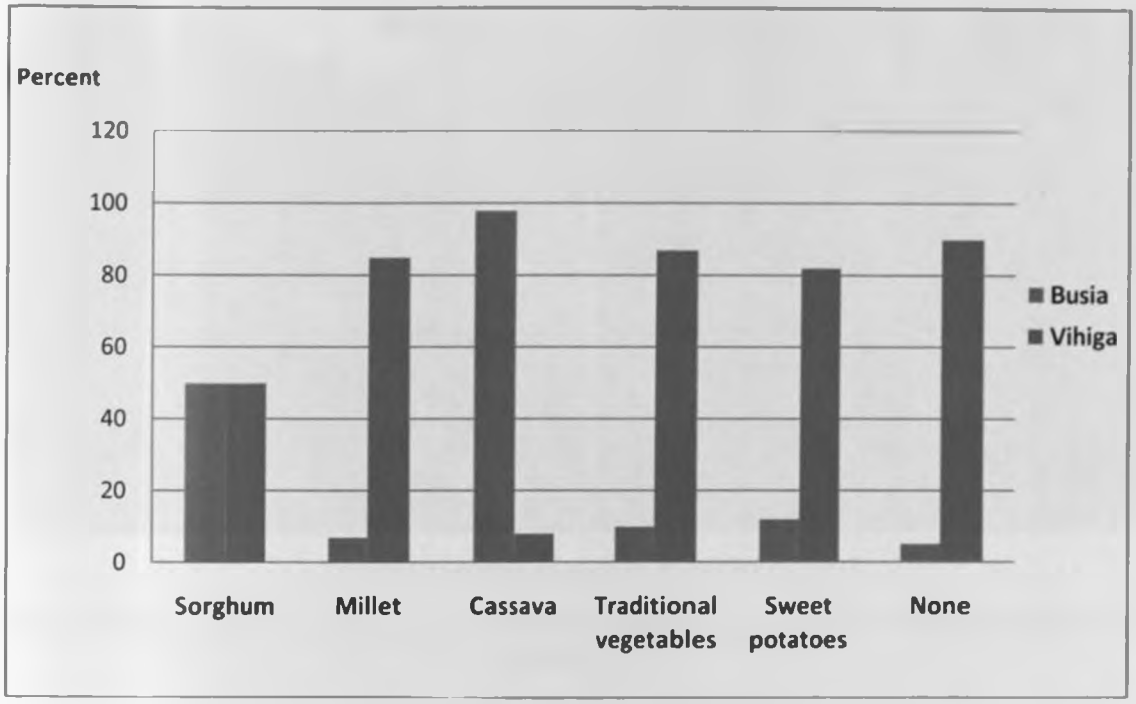
District	Staple crop	Number households	*Percent*
Busia	Maize	186	85.7
	Sorghum	9	4.1
	Cassava	22	10.1
	Total	*217*	*100.0*
Vihiga	Maize	280	99.3
	Sorghum	1	0.4
	Cassava	1	0.4
	Total	*282*	*100.0*

Source: Household survey data, 2006-2007

Figure 5.10 shows the main traditional crops grown in Busia and Vihiga districts. Cassava was found to be a major traditional crop in Busia grown by 86 % of the households while millet was important in Vihiga grown by 96 % of households (Figure 5.10). Households grew traditional crops because they formed part of staple crop (Busia) and for food security (Vihiga) (Figure 5.11). About half of households in Vihiga did not grow traditional crops due to various factors including limited land resources. The predominance of traditional crops such as cassava and sorghum in Busia made the households to rely less on the markets for food supplies unlike the households in Vihiga.

When emphasising the importance of traditional crops and intercropping in enhancing food security, Clementina Nabwire, 68 year old woman from Sigalame village in Busia said;

> *"Madimwa kaleranga inzala,noraka madimwa makhaya uva urakile inzala,vandu varaka madimwa makhaya inzala ivaluma"(Maize causes hunger, if you plant maize alone you will have planted hunger, farmers who plant maize alone are affected by hunger")*



Source: Household survey data, 2006-2007

Figure 5.10: Main traditional crops

The study revealed that even though households in Busia had relatively larger farm sizes than Vihiga, maize production was generally low with a mean of 420kg per hectare in Busia and 503 kg per hectare in Vihiga. This was attributed to more intensive nature of production including more use of fertilizers in Vihiga than Busia. Sorghum production was however higher in Busia at 124kg per hectare as compared to 79 kg per hectare in Vihiga. This was probably due to the importance of sorghum in the diets of households in Busia. Majority of households mixed maize, sorghum and cassava to prepare flour for making *ugali*, the staple food (plate 2). Several pulses were also grown usually intercropped with maize in Vihiga and sometimes sorghum in Busia .These included beans (*Phaseolous vulgaris*), pigeon peas (*Cajanus cajan*), cowpeas (*Vigna unguiaculata*) and groundnuts (*Arachis hypogaea*) (Plate 1).

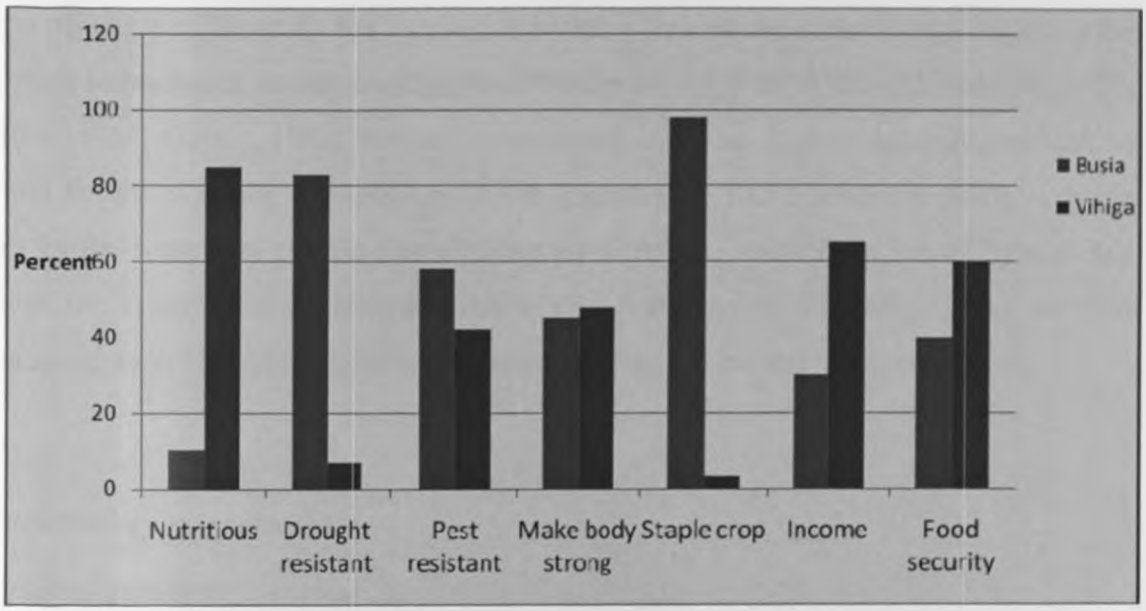
Source: Household survey data, 2006-2007

Plate 1: Hybrid maize (a) intercropped with beans in Busia and (b) with groundnuts in Vihiga

Plate 1 show maize crop which had been intercropped with beans and groundnuts. Pulses are high value crops whose production could be expanded to increase the income of households. However, production of these crops was still low for instance Busia households recorded 70 kg per hectare while Vihiga households produced 66kg per hectare of beans. More households (77 %) cultivated beans in Vihiga as compared to 49 % in Busia.

Vegetables included *sukuma wiki* (kales or *Brassica carinata*) pumpkin (*Cucurbita moschata*) tomatoes, *saga*, drumhead cabbage (*Brassica capita*).There were also wild dark green vegetables that were gathered and consumed by locals in both districts. They included. *lisaka* (*Gynandrapsis gynandra*), *zimboka* (*Amaranthus. blitum*), *inderema* (*Basellaalba*), lisutsa (*Solanum nigrum*), *lisebebe (pumpkin leaves), shirietso* (*Erythrococca bongensis*) among others and various varieties of mushrooms.

The horticultural sector in Busia and Vihiga districts was composed of citrus fruits such as sweet orange (*C.sinensis*) and lemons (*C.limon*) although on a limited scale, bananas (*Musa spp*), papaya, mangoes (*Mangifera indica*) and avocadoes. Cotton is a major cash crop in Busia others were sisal (*Agave sisalana*) and tobacco while maize, tea and coffee were major cash crops in Vihiga.



Source: Household survey data. 2006-2007

Figure 5.11: Reasons for growing traditional crops

The study observed that rain fed agriculture was dominant despite unreliable rainfall and long dry spells in some regions such as Funyula and Budalangi. Only 13 % of households practiced irrigation in Busia and 6 % in Vihiga .The low irrigation in Vihiga was probably due to the fact that rainfall was relatively higher and well distributed throughout the year unlike in Busia .Overreliance on rain fed agriculture, to some extent contributed to acute food poverty since the types of crops grown and crop productivity in general was limited by low soil moisture most of the year. The most important crop irrigated were vegetables mainly kales and traditional vegetables.

5.3 CURRENT STATUS OF TECHNOLOGY USE AMONG SMALLHOLDERS

The first objective of the study was to provide baseline data on the current status regarding the use of farm technologies among smallholders.. Studies in 1970s and 1980s (Hesselmark, 1975; Rundquist, 1984; Gilbert, 1995) indicated widespread adoption of farm technologies such as HYV and fertilizers among smallholders. It was important to find out whether there were any changes in the context of current liberalization environment. Apart from use of hybrids and fertilizers the study included animal traction and post harvest technologies due to their importance in improving labour productivity and reducing post harvest loses respectively.

5.3.1 Soil fertility management

5.3.1.1 Use of fertilizer

Table 5.7 shows the use of fertilizer on maize in Busia and Vihiga districts. About 57 % of households used fertilizers in Busia and 61 % in Vihiga .In an earlier study of Vihiga households, Salasya (2005) found that 73.3 % of households used fertilizers in Vihiga. The percentage was probably higher due to the fact that the study comprised of farmers who grew tea while the current study concentrated on smallholders without cash crops. Majority of households used the fertilizer on maize in both districts. Fertilizer application rate was on average 72 kg per hectare, which was much lower than the recommended rate of 130kg per hectare. The application rate was 37kg per hectare in Busia and 96 kg per hectare in Vihiga. Vihiga district is considered one of the districts with high fertilizer consumption rate in the country (Ariga et al, 2006). This is attributed to cultivation of horticultural crops which are profitable making farmers to fertilize maize intercropped with horticultural crops. Ariga et al (2006) found that about 87 % of small farmers in high-potential maize zones in Western Kenya used fertilizer on maize at a rate of 163 kg per hectare. This however, included farmers who grew sugarcane, coffee and tea and accessed fertilizers through sugarcane out grower programs, coffee cooperatives and Kenya Tea Development Authority respectively.

The study showed that the most commonly used fertilizer was DAP (Di-ammonium Phosphate) (49 %), CAN (Calcium Ammonium Nitrate) and urea (24 %) and DAP and CAN (15 %). DAP

and CAN were used on maize as basal as well as for top dressing respectively. However, not all the households that used fertilizer as a basal also top dressed because this was an added cost. Only 25 % of the households who used fertilizers on maize also top dressed using CAN. Generally, the national consumption of planting types of fertilizers (DAP, MAP,TSP,SSP,NPK) is 44 % while the use of top dressing fertilizer types (CAN,UREA,ASN,SA) stands at 23 % (Ariga et al.,2006). This study observed that traders stocked DAP, CAN and urea. None of the retailers stocked Tripple Super Phosphate (TSP) and Rock phosphate (RP) which were being recommended due to low phosphorous level in soils. The households probably preferred DAP due to its lower cost relative to TSP and RP.

The results are consistent with those of Fufa and Hassan (2006) in Dadar district in Ethiopia. However, the use of fertilizers and other inputs such as improved seeds depended on farmers income variations associated with unstable prices of farm products (Fufa and Hassan, 2006). When the income of the household fluctuated, so did the expenditure on farm inputs such as fertilizers (Salasya, 2005).

Generally, consumption of fertilizers by smallholders in Kenya has increased and this is the same trend in Western Province. In 1980s the consumption was 180,000 metric tones per year which increased to 325,000 metric tones in 2000/2003 and 351,776 metric tones in 2004/2005 (Ariga et al., 2006).

Table 5.7 Use of fertilizer on maize

District	***Percentage using fertilizer***	***Application rate kg/ha***	***Recommended rate kg/ha***
Busia	57	37	130
Vihiga	61	96	130

Source: Household survey data, 2006-2007

5.3.1.2. Use of farmyard manure

Use of farm yard manure was considered an important source of nutrients for the soils. Even though it is well understood that farmyard manure contain low amount of nutrients especially phosphorous, organic sources of fertilizers were particularly useful in densely populated areas such as the study area (Salasya, 2005 ;Tripp et al., 2006; Morris et al.,2007). This was attributed to the fact that the animals were confined and fields were near the homesteads. Organic fertilizers are preferred due to their lower cost compared to inorganic fertilizers. The preference of manure use was also due to its effect in improvement of aggregate soil structure, chemistry and biological activity in the soil, in addition to raising the organic matter content of the soil. However, the nutrient content in manure was much lower (1.2 to 2 %) nitrogen and negligible amounts of phosphorous (Salasya, 2005). In addition, the nutrients in manure are released when plants do not need them. This implied that large quantity of manure was to be used in order to make any significant contribution to soil nutrient replenishment. The other problem associated with manure use was its poor quality due to poor methods of preparation and from grazing methods which were predominantly open grazing, especially in Busia. It was difficult to measure the quantity of manure used especially for those households that produced their own because they did not keep records. However, for the households that bought from neighbours or borrowed from relatives they carried on wheelbarrows and could be evaluated. In Busia 43 % of households used manure and 39 % in Vihiga (Table 5.8). The lower percentage of households using manure in Vihiga was due to the fact that majority used fertilizers and there was limited number of livestock kept due to limitation of land. The application rate of manure was also higher in Vihiga than Busia (1.5 and 0.94 tonnes per hectare respectively) (Table 5.8).

Table 5.8 Use of manure on maize

Region	*% Households*	*Application rate tonnes/ha*	*Recommended rate tonnes/ha*
Busia	43	0.94	10
Vihiga	39	1.5	10

Source: Household survey data, 2006-2007

5.3.2 Production technologies for maize

Proper land preparation was considered essential in agricultural production process. In this study it was observed that the households used the slasher (69 %) or *panga* (30 %) to clear the land before ploughing. Well prepared seedbed ensured better growth of plants as well as minimized the incidences of weeds. A good seedbed also reduced time consumed removing weeds and also ensured less competition for nutrients. Timely planting of crops also depended on how fast the land was prepared and this in turn depended on the technology used. In 1970s tractor hire programme was introduced in Western Kenya in order to improve productivity (Oluoch-Kosura, 1983). This programme was however unsuccessful due the high costs associated with it. The programme was also benefiting high income farmers. The current study put emphasis on animal traction technology due to its cost effectiveness and its importance in improving labour productivity. The plough inverted the soil and had the advantage of good weed control however it encouraged moisture loss from the soil and promoted the susceptibility of soil to erosion especially in light soils (Dibbits, in Starkey et al., 1992). The benefits of the plough however, far outweighed its disadvantages. More than half (52 %) of the households interviewed in Busia used ox-drawn ploughs as compared to only two percent in Vihiga. The hoe was the dominant tool for land preparation in Vihiga used by 98 % of the households (Table 5.9). On average, ploughing using oxen costs Ksh.1, 367 per hectare in Busia and Ksh.2, 300 in Vihiga. The farm

sizes in Vihiga had been fragmented to uneconomical units due to population pressure thereby making it too costly to use either tractors or ox-drawn ploughs on such small farms.

Weeding was the most dreaded activity since it was carried out at least twice in a season due to high soil moisture that encourages proliferation of weeds. Weeds depressed crops essentially through competition for light, water and nutrients. In fact all the households in the survey used the hoe for weeding .Weeding was mostly done by women. Women performed farm activities using rudimentary farm tools such as the hoe that had been put out of use in other parts of the world outside Africa. The hoe still remained the most important tool for weeding not only in this region but in most parts of Africa.

Table 5.9 Tools used for ploughing

District	*Tools for Ploughing*	*Number of households*	*Percentage of Households*
Busia	Hoe	101	46.5
	Ox-plough	113	52.1
	Tractor	3	1.4
	Total	*217*	*100.0*
Vihiga	Hoe	275	97.5
	Ox-plough	6	2.1
	Tractor	1	0.4
	Total	*282*	*100.0*

Source: Household survey data, 2006-2007

Plate 2 shows a combination of cassava, maize and sorghum that had been processed and ready for grinding. The study found that harvesting was done using bare hands by 53 % of the households while 44 % used a knife .While large scale maize farmers used tractors in threshing their harvested crop, the smallholders used hands thereby consuming most valuable time that

could be used for other activities. In Vihiga, some households indicated that the wheelbarrow was the most important farm equipment used during harvesting to carry the harvested crop from the fields to the homestead. The wheelbarrow was also useful during drying of the maize under the sun.

Source: Household survey data, 2006-2007

Plate 2: Drying a mixture of cassava, maize and sorghum under the sun, and granary for storage of cereals in Busia

The demand for labour was usually high during the peak periods in agricultural calendar namely land preparation, weeding and harvesting hence farmers hired labour. The number of labourers hired however depended on the financial resources that the household had. In Busia district 58 % of households hired labour as compared to 62 % in Vihiga. The lower percentage of households that hired labour in Busia in spite of larger farm sizes could be attributed to larger household sizes occasioned by polygamy. On average Busia households hired 9 people who spent Ksh.1770 while Vihiga hired 5 labourers and spent Ksh. 903 per annum.

5.3.3 Storage methods

The survey revealed that more than 90 % of the households stored their maize in gunny bags .This is a changing trend from the storage of grains in the granary in the 1970s and earlier. Various reasons were given for storing in gunny bags amongst them low production, security and

low cost of gunny bags. Security was a more important reason for storing maize in gunny bags in Busia (76 %) than Vihiga (27 %). According to Wambugu, et al (2007) the most common storage methods in Siaya and Busia districts were gunny bags (55%), plastic containers (24 %) and hanging over the fireplace (13 %). Since most households produced and stored their own seeds for planting in the next cropping season, better storage methods were necessary to enhance seed security.

Theft of food was a clear indication of food insecurity and poverty in the region. In Vihiga, however, majority of households (42 %) stored in gunny bags due to low production resulting from small farm sizes .In fact some households recorded no harvest since all the maize was consumed while green. It was difficult to obtain quantities of green maize consumed by households owing to lack of records. Security of the harvested crop was also a concern in Vihiga as observed by Wanyama (2003).

In Busia some households harvested, processed and stored cassava and sorghum in the granary but maize was stored in bags inside the house. Plate 2 shows a granary in Busia used for sorghum storage. This was because maize was more likely to be stolen when stored in the granary as compared to cassava and sorghum. Majority of households however harvested the cassava when they needed it. In Funyula which was drier as compared to other divisions, and where cassava was a dominant crop, the women talked of having 'a granary on the farm'. The study observed that improved storage methods such as metal or plastic drums, solid wall bins, concrete/synthetic and metal silos were not used by households in the study area. This could explain for the high post harvest losses in the region. Wambugu, et al (2009) observed that farmers treated their maize seeds using cow dung ash (51%) and actellic (30%) while 23 % did not treat their seeds and the rest used pepper and kerosene.

It was observed that post harvest losses accounted for more than 25 % of the food produced. Despite this, many households (88 %) did not use pesticides for storage. Reduction of post harvest loses could go along way in reducing food insecurity in the two districts. This could be done through improved processing of food stuffs as well as use of better crop protection technologies. The study observed that weevils were a major problem that destroyed stored maize

followed by rodents. Where post-harvest losses were high, farmers often cultivated the land more intensively to obtain the same yield. This placed additional stress on both physical and biological environment. Providing rural women with the information and technologies needed to reduce post-harvest losses was an important means of increasing available food supplies, reducing women's time and labour constraints, and easing environmental stress (FAO, 2001).

Although the households in Vihiga harvested more maize per hectare, their consumption rate was high due to high population hence they were as food insecure as their counterparts in Busia. They did not experience any problems with storage due to high consumption rate and low production. In actual fact, they purchased food for eight months of the year while those in Busia bought food for only three months. Majority of the households used ash to protect maize against the weevils. Traditional methods of storage of seeds encouraged insect damage and higher moisture content as compared to when maize was stored in airtight containers with either mortein doom or cow dung ash as seed treatment (Wambugu et al., 2009).

5.3.4 Discussions, conclusions and implications

The preceding section brings to the fore the low intensity of use of farm technologies amongst smallholders. Increasing agricultural productivity requires use of farm inputs in their right quality, quantity and combinations. Yet majority of the households in the study area either used the inputs piecemeal or continued using rudimentary technologies that contributed to deteriorating soil fertility and contributed to the general stagnation of agriculture.

Land preparation by the hoe encouraged proliferation of weeds that were not adequately removed thereby reducing yields. The use of ox-drawn plough and harrowing, although often encouraged soil erosion, compaction and poor aeration when unprofessionally done, had the advantage of preparing a fine seedbed which encouraged rapid germination and weed-free environment. Land preparation costs and high costs of farm equipments affect the quality of the seedbed and timeliness of farm operations thereby compromising the yield in addition to inflating the production costs. For an optimum yield, maize should be sown in dry soil just before the onset of the rains. Great losses were incurred when maize was sown late to the tune of 55-110kg per hectare per day delayed after the onset of the rains (Acland, 1971). Likewise

important herbicides such as 2, 4-D amine and atrazine that were useful in weed control were not commonly used in the study area. Yet they could help to reduce drudgery on the side of the women.

Improvement in crop husbandry such as good seed bed preparation, proper plant density, correct spacing, weed control, timely planting and soil nutrient replenishment was mandatory for a good harvest. Choice between use of fertilizers or manure was a major decision that a household had to make. Expenditures on production inputs such as fertilizer and seed depended on incentives and capacity to purchase (Reardon et al., 1995). Incentives to purchase inputs were determined by the net returns of the input expenditure (profitability of the expenditure relative to the returns expected from alternative farm and non farm opportunities) and the riskness of the expenditure, as compared to outflow on alternative crop, livestock or enterprise activities.

Capacity to purchase inputs depended on the household's land holdings; physical, financial, and human capital; and labour availability. Both incentives and capacity are affected by broader factors such as technologies, institutions, and policies, by trends such as globalization, and by extension and demonstration programs that are designed to improve crop husbandry knowledge and induce farmers to purchase inputs and/or make more effective use of them.

Expenditure on fertilizers was a significant investment decision for households. However, the high cost of fertilizers was a major challenge to smallholders. This was worsened by deteriorating soil fertility that made it necessary to use either organic or inorganic nutrient enhancement technologies. Karanja, et al, (1999) observed that fertilizer use on maize was profitable to the farmer especially when used on hybrid maize. They found the mean value to cost ratio for DAP fertilizer on maize to be 5:86, which meant that for every Ksh. spent on the fertilizer, the farmer got back Ksh.5.86 in value of maize output (Karanja et al., 1999). Economic returns therefore played an important role in household's choice of nutrient management technologies thereby affecting their resource allocation decisions (Bamire et al., 2005: Nkonya et al., 1997).

A combination of nitrogen, phosphate and potassium (NPK) gave a better yield (Acland, 1971, KARI) and was the recommended fertilizer for maize .The predominant use of DAP on maize and the lower rate of application did not provide adequate nutrients to the soils especially nitrogen and phosphorous (DAP contains only 18 % nitrogen and 46 % phosphorous).The soils in this region lacked these nutrients which were very essential in improving soil fertility. Ministry of Agriculture trials in Vihiga showed that without fertilizers farmers could realise 3800kg per hectare of maize. With the use of NPK fertilizer (60-60-0), the yield could rise to 6100kg per hectare. This is much higher than the current maize production of 503kg per hectare. The low rate of application of fertilizer on maize was one of the causes of low yield which fell much below the average national yield of 1100-1,350kg per hectare and average possible yield of 14,220 kg per hectare (Acland, 1971; KARI, 1998; KARI, 1994; MoA,).

Fertilizer market was liberalized in 1993 by abolishing quotas and price controls. Traders in rural areas were able to sell fertilizer in small quantities as small as 500 gms. With the liberalization of the fertilizer market, Kenya has more than 10 importers of fertilizers, 500 wholesalers and 7000 retailers operating in the country (Ariga et al., 2006; Morris et al, 2007). This has made fertilizers readily available with the distance to nearest fertilizer retailer declining by half from 8.4km to 4.1km between 1997 and 2004 (Ariga et al., 2006; Morris et al, 2007). Before liberalization it was sold in 50 kg packets (Salasya, 2005). Even though there has been improvement in fertilizer consumption, fertilizer use by smallholders is still below recommended quantity.

Fertilizer use can be attributed to demand and supply nexus. On the demand side, fertilizer use may not be perceived as profitable on average by farmers, or it may be perceived as profitable but too risky in financial terms. Typically, lack of profitability may be associated with low crop response resulting from the ecological constraints, use of seed varieties that are unresponsive to fertilizer, inappropriate application rates and poor crop husbandry practices. On the other hand, low profitability on the side of the farmer may also be due to high fertilizer prices or low prices of outputs. This may reflect high transport costs, transaction costs, policy interventions, or in some cases, non-competitive behaviour of marketing agents. There are cases where households wished to acquire fertilizer, but lacked the cash or access to credit necessary to finance the purchase.

On the supply side, access to fertilizer may be limited by high costs at the source (importer or local manufacturer), inadequate arrangements for financing the purchase of fertilizer by importers and traders, retail price controls, import licensing quotas, foreign exchange controls, poor port, rail and road infrastructure, transaction costs, non-competitive behaviour of suppliers, and policies, institutions or programs (e.g. subsidized or free input distribution) that undercut private markets and increase the uncertainty of input marketing, or that restrict competition and increase marketing costs.

The prices of DAP which were $252 per tone in January 2007 tripled to $752 per tonne by January 2008 (FAO world fertilizer outlook). Fertilizer prices varied according to nature of infrastructure (Omamo and Mose, 2001) and also by distance from the source. The long distance of Busia and Vihiga from the port of Mombasa and from Nairobi meant that prices of fertilizers were relatively higher than other regions such as Central Kenya (Salasya, 2005). Although fertilizer marketing costs reduced by 55% from Mombasa to Western Kenya following liberalisation and improvement in policy environment (Ariga et al., 2006), farm gate prices are still out of reach for many smallholders. Supply in some areas could also be limited by traders' perceptions of low farmer demand, which implies high costs and risks in building a supply network.

Pest menace such as the stalk borer (*Busseola fusca*), armyworms (*Spodoptera exempta*) attacked the maize crop seriously damaging the leaves and the maize cobs. Inspite of their effect on crop yield, majority of the farmers did not use any pesticides to deal with the problem. DDT was initially the most widely used pesticide but was banned by WHO due to its negative effects on the environment. Apart from the pests that affected maize on the fields, weevils and rodents were major concern due to their effect on the harvested crop. Other threats included diseases such as white leaf blight (caused by the fungus *Helmintho- sporium turcicum*), maize streak and rust.
In order to encourage households to increase the use of farm inputs there was need for more extension service and affordable, friendlier and efficient credit system that addressed the specific needs of smallholders (Segers, 2009). There was also need for price incentives that could motivate the households to increase the use of both fertilizers and hybrid seeds in order to improve productivity.

Research on efficient preparation and use of organic fertilizers to supplement inorganic sources could be appropriate since it was an alternative to households with financial constraints. While inorganic fertilizers helped to quickly restore lost nutrients in the soils, organic fertilizers had along term effect of building up soil structure, texture and organic matter content for more sustained productivity. The soils in the study area are however so deficient in soil nutrients such that use of inorganic fertilizers is necessary. It should be noted that promotion of fertilizers should be accompanied by interventions on soil and water conservation, strengthening output markets, capacity building for farmers, infrastructure development and institutional reforms. Alternatives practices such as Conservation Agriculture (CA) mechanization schemes (Kaumbutho, 2008) that had been undertaken elsewhere and that were contributing to increased yields and better environmental management could also be researched further in order to identify their suitability in the study area.

5.4 TECHNOLOGY USE AND FOOD SECURITY IN DIFFERENT HOUSEHOLDS

The second objective of the study was to evaluate the impact of technology use on food security in different households (Male headed, *De jure* female headed, *De facto* female headed). Two hypotheses were tested under this section, one, the effect of technology on food security (maize yield) and two, the effect of household headship on nutrition status of children and women. Households were categorized using headship (male-headed, *de jure* female headed and *de facto* female headed) while technology was measured in terms of expenditure on fertilizers, seeds and production tools. Likewise to measure the effect of household headship on household food security we used the nutrition status of children and women, and maize yield as dependent variables.

5.4.1 ANOVA results of impact of technology on food security in different households

5.4.1.1 Expenditure on inorganic fertilizers and maize output

A two- way (between groups) analysis of variance (ANOVA) was conducted to explore the impact of household headship and fertilizer expenditure on maize production. Households were divided into three groups namely; male headed, *de jure* female headed and *de facto* female

headed households. Expenditure on fertilizer was grouped hierarchically into 4 groups (Ksh. per hectare) (group 1: 0-5000, group 2: 5001-10,000, group 3: 10,001-15,000, group 4: 15,001-20.000). Maize production (kg/Ha) was grouped into six categories (group 1:0-500, group 2: 501-1,000, group 3:1,001-1,500, group 4:1,501-2,000, group 5:2,001-2,500 and group 6: 2,501-3,000). There was a statistically significant main effect for fertilizer expenditure [F (1, 284) =7.08, p=.000] (Table 5.10) and the effect size was medium (Eta Squared= 0.063). Household headship had no significant effect ($p \geq .05$) and interaction effect of the two independent variables (expenditure on fertilizers and household headship) was not statistically significant ($p \geq .05$) (Table 5.10).

Table 5.10: Two-way ANOVA results showing the effects of fertilizer expenditure and household headship on maize output

Dependent Variable: maize produced (kg/hectare)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Corrected Model	37.171[b]	9	4.130	3.580	.000	.102	32.218	.990
Intercept	157.345	1	157.345	136.4	.000	.324	136.378	1.000
TYPHSHD	1.136	2	.568	.492	.612	.003	.985	.130
FERTCOST	24.514	3	8.171	7.083	.000	.070	21.248	.980
TYPHSHD * FERTCOST	9.772	4	2.443	2.117	.079	.029	8.470	.625
Error	327.662	284	1.154					
Total	1205.000	294						
Corrected Total	364.833	293						

a. Computed using alpha = .05

b. R Squared = .102 (Adjusted R Squared = .073)

Source: Household survey data, 2006-2007

The results showed that the difference in the means of maize produced was not significant according to household headship ($p \geq .05$) (Table 5.10) but was significant with respect to expenditure on fertilizer ($p \leq .05$).

Table 5.11 shows the variation in maize production in relation to different soil nutrient management methods. The households that used farm yard manure obtained the lowest amount

of maize while those that used inorganic fertiliser produced the highest amount of maize per hectare.

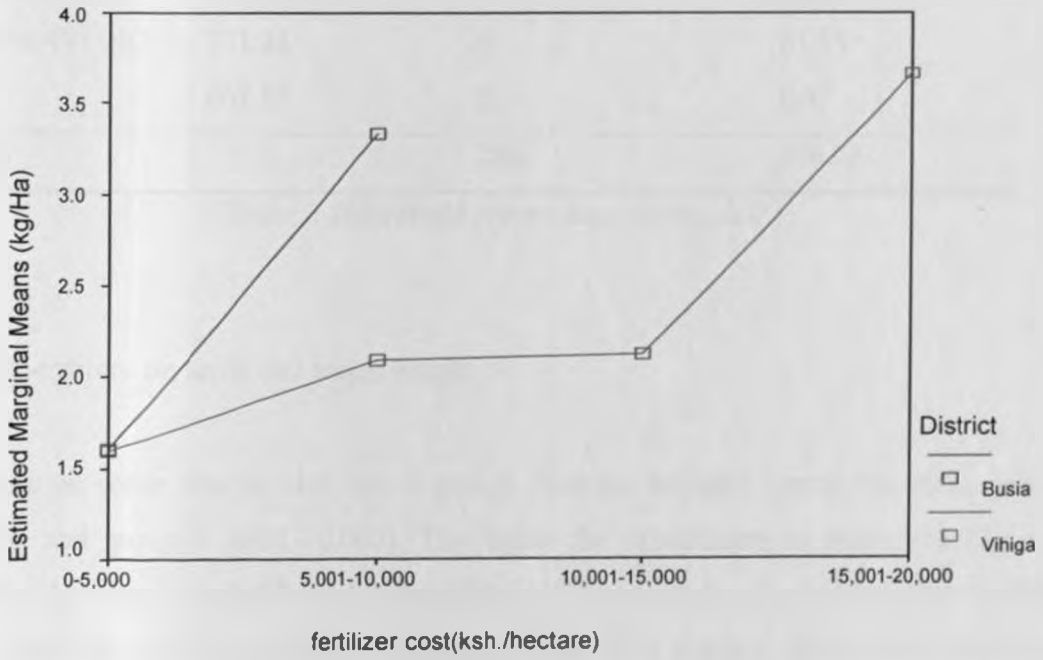
Table 5.11 Maize production (kg/ha) in relation to soil nutrient management methods

District	*Soil nutrient management*	*Mean (kg/ha)*	*Number of households*	*% of households*
Busia	Farmyard manure	375.16	94	43.32
	Inorganic fertilizer	522.04	93	42.86
	Doesn't use	243.89	30	13.82
Total			**217**	**100.0**
Vihiga	Farmyard manure	359.00	109	38.65
	Inorganic fertilizer	607.22	168	59.57
	Doesn't use	154.11	5	1.77
Total			**282**	**100**

Source: Household survey data, 2006-2007

Having found a significant difference in the means of maize production resulting from variation in expenditure on fertilizers, we sought to find out whether the same independent variable (expenditure on fertilizer) affected the income accrued from sale of maize by households. A simple regression analysis was used to test for the effect of fertilizer expenditure on income .The results showed that expenditure on fertilizer accounted for a 12 % variation (Adjusted R Square =0.121) in income from maize. The ANOVA table also showed a significant effect of expenditure on fertilizer ($p \leq .05$). What this meant was that an increase in money spent on fertilizers had a likelihood of increasing the income that the farmer received from maize by 12 % other factors being held constant. A higher expenditure on fertilizers indicated higher quantity of fertilizer used and under favourable conditions the output was expected to be higher. It therefore meant that if the household spent less on fertilizer their output would be lower and there would be no surplus for the market. Households which lacked financial resources tended to use readily available cost effective manure and as the results showed that their returns were usually low (Imai, 2003).

Households in Busia district spent less on fertilizers where the highest amount was in the category of Ksh.5001-10,000 per hectare per annum. Those in Vihiga spent more with the highest output being realized by households who spent between Ksh. 15,001 to 20,000 per hectare (Figure 5.12). Majority of the households in both districts preferred to use DAP on maize. Never the less, the results indicated a steady rise in maize output with an increase in the amount spent to purchase fertilizers. The results concur with findings in Nigeria where a combination of crop rotation and use of inorganic fertilizers was found to be important variables influencing productivity and net returns to rice production (Bamire et al., 2005)



Source: Household survey data, 2006-2007

Figure 5.12: Variation in expenditure on fertilizers and effect on maize output in Busia and Vihiga

The households that used *mavuno* type of fertilizer produced higher maize per hectare while those who combined DAP and *mavuno* produced the lowest (Table 5.12) .This however, had nothing to do with the fertilizer quality but it depended on the quantity of each of the fertilizers

used as well as crop husbandry such as seed bed preparation, timely planting, weed management, timing of top dressing and particularly the use of fertilizers on hybrid seeds.

Table 5.12 Maize production per hectare in relation to fertilizer types

Type of inorga fertilizer	*Mean(kg/ha)*	*Number of households*	% of households using fertilizers
DAP	474.69	145	48.99
CAN	709.19	10	3.39
UREA	686.62	17	5.74
DAP/UREA	605.63	70	23.65
DAP/CAN	680.52	45	15.20
MAVUNO	723.47	3	01.01
DAP/MAVUNO	331.93	4	01.35
NPK	667.18	2	0.67
Total		**296**	**100.00**

Source: Household survey data, 2006-2007

5.4.1.2 Expenditure on seeds and maize output

Expenditure on seeds was divided into 3 groups (Ksh.per hectare) (group 1:0-3000, group 2: 3001-6000, and group 3: 6001-10,000). The higher the expenditure on seeds, the higher the probability that the household used hybrid seeds. This was due to the fact that traditional varieties were cheaper and sometimes households preserved seeds to plant in the next season hence they did not always source from the market (Wambugu et al., 2009). Use of hybrid varieties with good agronomic practices including use of fertilizers increased maize output. This ensured adequate supply of maize, a major source of calories for the households. Table 5.13 shows the results of the effect of expenditure on seeds on the maize output. There was a statistically significant effect of expenditure on certified seeds on maize output [F (2, 301) = 4.24, p = 0.015]. However post- hoc analysis using the Tukey's Honestly Significant Difference

(HSD) revealed no significant effect between the different levels of seed cost. Eta squared was calculated to establish the effects size. The Eta squared was 0.03 which is a small effect size according to Cohen's (1988) who classifies .01 as small effect, 0.06 as medium, and 0.14 as a large effect.

Table 5.13 One- Way ANOVA results of effect of expenditure on maize seeds on maize output

maize produced (kg/hectare)

	Sum of Squares	df	Mean Square	F	Sig.
Between Group	10.637	2	5.319	4.236	.015
Within Groups	377.912	301	1.256		
Total	388.549	303			

Source: Household survey data, 2006-2007

Maize output increased steadily with increase in expenditure on seeds. The implication of the results was that hybrid seed varieties which cost more than traditional varieties, contributed significantly to higher maize yield.

It is therefore clear that use of improved technologies such as fertilizers and hybrid seeds had a significant effect on food security through its effect on increased output of maize, the staple crop and major source of calories for majority of the households. In order to establish the size of the effect of expenditure on seeds on maize output, a Simple Regression analysis was conducted. The regression results showed that expenditure on seeds accounted for about 17 % of the variation in maize yield (Adjusted R Square= 0.165). The ANOVA results also indicated a very significant effect [F (1, 298) = 60.26, p=.000] (Figure 5.14). The effect of certified seeds was large since maize production was also affected by physical variables like soil fertility and rainfall amounts and variability, social dynamics such as education and age of the farmer among other factors.

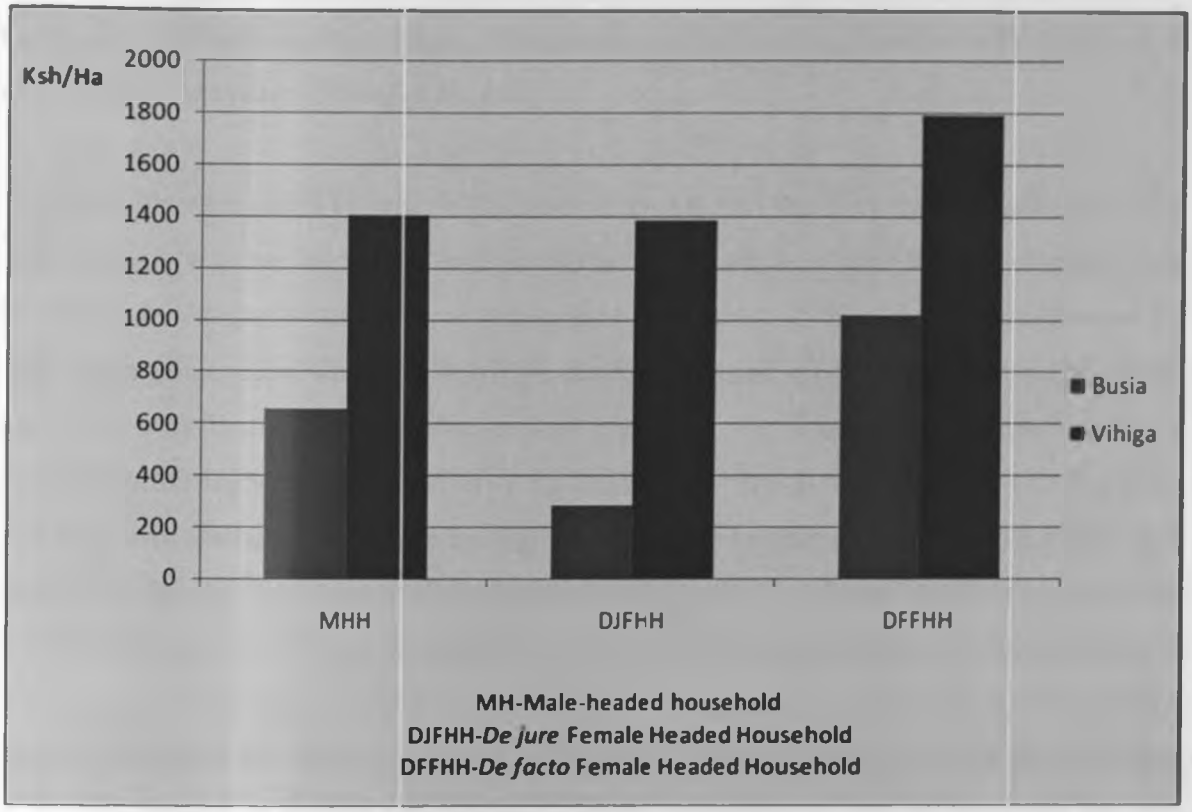
Table 5.14: A summary of regression results showing effect of expenditure on seeds on maize output

Summary model			ANOVA		
R	R Square	Adjusted R Square	df	F	Sig
0.41	0.168	0.165	Regression **1** Residual **298** Total **299**	60.26	.00

Source: Household survey data, 2006-2007

Expenditure on both seeds and fertilizers varied in relation to household headship. *De facto* female headed households spent more on seeds in both districts (Ksh.1, 018.80 in Busia and Ksh.1, 792.09 in Vihiga respectively) (Figure 5.13) as compared to male and *de jure* female headed households. This was probably due to their access to resources such as remittances from their husbands who lived in other areas and who were likely to be employed in non-agricultural sector. It also clearly indicated that women allocated more resources especially income, to food production and to the provision of food and nutrition security for their households. On average households in Vihiga spent more money on seeds (ksh 1,480 per hectare) than Busia households who spent ksh 690 per hectare.

Generally, with the liberalisation of the seed market in Kenya, there is a wide range of certified seeds on the market such as Pannar, Pionneer, Duma, Maseno Double Cobber and Simba, however the presence of counterfeit seeds is still a major challenge that comprises the quality of seeds and productivity (Nyoro et al.,n.d).



Source: Household survey data, 2006-2007

Figure 5.13: Expenditure on seeds in relation to household headship

The results indicated that households that cultivated hybrid varieties obtained more yields than those who grew traditional varieties. Those who planted hybrid varieties comprised 44.3 % and obtained 614 kg per hectare an equivalent of 6.8 bags (one standard bag is 90kg). The households that cultivated traditional varieties were the majority making up 55.7 % and realised 349.5 kg per hectare equivalent of 3.8 bags. Generally in Kenya with better crop husbandry, favourable weather conditions and use of inorganic fertilizers on hybrid maize it is possible to achieve 1225 kilograms per hectare which is about 13 bags of maize while in Kitale the 'food basket' of Kenya, the yields are as high as 5,600 kilograms per hectare (62 bags) (Acland,1971,KARI). The production varies with the length of the growing season, ecological conditions, availability of soil nutrients, crop husbandry and weather conditions. The maize yield in the two districts can therefore be said to fall far below Kenyan and global standards. Nyoro, et al (n.d) found production costs of both inter-crop and mono crop maize to be lower in Uganda

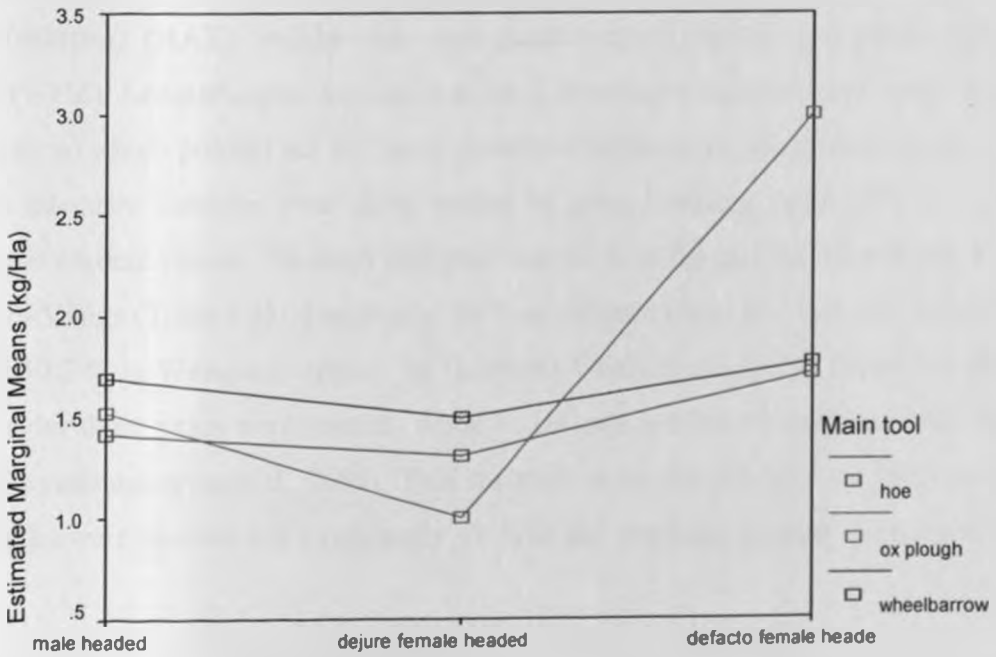
than Kenya partly because of low costs of farm inputs especially machinery, seeds and fertilizers. Other reasons for lower production costs in Uganda included good seed quality, diversified certified seeds including use of Open Pollinated Varieties (OPV), better crop husbandry and stronger extension system (Nyoro et al., n.d).

The households were asked to indicate the most important tool that they used in agriculture. Ox-plough plough was an important tool in Busia while the hoe and the wheelbarrow was predominant in Vihiga. It was observed that in the two districts, 75 % of the households used the hoe for land preparation while 24 % of the households used ox drawn ploughs. The use of tractors was very limited probably due to their high cost. The households that used ox-drawn ploughs reported higher maize yield (517 kg per hectare) which was equivalent to 5.7 bags. Those who used the hoe produced an average of 452 kg per hectare an equivalent of 5 bags. The mean production for the tractor was lowest probably due to the unprofitable nature of its use given the high costs, small land sizes and liquidity constraints of households. Even though use of ox ploughs increased the land under cultivation thereby increasing output, better crop husbandry, nutrient replenishment, use of certified seeds and fertilizers were essential to maximize production. This could explain for the small difference between those who used the hoe and those who ploughed. Generally, a large proportion of the farmers that used the hoe were from Vihiga district and they used inputs much more intensively than those from Busia where over 50 % used ox plough.

According to FAO (1998) maize yield statistics, Rift valley province had the highest maize output (3186-5350kg/ha) followed by Western province (1436-3185kg/ha). From the results of the present study it appears that maize production in the two districts fell much below the average production in the province. The daily consumption of maize was 4kg per average household of six. This translated to 120kg per month and 1440kg (16 bags) per annum. This meant that majority of the households in the two districts were not able to meet their daily food requirements through own production.

Figure 5.14 clearly shows variation in production in different households with *de jure* households recording low production either with a hoe, a wheelbarrow or ox ploughs. *De facto*

female headed households on the other hand recorded the highest produce with ox plough and lowest with hoe. Male headed household on the other hand, recorded high produce with a wheelbarrow and lowest with a hoe. Interestingly, *de facto* female headed households realised high income with increased use of farm inputs as compared to male headed and *de jure* female headed households. This could be attributed to the fact that majority of women in *de facto* female headed households, managed the day to day allocation of resources to food production independently from their husbands and they had access to some resources. The *de jure* female headed households on the other hand, were constrained by resources such as land and capital. Most of the *de jure* female headed households were headed by widows who lacked control over land since it was under the jurisdiction of their in-laws. This clearly showed that not all female headed households were poor and vulnerable. Characteristics of households were defined and influenced by relationships within the household (intra-household) and between (inter-households) various households. Households were embedded in broader social structures and networks and therefore could not be understood wholly by simply examining their internal dynamics.



Source: Household survey data, 2006-2007

Figure 5.14: Effect of production tools on maize output in different households

Hypothesis 1

H_0: Modern farm technologies have no significant effect on household food security

H_1: ALTERNATIVE

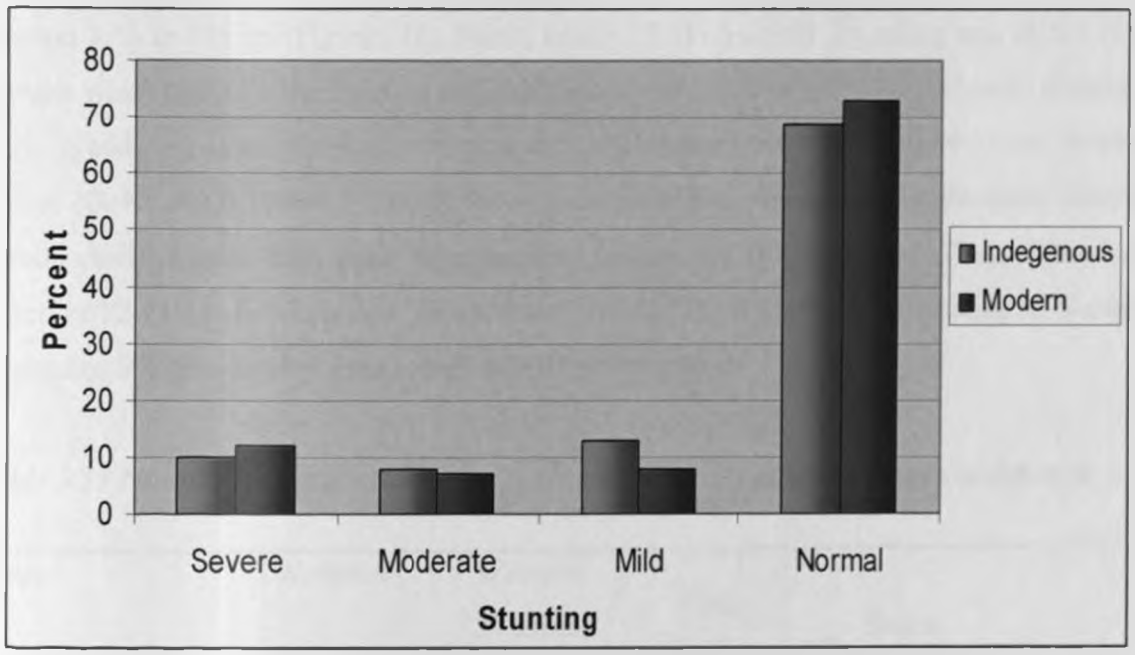
To test the above hypothesis we used ANOVA results showing the effect of expenditure on farm inputs (fertilizers and seeds) on maize yield. The preceding results indicate that farm technologies as demonstrated by expenditure on seeds and fertilizers had a large and significant effect on maize yield ($p \leq .05$). It is also clear that increased expenditure on seeds and fertilizers had a significant effect on household income. The results show that even though households in Busia used ox ploughs and realised higher yield than those who used the hoe, this did not reach a significant effect. Maize yield was influenced by use of fertilizers on hybrid seeds. It is on this basis that we reject the null hypothesis at 0.05 significance level and adopt the alternative hypothesis.

5.4.2 Household headship and nutrition status of children

In order to measure the nutrition status of children, three indices were examined length/height –for- age (stunting) (HAZ), weight –for- age (underweight) (WAZ) and weight –for-height (wasting) (WHZ). Length/height- for -age was used to measure incidences of stunting (chronic under nutrition) which pointed out the linear growth of children. It reflects the failure of a child to receive adequate nutrition over along period of time. Stunting could also be caused by recurrent and chronic illness. The study observed that 37 % of the children were stunted in Busia and 25 % in Vihiga (Table 5.15). Nationally, 30 % of children under age five were stunted (GoK, 2003) and 30.2 % in Western Province. In Botswana Salah, et al., (2006) found that 38.7 % of children under three years were stunted, while in Uganda, 41.6% of children under five were stunted (Turyashemererwa et al., 2009). This study observed that 40 % of the children between 12-23 months were stunted while nationally 43 % in the same age bracket were stunted (GoK, 2003).

With regard to stunting there was slightly higher number of children who were severely stunted in modern households than indigenous households (Figure 5.15). The number of moderately

stunted children were however higher in indigenous households. This indicator therefore did not vary with the season the data was collected. It was most likely that even though modern households produced more maize and received higher income, they were not directing the same to consumption. The income was most likely used to meet other household needs. The complex nature of household access and control of resources necessary for acquisition of food was likely to be another reason.



Source: Household survey data, 2006-2007

Figure 5.15: Stunting in relation to technology

There was a gender difference in nutrition of children of the same age with more boys (37 %) than girls (33 %) being stunted .This observation was also made by KDHS (GoK, 2003). Kennedy and Cogill (1987) also observed that male children performed poorly on all the three measures of growth namely stunting, wasting and underweight cases. However, in Tanzania more boys than girls were found to have better nutrition (Mbago and Namfua, 1991), while in Botswana girls were better nourished than boys (Salah et al., 2006). Abdulkadir, et al (2009) in a study in Western Kenya found that 70 % of school going female children were overweight as compared to 42 % of boys. The better nutritional status for girls could be attributed to the fact that they accompanied their mothers during the daily chores hence were most likely to benefit

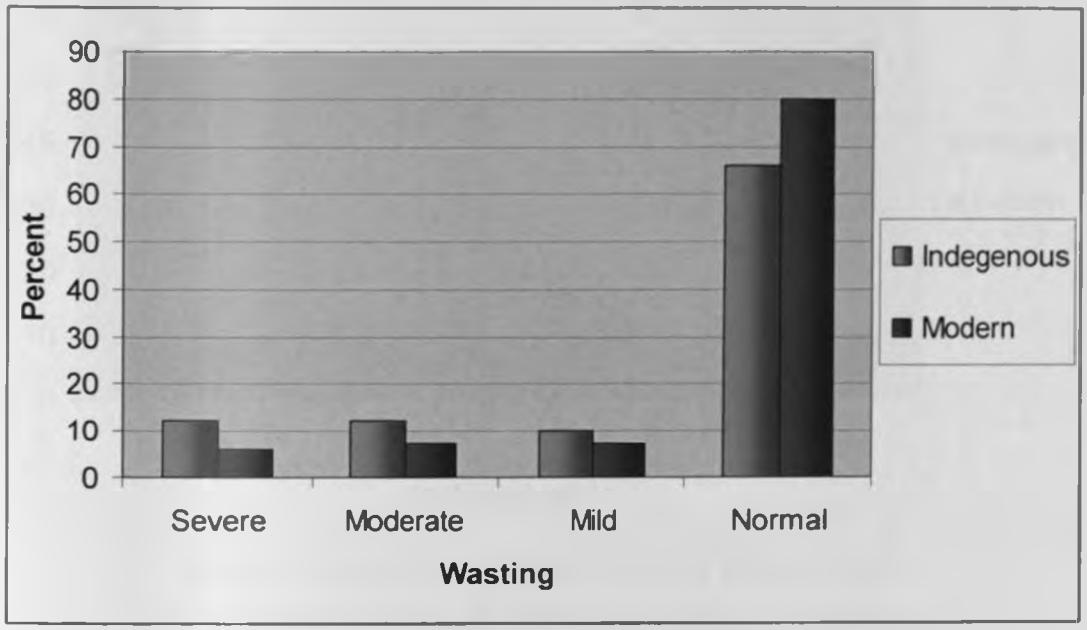
from additional nurturing and feedings. The perceived economic value of girls with regard to pride price could also be another factor contributing to better nourishment as a way of preparing them as future mothers and wives.

Weight –for-height was used to measure incidences of wasting (acute under nutrition). Weight-for-height measured the body mass in relation to body length/height and described the current nutritional status. Children were described as being too 'thin' for their height or 'wasted' if they had Z-scores of less than -2 SD. The study found that 9 % of children were wasted, 16 % in Busia and 3 % in Vihiga (Figure5.16). Salah, et al (2006) observed a wasting rate of 5.5 % in Botswana while Turyashemererwa, et al (2009) observed 3.4 % wasting in Kaborole district in Westrn Uganda. At a national level in Kenya, 6 % of children were wasted and 4.5 % in Western Province (GoK, 2003) (Table 5.15). Children from indigenous households were more severely and moderately wasted than those from modern households (Figure 5.16). There were more children in 12-23 age brackets that were wasted (10 %). The high %age of wasting in Busia as compared to Vihiga was attributed to higher food poverty levels.

Table 5.15 Nutritional status of children in Busia, Vihiga, Western province and Kenya

Indices	*National*	*Western Province*	Vihiga	Busia
Mean Height (cm)	na	na	82.4	81.3
Mean Weight (kg)	na	na	11.2	10.5
% Stunted	30	30.2	25	37
% Wasted	6	4.5	3	16
% underweight	20	19	10.7	14
Total number of children	**5,307**	**739**	**112**	**87**

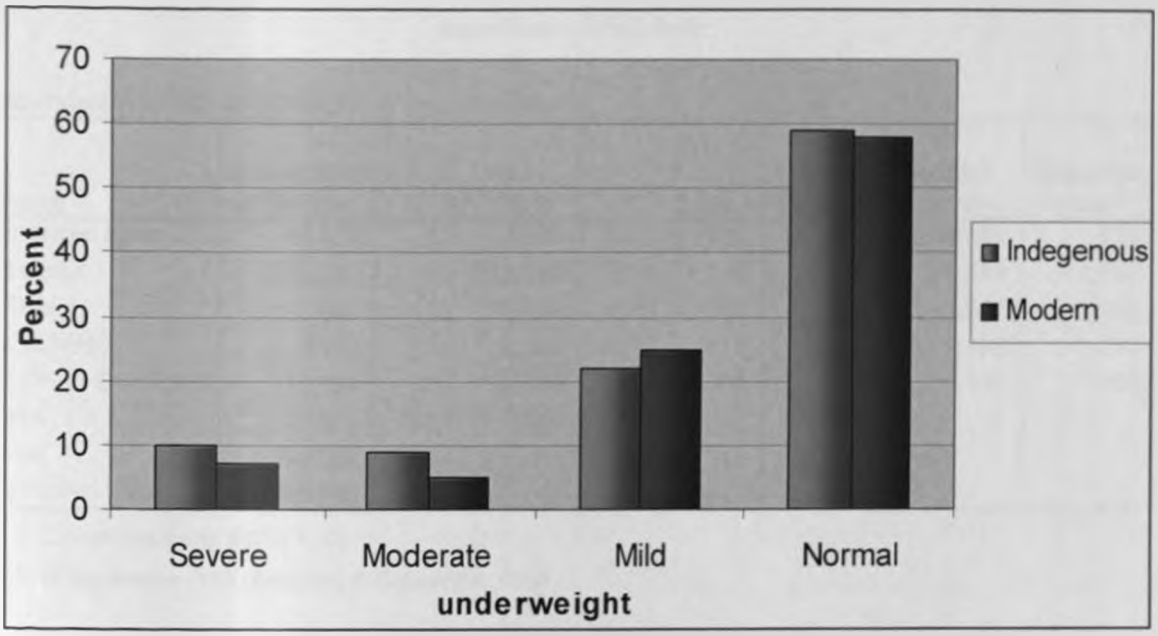
Source: Household survey data 2006-2007 and GoK, 2003



Source: Household survey data 2006-2007

Figure 5.16: Wasting of children in relation to technology

Another index measured was weight -for-age which measured underweight among children. The results showed that 24.7 % of children between 6 months and 60 months were underweight (Table 5.15). This included 14 % in Busia and 10.7 % in Vihiga district (Figure 5.17). This compared favourably with 19 % underweight children in Western Province and 20 % at national level (GoK, 2003). In Western Uganda, Turyashemererwa, et al (2009) found under weight prevalence rate of under fives to be 15.7 %. There was also a variation of underweight children in relation to technology with higher proportion from indigenous than modern households



Source: Household survey data 2006-2007 and GoK, 2003

Figure 5.17: Underweight children in relation to technology

Two -way ANOVA was conducted to test the effect of household headship and technology on nutrition status of children. Stunting was used due to its strength in measuring long term effect of food scarcity as compared to wasting and underweight which may vary depending of the period the data was collected (seasonal variation). The results show a statistically significant effect for household [F (1, 93) = 4.675, p=.0.012] and the ETA Squared shows a large effect (Eta Squared=.091) (Cohen, 1988). However, technology had no significant effect on stunting (TECH p=0.318) (Table 5.16).The combined effect of technology and household headship was also not statistically significant (TECH*HOUSEHOL, p=0.090).

Table 5.16: Two way ANOVA results of effect of technology and household headship on nutrition of children

Dependent Variable: length/height -for -age Z-score

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared	Noncent Parameter	Observed Power[a]
Corrected Model	12.874[b]	5	2.575	2.452	.039	.116	12.259	.750
Intercept	272.323	1	272.323	259.3	.000	.736	259.299	1.000
TECH	1.060	1	1.060	1.010	.318	.011	1.010	.169
HOUSEHOL	9.820	2	4.910	4.675	.012	.091	9.350	.773
TECH * HOUSEHOL	5.196	2	2.598	2.474	.090	.051	4.948	.486
Error	97.671	93	1.050					
Total	595.000	99						
Corrected Total	110.545	98						

a. Computed using alpha = .05

b. R Squared = .116 (Adjusted R Squared = .069)

Source: Household survey data, 2006-2007

Hypothesis 2

H_0 There is no significant difference in food security in various types of household.

H_1: ALTERNATIVE

The above hypothesis was tested using the two way (between groups) ANOVA results shown in Table 5.16. There were two independent variables; household headship (male headed, *de jure* female headed and *de facto* female headed) and technology (indigenous and modern). The dependent variable was height/length-for-age Z-scores, which measures stunting. The results showed large and significant effect for household headship ($p \leq 0.05$) but not for technology ($p \geq 0.05$). On this basis therefore we rejected the null hypothesis and adopted the alternative hypothesis at 0.05 significance level.

Generally, 21 % of rural children were underweight (GoK, 2003). The results show a slightly higher figure than what was observed in Botswana where 15.6 % of children were underweight (Salah et al, 2006). The high number of underweight children in the two districts can be attributed to high levels of food poverty which were at 65.9 % in Busia and 62 % in Vihiga (GoK, 2000b) that limited access to adequate food by households.

5.4.3 Technology and nutrition status of women

Among the households visited, 74 % of women had been sick and only 43 % had visited a health care facility. They cited financial constraint as the reason for not visiting a health facility and not having adequate time to travel to health facilities which were often found far away. In Kenya and Peru, distance and user fees were a large obstacle to women more than men in seeking medical care (Mwabu, et al., 1993; Gertler and Van der Gaag, 1990, cited in World Bank 1997)

Malaria was the most important disease affecting 69 % of the women in the household survey followed by typhoid. This is consistent with national statistics that indicate morbidity and mortality from malaria to be the highest (Amuhaya and Opondo, 2003; MOH, 2000; GoK, 2000c; GoK, 2003). Malaria creates an economic burden through direct costs to the households that have to spent money on preventive and curative measures such as insecticide treated bed nets and anti-malaria drugs. Indirect costs associated with malaria include lost work time through illness or tending to sick adults and children (Chima et al., 2003). High incidences of malaria in the study area was attributed to lower rate of use of treated mosquito nets while typhoid was as a result of lack of clean water and general poor hygienic conditions aggravated by high levels of poverty. The study area had poor tap water supply with rivers, springs and streams being major sources of water. This imposed extra burden on women because of their household responsibilities of fetching water and fuel wood. In Tanzania, women used up to 20 % of their calorie intake collecting water (World Bank, 1997). Barwell and Malmberg-Calvo (1988) observed that on average a woman in Makete region in Tanzania spent 1,600 hours a year (four hours a day) on transport alone and 1,000 hours per year in Ghana (cited in Stackey, 1994). Most of the time used on transport involved carrying water, firewood, and taking maize to the grinding mill (Doran in Starkey, 1994)

The BMI was classified into categories of above or below the cut off point of 18.5kg/m^2 (GoK, 2003). This is regarded as grade 1 of Chronic Energy Deficiency. Table 5.17 shows that the mean height for women in Vihiga was 159cm, while that of Busia was158cm .This compared favourably with height of 159 cm that was observed in Kenya Demographic and Health Survey (KDHS) (GoK, 2003) but was much higher than 153.6cm observed for women in Coast province

(Hoorweg et al., 1995). The mean weight was 56kg for Vihiga while for Busia it was 57kg (Table 5.17). In Coast province, Hoorweg et al (1995) observed mean weight of 48.0kg which was much lower than what this study observed in Busia and Vihiga.

Women in Busia had BMI of 22.7 while those from Vihiga had 21.9 (Table 5.17). This fell within the normal range but was slightly lower than a mean BMI of 23 observed by KDHS (GoK, 2003). Only 1.8 % of women in Vihiga were found to be severely thin with a BMI of less than 16. In Coast province 24.7 % of women had a BMI of less than 18.5 (Hoorweg et al., 1995). According to KDHS, 2003 only 2 % of women in Kenya were severely thin (BMI ≤16.0).

Table 5.17: Nutrition status of women in Vihiga, Busia, Western province and Kenya

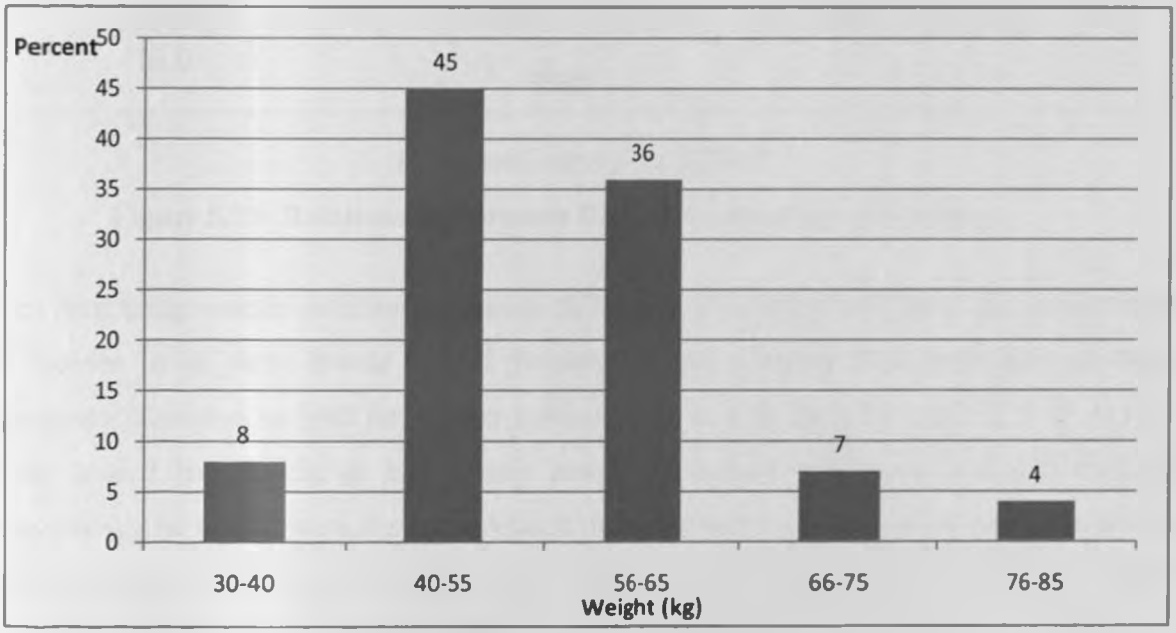
egion	*Weight average*	*Height averag (cm)*	*BMI (Kg/n*	*% of women with CED*	*% overweig*	*Number of women*
usia	56.7	158	22.3	0	14.0	87
ihiga	55.9	159	21.7	1.8	16	112
Vestern	na	160.9	22.1	1.0	16.4	798
ation	na	159	23	2	23	7047

Source: Household survey, 2006-2007 and GoK (2003)

Figure 5.18 shows that 8 % of women had body weight of between 35-45 kg. These are the women who were at high risk of giving birth to underweight babies and also having other delivery related complications (World Bank, 1997). Children born to malnourished mothers or mothers who were malnourished during childhood, can suffer cognitive losses that are associated with lower productivity and low incomes when adults. Malnutrition affects the intellectual and

physical development of children hence good health of the mother is crucial for the wellbeing of the child

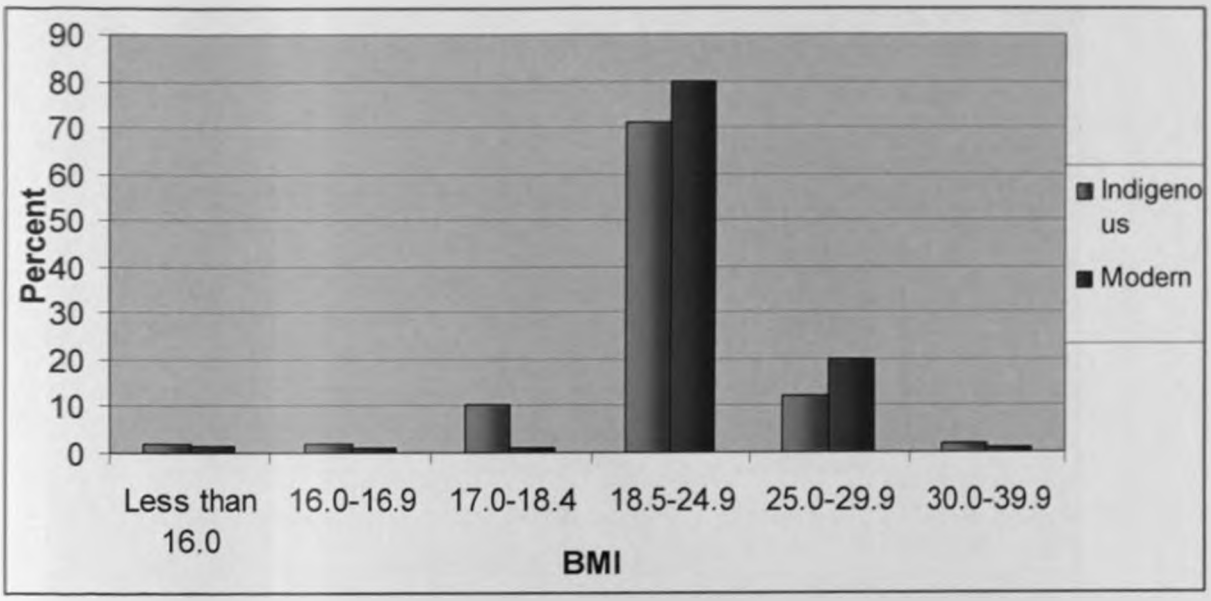
There were 14 % of women in Busia who were overweight as compared to 16 % in Vihiga district. GoK (2003) observed that 23 % of women nationally were overweight with the highest proportion (41 %) falling in 45-49 age bracket. This study also found ages of overweight women to be in 40-45 age bracket while those who had lower BMI were in 30-34 age brackets.



Household survey 2006-2007

Figure 5:18: Percentage of women in different weight groupings

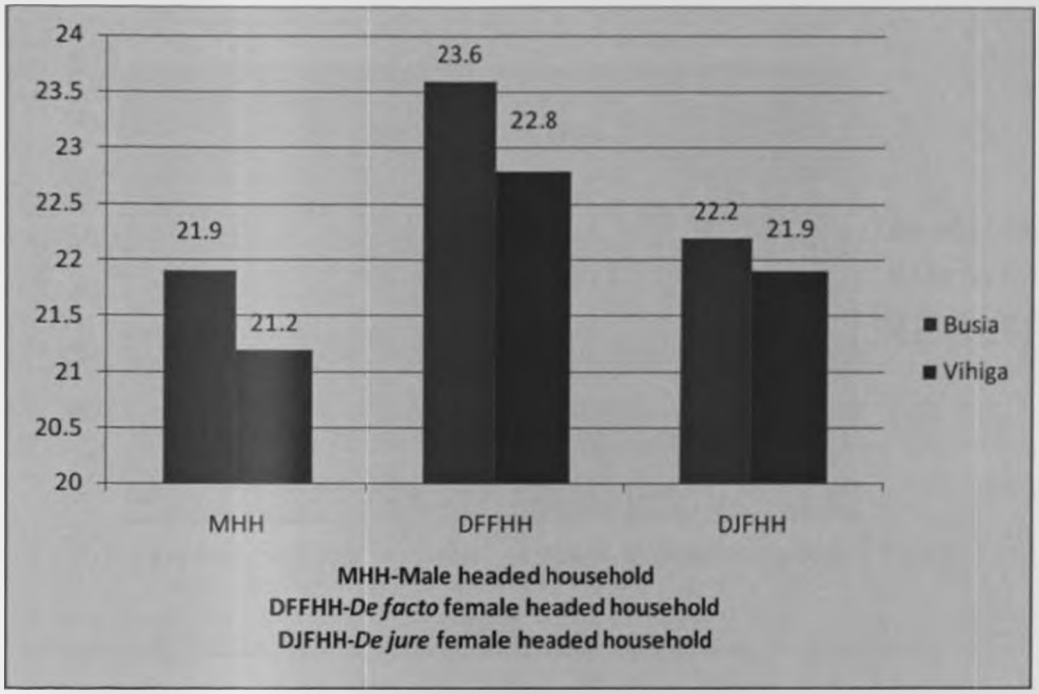
There was a slight difference in BMI of women according to technology orientation with indigenous households having a mean BMI of 21.95 while those from modern households had 23 .Figure 5.19 shows that the women who had a BMI of less than 18.5 came from indigenous households. There were also more women from modern households that had higher BMI of over 18.5. Women from modern households were also much more likely to be overweight (BMI≥ 25.0) than those from indigenous households.



Household survey 2006-2007

Figure 5.19: Relationship between BMI and technology orientation

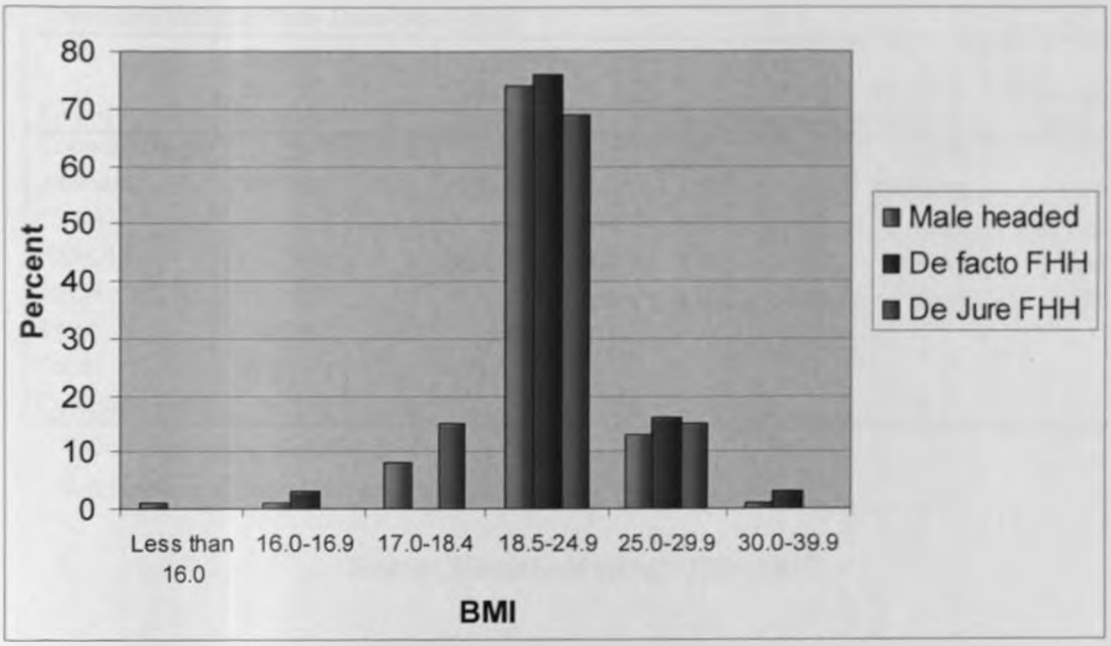
When comparing women nutrition in relation to household headship (Figure 5.20), it was found that women in *de facto* female headed households had a higher BMI than those in other households. Variation in BMI for women in Busia district was 23.6, 22.2 and 21.9 in *de facto* female headed households, *de jure* female headed households and male headed households respectively. The results were similar in Vihiga district where women in *de facto* female headed households had a BMI of 22.8 while those from *de jure* female headed and male headed households was 21.9 and 21.2 respectively.



Household survey 2006-2007

Figure 5.20: Variation in BMI in different households in Busia and Vihiga

Figure 5.21 shows that there were more women who were thin (BMI ≤16.0) from male headed households than from female headed households .It is evident that 1.8 % of women who had BMI of less than 16 (severely thin) came from male -headed households. Generally, although there was a difference in BMI in different households (Figure 5.20), the mean in all households fell within the normal condition. This meant that majority of women in the two districts were adequately nourished.



Household survey 2006-2007

Figure 5.21: Variation in BMI in relation to household headship in the study area

In order to test whether there was significant difference in nutrition of women in relation to household headship, two- way ANOVA tool was used. Body Mass Index was used as the dependent variable while technology orientation and household headship were independent variables. ANOVA results showed no significant effect of household headship on BMI of women [F (1, 93) =0.107, p=.898] (Table 5.18). Likewise technology orientation did not have a significant effect on women nutrition status ($p \geq .05$). The combined effect of household headship and technology (TECH*HSHOLD) was also not statistically significant [F (1, 93) =0.915, p=.404] (Table 5.18).

Table 5.18: ANOVA results of technology and household headship on maize output

Dependent Variable: Body Mass Index (BMI)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Corrected Mode	2 277[b]	5	.455	.972	.439	.050	4.860	.333
Intercept	893.535	1	893.535	1908	.000	.954	1907.605	1.000
TECH	.638	1	.638	1.363	.246	.014	1.363	.211
HSHOLD	.100	2	025E-02	.107	.898	.002	.215	.066
TECH * HSHOL	.857	2	.428	.915	.404	.019	1.830	.204
Error	43.562	93	.468					
Total	1662 000	99						
Corrected Total	45 838	98						

a. Computed using alpha = .05

b. R Squared = .050 (Adjusted R Squared = -.001)

Source: Household survey 2006-2007

Hypothesis 3

H_0. The use of modern farm technologies has no significant effect on the nutrition status of women and children.

H_1: ALTERNATIVE

To test the above hypothesis, two way (between groups) ANOVA was used. Technology and household headship were used as independent variables while BMI and height-for-age Z-scores were used as dependent variables. The results show that technology use had no significant effect on nutrition of women and children ($p \geq 0.05$) (Tables 5.16 and 5.18). However, household headship had a significant effect on children ($p \leq 0.05$) (Table 5.16). It is on this basis that we accept hypothesis 3 at 0.05 significance level.

5.4.4 Discussion, conclusions and implications

More than 80 % of the women in reproductive age had normal Body Mass Index (BMI) hence Chronic Energy Deficiency (CED) was not a major problem in the study area. Even though there were a few cases of CED, especially in male headed households and indigenous households, the results indicated that this did not reach statistical significance ($p \geq .05$). The results compared well

with the Demographic and Health Survey results (GoK, 2003) which found BMI of majority of women in reproductive age to be normal (between 18.5 and 24.9).

The study also observed that household headship had a significant effect on the nutrition of children ($p \leq .05$) but not for women ($p \geq .05$). This was attributed to the different resources that households had at their disposal that affected their access to food and the care they provided to their young children. Children were also more vulnerable to malnutrition as compared to their mothers. *De jure* female headed households were the most affected by food poverty and there were higher incidences of malnutrition from these households as compared to male headed and *de facto* female headed households. Children from *de facto* female headed households were also better nourished than those of male- headed households. This compared well with various studies that observed that women spent more of their income on food and care of their children hence in households where they had some control over income, there was a likelihood of improved nutrition status of household members especially the children (Kumar, 1994; Kennedy, 1989; Kennedy and Cogill, 1987; Kennedy and Cogill, 1988; Kennedy and Peters, 1992). Other important factors that affect children nutrition include; education level of mother, age of child, receipt of information on child feeding, illness and time of introduction of other foods (Turyashemererwa et al., 2009).

The high incidence of stunting in both districts requires various programmes that provide supplementary feeding for children under five. There is also need for nutrition awareness campaigns to encourage mothers to adopt appropriate nutrition practices and to better utilize various food stuffs grown in the region in order to enhance the nutrition levels of their children. Emphasis should also be put on enhancing the well being of women in various aspects such as decision making at household level, improvement of income, in addition to better access to maternal heath.

Technology orientation positively affected the production of maize the staple crop and also the income accrued from crop sales. However, this did not have any effect on the nutritional status of both women and children. It clearly showed that households had many needs that they strived to meet apart from food requirements. Any additional income did not necessarily go towards

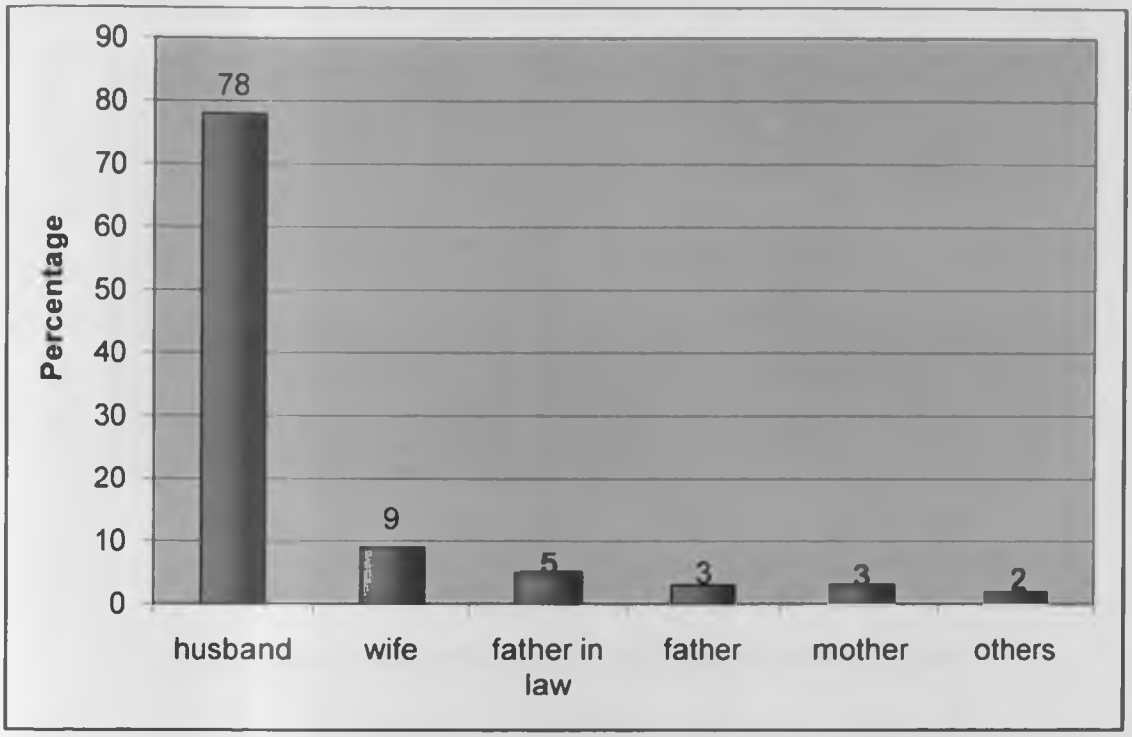
meeting the consumption needs but was used to meet other necessities such as building a house, paying school fees, buying clothing among others. In a study of the impact of cash crop farming on food security in Western Kenya, Kennedy and Cogill (1987), observed no significant difference in nutrition status of children in households that grew sugarcane and those that did not despite the fact that the former had higher income.

5.5 GENDER SPECIFIC CONSTRAINTS THAT AFFECTS THE IMPACT OF TECHNOLOGIES ON FOOD SECURITY

In this section the gender specific constraints that affect the adoption and impact of farm technologies on household food security are analysed. An evaluation of such constraints was useful in identification of policy recommendations necessary for improvement of the productivity of both male and female farmers.

5.5.1 Access to and control of land resources

Access and control over land resources was by far the most important constraint facing women farmers. The results indicated that a large percentage of land was owned by men (78 %), while women owned only 9 % of the land (Figure 5.22). Majority of the women owned the land through their male relatives (fathers, brothers, sons, uncles and brother-in-laws). Similarly 69 % of husbands controlled the land and capital resources necessary for food production while their wives controlled only 27 %. Where the husband was not present for instance in some *de facto* households, the sons controlled the resources .This results are consistent with those of Fakoya (2004) where 91.3 % of the women gave access to land and control over land resources as some of the important factors necessary for improving sustainable crop farming activities in Ogun State of Nigeria.

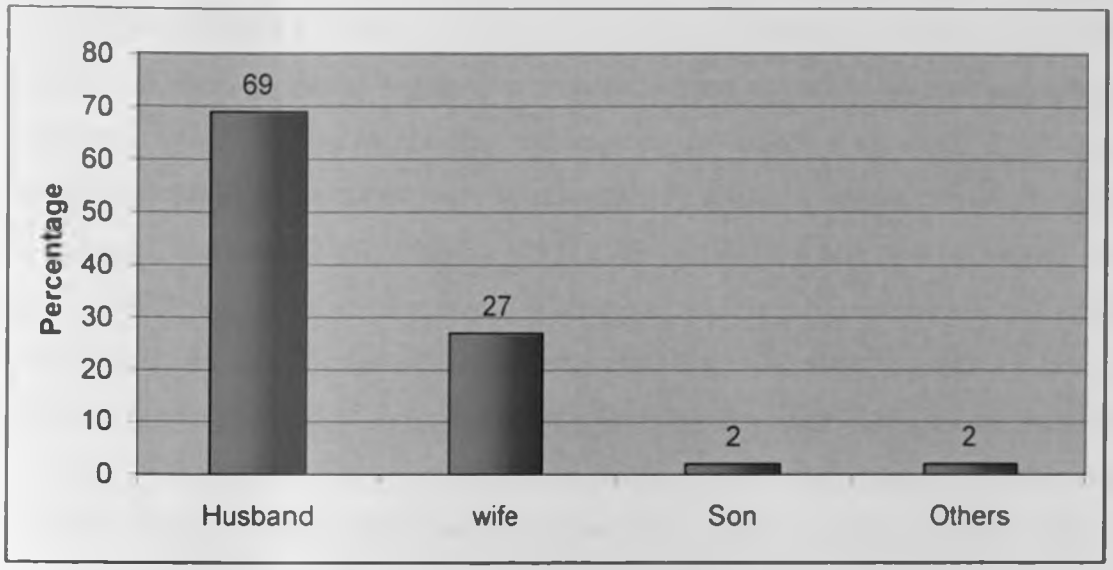


Source: Household survey 2006-2007

Figure 5.22: Land ownership by household members

Although the proportion of women heads of household continues to grow in Kenya, women's entitlement to land resources continued to be just a dream. Land reform programmes and the break-up of communal land holdings continued to transfer exclusive land rights to males as heads of households (Quisumbing, 1994). Lack of entitlement to productive resources by women especially de jure female headed households, was one of the major constraints that limited agricultural productivity and accounted for the slow attainment of national food security goals. The insecure land tenure reduced the likelihood of women investing much of their time and resources on land, or even adopting environmentally sustainable farming practices such as planting trees (Otsuka and Quisumbing, 1994).

Women and men had control over the production of different crops, and performed different tasks in the production cycle. This implied that women and men had access to different income, incentives and services depending on the importance attached to the crops in the national food security strategy.



Source: Household survey 2006-2007

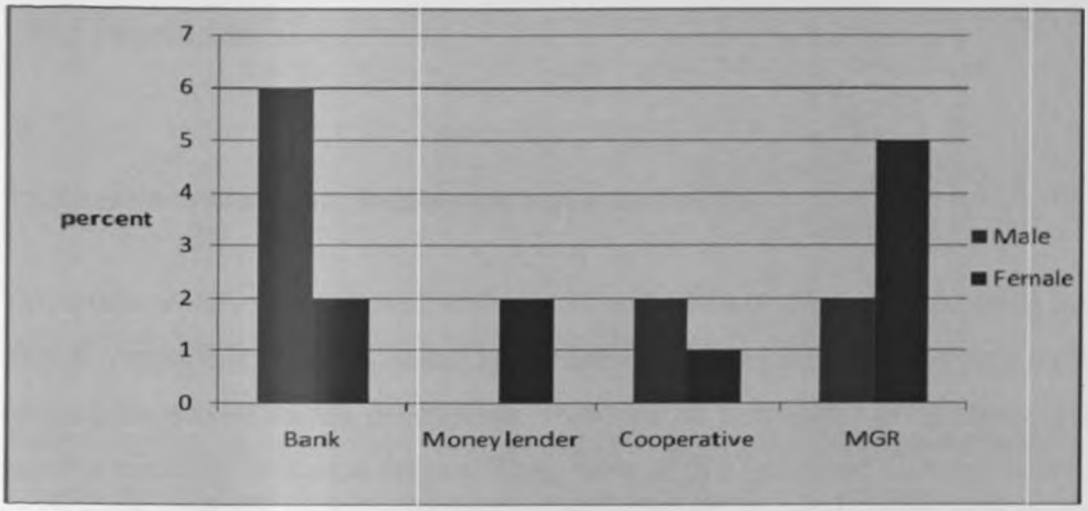
Figure 5.23: Person who controls land and capital resources

5.5.2 Access to credit facilities

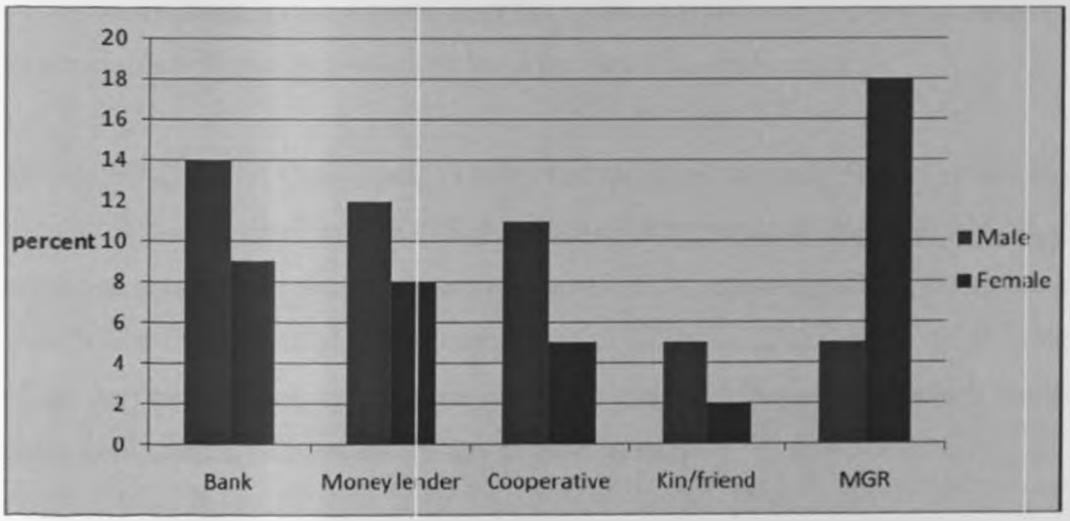
Access to credit was the second most important constraint facing both male and female farmers. New technologies made the households to depend on the market for the supply of inputs namely seeds and fertilizers. The new inputs were expensive compared to average income of the farmers therefore accessibility to credit facilities from various institutions such as banks, cooperatives and other informal institutions was necessary. Women were rarely members of co-operatives, which often distributed government-subsidized inputs to smallholder farmers. In addition, they lacked the cash income needed to purchase inputs even when the same inputs were subsidized by the government. Facing restricted accessibility to formal credit, women relied heavily on informal sources of credit from family, friends and traditional moneylenders. Rotating savings and credit associations fulfilled economic as well as social purposes (Salasya et al., 1998, Salasya, 2005; Quisumbing, 1996). However, these informal credit institutions were not always dependable; they often had high cost and offered limited capital. Many did not offer a secure place to save money or earn a return on savings. The large percentage of women who accessed credit through informal sources indicates the willingness of women to acquire credit, yet none of the women interviewed had access to credit from Kenya Women Finance Trust (KWFT) - an indication of unfavourable borrowing conditions for smallholders. This study established that

men had access to credit from banks, moneylenders, and cooperatives while women sources of credit were kin/friend and Merry Go Round (MGR) locally referred to as '*lisanga*' (Figure 5.24). Funds from merry go round was used by women to meet various needs such as buying utensils, furniture, clothes, paying school fees and meeting household food needs. In Vihiga district money from MGR was used for dairy farming and consequently helped to raise the income level of women (Wanyama, 2001; Mutoro, 1997). This showed the potential of women to increase farm productivity and their livelihoods if they had access to more reliable and secure credit source. In Busia, due to relatively larger farm sizes, the MGR also served as a source of labour for members for free and to non-members at a fee. Labour was provided to each member in turn, on a mutual aid basis and to non-members on a contractual basis to enable the group members to generate income. Occasionally women groups helped members during funerals and weddings either in cash or in materials.

Access to credit facilities was essential to improve food production as well as for consumption purposes. Borrowing for consumption by households, generally increased when incomes were temporarily depressed, either because of seasonality in agricultural production or because of reduced crop incomes due to unfavourable weather. Since women rarely had physical collateral for credit acquisition, most of credit from formal sources went to men. Women farmers were as productive as male farmers when they were given access to resources (Saito and Spurling, 1992; Mutoro, 1997). Provision of inputs and access to credit was emphasized by 76 and 80 % of women respectively as important factors that facilitate sustainable crop production activities in Ogun State of Nigeria (Fakoya, 2004)



a) **Busia**



b) **Vihiga**

Source: Household survey 2006-2007

Figure 5.24: Sources of credit according to gender

In this study majority of households in Busia did not have access to credit (90 %) while in Vihiga, 41 % of households had access to credit. Out of the households that had access to credit in Busia, 7 % had received a loan in the year preceding the study .In Vihiga more households (39 %) had accessed loans. Very little of the credit acquired went towards crop production while most of it was used for animal husbandry (50 and 61 % in Busia and Vihiga respectively). The use of credit for animal husbandry in Vihiga underscores the importance of dairy farming as a

source of income. Some credit went towards education of children (19 % and 10 % in Busia and Vihiga respectively)

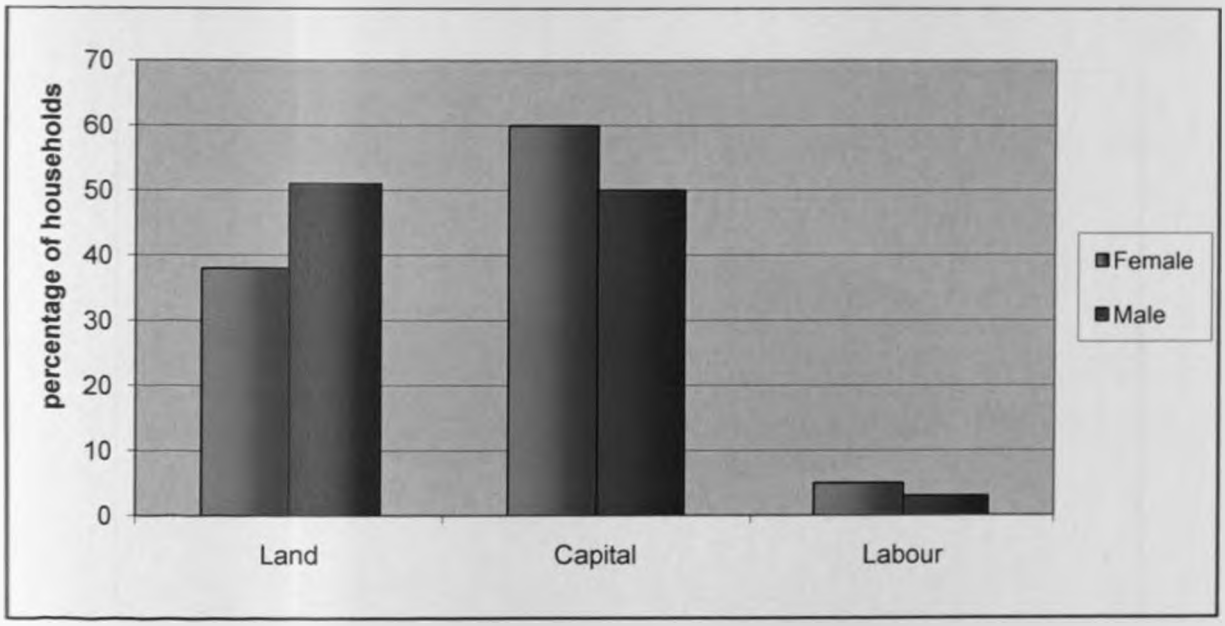
5.5.3 Access to education, training and extension services

The results in this study showed that only 20 and 18 % of the household heads in Busia and Vihiga respectively had been visited by an extension officer, thus demonstrating the inadequacy of extension service among smallholders. There was no discrepancy in the number of males and females visited by extension officers. There were 20 % of men and 21 % of women who were visited by extension officers .This contradicted the earlier belief that extension officers preferred to talk to the men who were heads of households (Saito et al., 1994; Lastarria-Cornhiel, 1988; Saito and Spurling, 1992). Only 4 % of the visits were solicited while 15 % were unsolicited. A larger number of men than women visited the farmer training centres.

Studies (FAO, 2002; Quisumbing, 1994b) had indicated that only 5 % of extension services had been addressed to rural women in Sub-Saharan Africa, while no more than 15 % of the world's extension agents were women. There was potential in improving access to extension not only to smallholder farmers but also to women. Another limitation of extension was the continued focus of the services on cash crops rather than food and subsistence crops, which were the primary concern of women farmers and the key to food security.

Women have always had little access to the benefits of research and innovation. This has been attributed to their dominance in subsistence food sector that had very low priority in crop improvement research and national food security strategy. In addition, women farmers' roles and needs were often ignored when devising technology that could cause labour displacement or increased workload. Although rural women were knowledgeable about and use traditional technologies, they had little access to modern technologies that could benefit them in their productive and reproductive activities. This was due to their lack of participation in setting research agenda or in enhancing and disseminating conventional technologies and local knowledge.

When asked about the most limiting factor of production, over 50% of women indicated capital, which includes both financial resources as well as farm equipments. On the other hand, 50% of the men indicated land as the most limiting factor (Figure 5.25). The women were unable to make decisions on the tools to use due to financial constraints as well as limited decision-making opportunities at the household level. In addition, the meagre income they had access to, was used in meeting the food security needs of the households. Given financial empowerment women would prefer to use technologies that reduced drudgery and time.

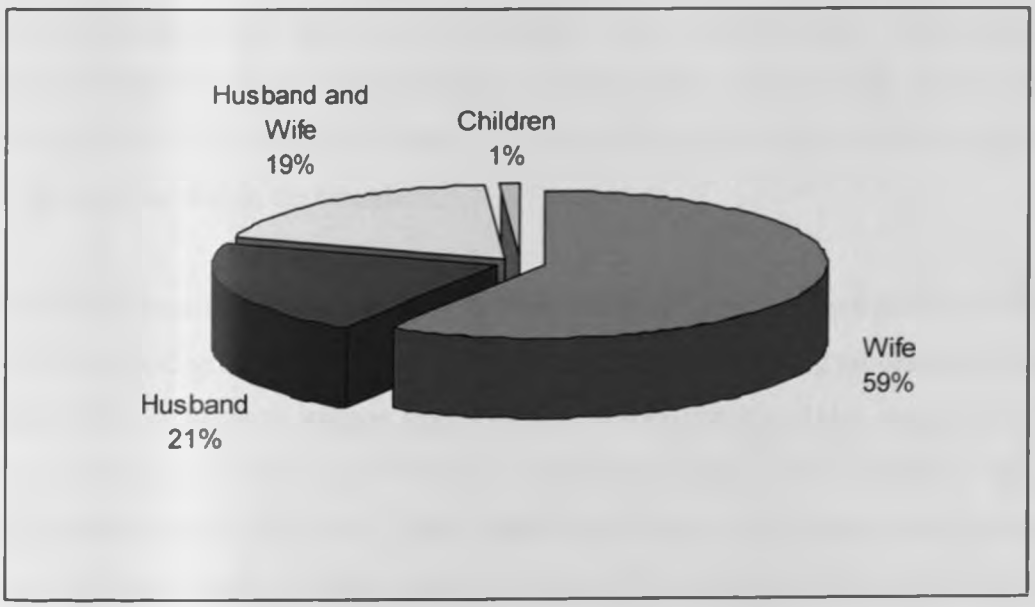


Source: Household survey 2006-2007

Figure 5.25: Most limiting factor of production according to gender

The results showed that men dominated in decision making on farming activities and choice of production tools. Husbands in both districts made over 70 % of decisions on tools. Women were limited on their decision-making opportunities probably due to their inadequate access to financial resources and little control over resources. Although great efforts had been made to develop technologies for land preparation -that fell under men's domain- very few technologies were available to women to perform activities that fell within their sphere. For instance, the use of land preparation technologies such as ox drawn ploughs increased land under cultivation, however, the limited weeding technologies increased women's workload. Over 50 % of women

were affected by labour changes caused by technology use as compared to 21 % of men (Figure 5.26). Use of HYV, fertilizers and mechanization increased the intensiveness of farm operations, thereby increasing demand for women's labour. This was also observed in India where introduction of mechanization not only increased workload but also depreciated wage rates for women from poor and landless households (*www.fao.org/FOCUS/E/Women/green-e.htm).* Women constantly face difficult choices in their time allocation decisions hence it is crucial that new technologies relieves women's time burdens in agricultural production and household maintenance without sacrificing their ability to earn independent income.



Source: Household survey 2006-2007

Figure 5.26: Household members affected by labour changes caused by technology

5.5.4 Access to and control over income

Control of income implies decision making about its use while access implies conditionality about using it and how it is used. The results in this study showed that majority of men controlled both off farm income (66 %) and farm income (55 %) (Figures 5.27 and 5.28). This implied that the women hardly had control of necessary income for agricultural production and provision of household nutrition needs. More women controlled farm income (36 %) than off

farm income (Figures 5.27 and 5.28). This was attributed to their dominance as full time farmers and the fact that they were more engaged in selling of farm produce. Their reproductive roles and their lower education levels reduced women's access to off farm employment. Women mostly controlled income from vegetables, poultry and some traditional crops such as millet. Income from traditional crops such as cassava and sorghum that are important in the diet of households in Busia was under men's control.

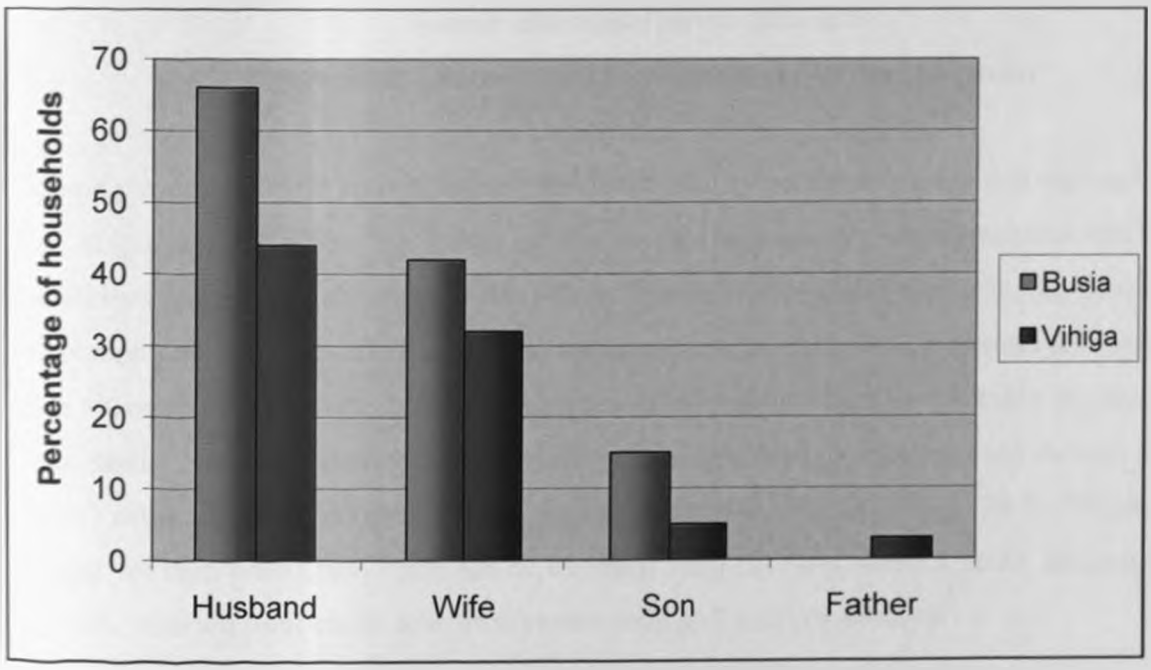
In majority of the households (53 %) income expenditure was done through consultation between husband and wife (jointly) while in 47 % of the households expenditure flow was separate. During the FGDs it emerged that even in situations where decisions on resource allocation were made jointly, the men had a final say meaning that women's views were rarely incorporated. Whatever income the household received either through credit or remunerations did not always benefit all members equally. Access to the income depended on position and status of the member within the household.

Improvements in household food security and nutrition are greatly associated with women's access to income and greater involvement in household decision making process particularly on expenditure. This is because women tend to spend a significantly higher proportion of their income than men on food for the family (Thomas and Chen, 1994; Smith et al., 2003; Quisumbing and Malucio, 2000). In Central American countries, for example, when grain grown by men was in short supply, income earned by women from the sale of eggs, cheese, fresh and processed fruit, vegetables and small stock contributed significantly to household food and non-food needs (IFPRI 2000; FAO 2001). In Philippines, Garcia (1991) observed that in households where women earned higher incomes, there were lower incidences of under five fever and cholera. While in Rwanda, cash income earned by a woman was positively and significantly associated with household calorie consumption (Braun et al., 1991).

Women's wage income from farm and non-farm employment, and from other income opportunities, is of particular importance for landless and near-landless rural households. Women's purchasing power was not only limited to buying food and other basic assets for themselves and their families, but also to paying for inputs used in food production. Thus, to

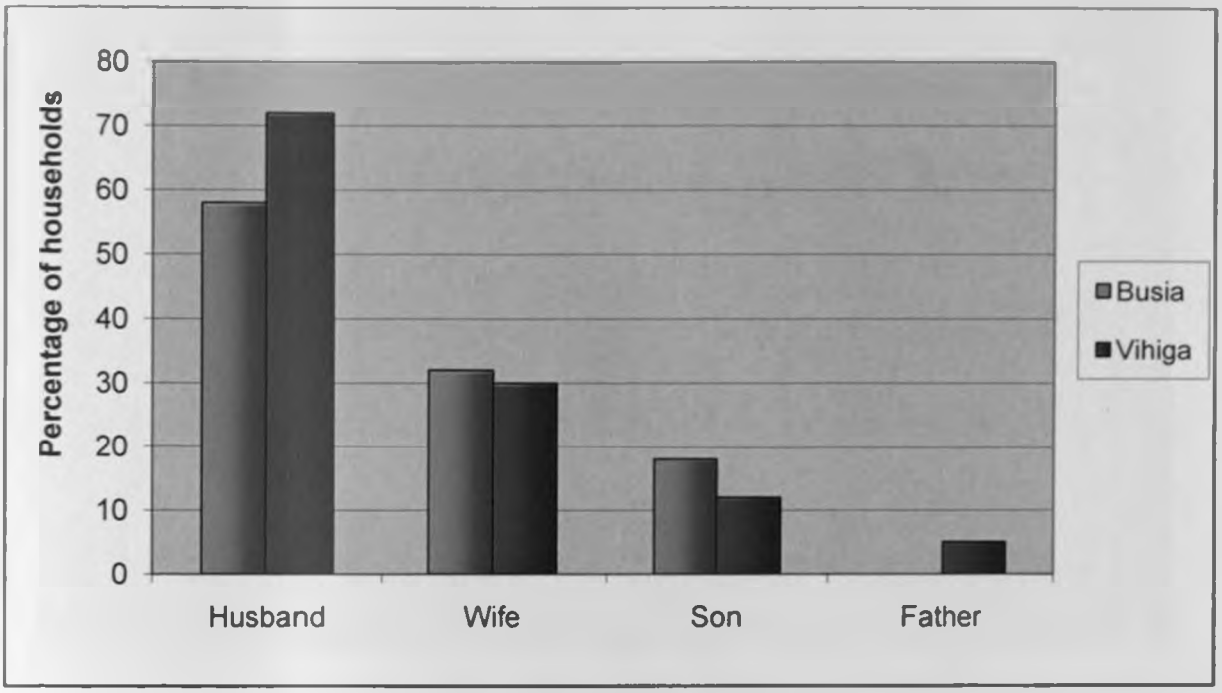
improve food production for the household, greater priority had to be given to increasing women's participation in market production as well as other income-generating activities.

The study also observed a discrepancy in amount of wages in relation to gender. The women earned Ksh.50 for farm work while men earned ksh 70 per day in Busia. The wage labour was more costly in Vihiga with women earning between ksh 50-70 per day, while men earned Ksh.70-100. This however, depended on the nature of farm work and whether or not meals were provided during the work. In a study in Northwest Rwanda, Braun and Wiegand-Jahn (1991) observed that despite the fact that female incomes were lower than total male incomes and men had 10 times as much off farm earnings as compared to women, there were no female-headed households with severely malnourished children. Likewise in Cote d'Ivoire the share of household cash income earned by women in the household had a positive and significant effect on budget share for food.



Source: Household survey 2006-2007

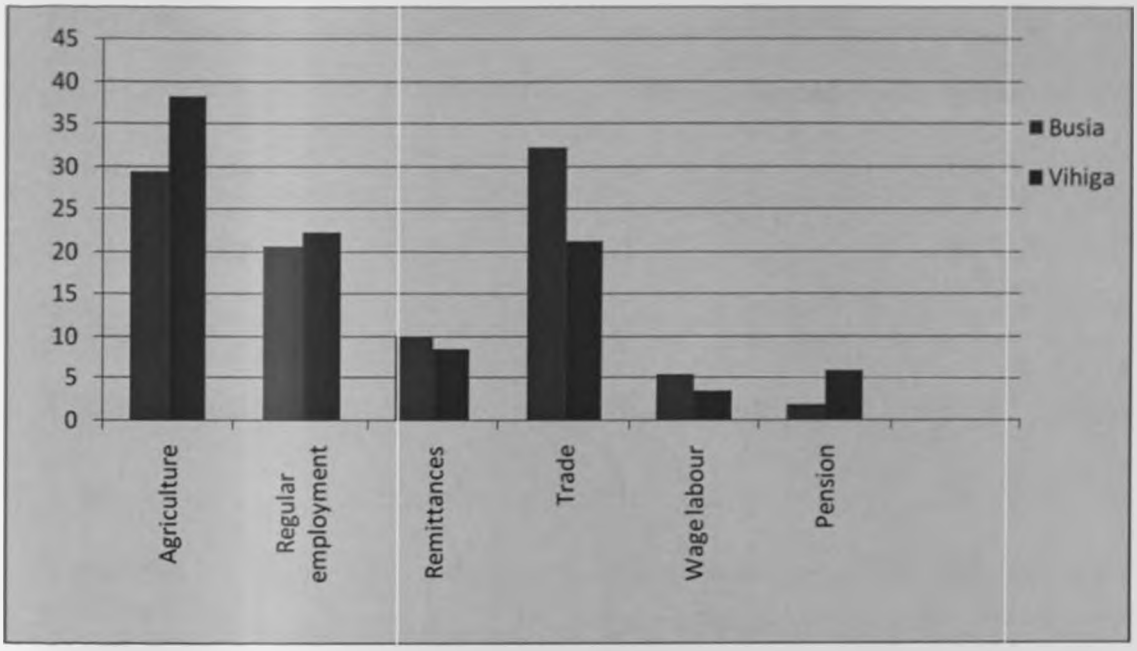
Figure 5.27: Control of farm income according to gender



Source: Household survey 2006-2007

Figure 5.28: Control of off farm income according to gender

Income played important role in meeting the food security needs of a household and paying for the cost of production. When the source of the income was secure, the households could cushion themselves against climatic vagaries that reduced production over and above buying farm inputs. As population pressure reduced farm sizes to uneconomical levels, it was important for households to have alternatives sources of income so that they could improve their accessibility to food and other basic needs. The study observed that majority of households in Busia received income from trade (70 %) while regular employment was a major source of income in Vihiga (90 %) (Figure 5.29). If income for crop production could not be obtained from off farm sources, trade, and agriculture, it had to be attained from credit sources to ensure food and nutrition security.



Source: Household survey 2006-2007

Figure 5.29: Source of income for households

5.5.5 Gender Analysis

a) Access and control of resources according to gender

Table 5.19 provides a summary of resources and who had control and access over them. Men had control over resources such as land, farm equipments, labour (including their wife's), credit, extension and cash. The women controlled basic needs such as food and together with their husbands they had control over education and training of themselves and their children (Table 5.19). In Ethiopia, Agarwal (1994) observed that men controlled use of draught power, sale of livestock hides and skins, while women had control over milk and milk products, dung, building materials and household fuel. Generally in many countries in Africa, women own and care for small animals such as chickens, goats and sheep, traditional crops and vegetables.

Table 5.19: Access and control of resources and benefits

Resources	*Access*		*Control*	
	Women	*Men*	women	Men
Off-farm income	*X*	*X*		X
Asset ownership	*X*	*X*		X
Basic needs	*X*	*X*	X	
Education/training	*X*	*X*	X	X
Land	*X*	*X*		X
Equipment	*X*	*X*		X
Labour	*X*	*X*		X
Cash	*X*	*X*		X
Benefits				
Credit	*X*	*X*		X
Extension	*X*	*X*		X
Incentives	*X*	*X*		X
In Cash	*X*	*X*		X
In kind	*X*	*X*	X	

***X** indicates who has access or control*

Source: Household survey 2006-2007

B) Division of labour according to gender

According to Table 5.20 there were various factors that influenced division of labour within the household. These were either constraints or opportunities for the households in terms of their

provisioning mechanisms. During the FGD, community norms, social hierarchy and social factors were mentioned as constraints due to the way they sidelined women in various aspects such as ownership of productive resources and their designation of gender roles. Institutional structures, legal parameters and training were given as opportunities since they empowered both men and women in recognizing their rights as well as providing a legal framework through which disadvantaged groups such as women found avenues for redress. Demographic, economic and political factors were seen as both constraints and opportunities in the access and control of resources for both men and women (Table 5.20).

Table 5.20: Factors that influence gender division of labour, access to and control over resources

Influencing factors	*Constrain*	*Opportunities*
Community norms and social hierarchy	X	
Demographic factors	X	X
Institutional structures		X
Economic factors	X	X
Political factors	X	X
Social factors	X	
Legal parameters		X
Training		X

Source: Household survey 2006-2007

C) Activity Analysis according to gender

Table 5.21 presents results of activity analysis of women. The daily calendar shows that women woke up very early (4.00 am) and were always the last to go to bed (10.00 pm). On average they spend 8 hours per day on household chores and another 8 hours on farm operations. All of the household chores and farm work were performed without the aid of any labour saving device. Since women were fully occupied with household chores and farm work, they hardly had time to

attend to their own health and nutrition needs let alone time for social activities. This put them at high risk of developing stress related ailments and back pains. In a study in Oyo State of Nigeria, Lawal, et al (2004) observed that time constraints was one of the factors that limited women's participation in food security and nutrition programmes implemented by the government.

Table 5.21: Daily calendar by gender (women)

Time	Activity carried out
4.00-5.00 am	Wake up and pray
5.00-5.30 am	Prepare fire and warm water for washing face
5.30-6.30 am	Cleaning of house and homestead
6.30-6.45 am	Give breakfast to husband, and children
6.45-12.00 noon	Farm work
12.00-1.00 pm	Prepare and eat lunch with the family
1.00-1.30 pm	Clean plates
1.30-4.30 pm	Farm work
4.30-6.00 pm	Clean the children, warm water for the husband
6.00-7.00 pm	Prepare and eat dinner with family
7.00-8.00 pm	Wash utensils
8. 00-8.30 pm	Pray and prepare to go to bed
8.30-10.00 pm	Bedroom issues
10.00-3.00 am	Sleeping time
3.00-.4.00 am	Bedroom issues
4.00-5.00 Am	Wake up and pray

Source: Household survey 2006-2007

Table 5.22 shows the daily calendar of men. Unlike women, the men woke up two hours later than women (6.00am) and retired to bed two and half hours earlier than women (7.30 pm). They spent no time on household chores and about 6 hours on the farm per day. Unlike women they had more time to rest and socialise with their friends.

Table 5.22: Daily calendar by gender (men)

Time	Activity carried out
6.00-6.30 am	Wake up and pray
6.30-7.00 am	Wash the face and have breakfast
7.00-12.00 noon	Farm work
12.00-1.00 pm	Have lunch
1.00-2.00 pm	Resting time
2.00-4.00 pm	Farm work
4.00 pm	Retire from the farm
4.00-6.00 pm	Rest/socialize with friends
6.00-7.30 pm	Take a bath and eat dinner
7.30 pm	Retire to bed
7.30-10.00 pm	Bedroom issues
10.00-3.00 am	Sleeping time
3.00-4.00 am	Bedroom issues
4.00-6.00 am	Sleeping
6.00-6.30 am	Wake up and pray

Source: Household survey 2006-2007

Smallholder agriculture is labour intensive production system that requires allocation of labour time by all household members to productive activities. There were certain activities that were regarded as men's while others were women's (Appendix IVa and IVb). Gender roles were differentiated on the basis of physical ability, skill, care and diligence. Land preparation (slashing, stumping and ridging) was done by men because it was a strenuous activity. Processing activities such as winnowing, milling and cooking were performed by women since they required a lot of skill, patience and endurance (Appendix IVa and IVb).This gender segregation of roles was also observed by Bacho (2004). Unlike Northern Ghana where men were in charge of storage and control of food (Bacho, 2004), this study observed that this activity fell within the domain of women. Women controlled the day to day allotment of food in 80 % of

the households. In households where men managed household food resources there were many complain of the food being sold to meet personal needs and for drinking.

5.4.6 Conclusions

The preceding section has shown that many problems that limit agricultural productivity among smallholders are not gender neutral. Both men and women faced various constraints that limited their ability to produce more food and earn extra income in order to improve their wellbeing. There were some constraints, however, such as lack of access to income, credit and land that were unique to women. On the other hand, there was no discrepancy in access to extension between men and women. This means that policy interventions must be gender specific if tangible results in terms of productivity are to be realised.

Diversification of household income could help households to intensify their farms in addition to helping the households to meet other household needs. Kenya has a new land policy in place that when implemented will enable women to have inheritance rights. This will improve the ability of very poor households to have access to land, a major source of livelihood. This is particularly important for those *de jure* female headed households. It should be noted however, that there exist many challenges in the implementation of new land policy. One important challenge is the predominance of men in decision making in customary law institutions which in most cases has precedence over modern law.

It is also clear from the preceding section that women are constrained by time hence the need for technologies that perform farm activities that fall within their domain cannot be over emphasised. Such activities include those that fall within the domestic sphere as well as farm activities such as weeding, harvesting and food processing.

5.6 IMPACT OF FINANCIAL AND HUMAN CAPITAL ON HOUSEHOLD FOOD SECURITY

The objective of this section was to assess the impact of financial and human capital on household food security. Apart from physical resources, financial and human resources were found to be very important in household provisioning mechanisms. The level of education of members of the household and their health status were influenced by social-cultural, economic and political factors. In households where physical assets were limited, members used human capital as a means of obtaining financial earnings to purchase food. Likewise investment in children's education was considered a way of cushioning the household against future income paucity. The importance of children as potential human capital for a household unit necessitated investment in their education and nutrition.

Human capital was measured in terms of education level of household head and number of contacts with extension personnel. The extent to which these variables influenced output of maize was examined.

5.6.1 Results of impact of financial capital on maize output

5.6.1.1 Education level of household head and access to extension service

Two-way ANOVA was used to measure the effect of education on maize output. Education was measured in terms of the education level of the household head (no education, non- formal education, primary, secondary, college and university education) and access to extension service was measured using the number of times the household head had contact with extension officer (group 1: 1-2 times, group 2: 3-5 times and group 3: 6-9 times). The assumption was that the higher the education level and the number of contact with extension officer the more the output due to the effect of education on enhancing production methods. The ANOVA results showed a statistically significant effect of education [(F (5, 83) =3.75, p=.0.004] (EDUCA) and extension service [(F (2, 83) = 9.055, p=0.000] (NOVIST) (Table 5.23). The combined effect of the two variables (EDUCA*NOVST) was also significant [(F (8, 83), 3.802, p=0.001] (Table 5.23). The effect size for the individual variables was large (Eta Squared, EDUCA =. 184, NOVST=. 179)

(Table 4.39). The combined effect size is also large (Eta Squared, EDUCA*NOVST=. 268) (Table 5.23).

In a study in Kenya, Alderman, et al (2003) observed that if women farmers were given the same levels of education experience and farm inputs as their male counterparts, the yield for maize, beans and cowpeas could increase by 22 % and yield could increase by 25 % if all women attended primary school.

There are only 8000 Ministry of Agriculture technical staff involved in extension service countrywide and only 34 Farmers Training Centres (FTC) most of which are not functional (Shikwati and Amuhaya,2005). Potential exists in increasing smallholder food production through expansion and equipping of FTCs as well as increasing the number of extension officers let alone re-orientation of the curriculum to match modern trends in agricultural technology development.

Figure 5.30 shows that as education level of household head increased maize output too increased. Those who had been visited by extension personnel the least times achieved the lowest production as compared to those in group three who had more contacts with the extension officers. The household heads who had high contact but were illiterate recorded the lowest production while the production picked up significantly with those with primary education level and above. The implication of these results was that extension service had a positive effect on farm output however the effect was high when the farmer had some education

Table 5.23: ANOVA results showing effect of education and extension on maize output

Tests of Between-Subjects Effects

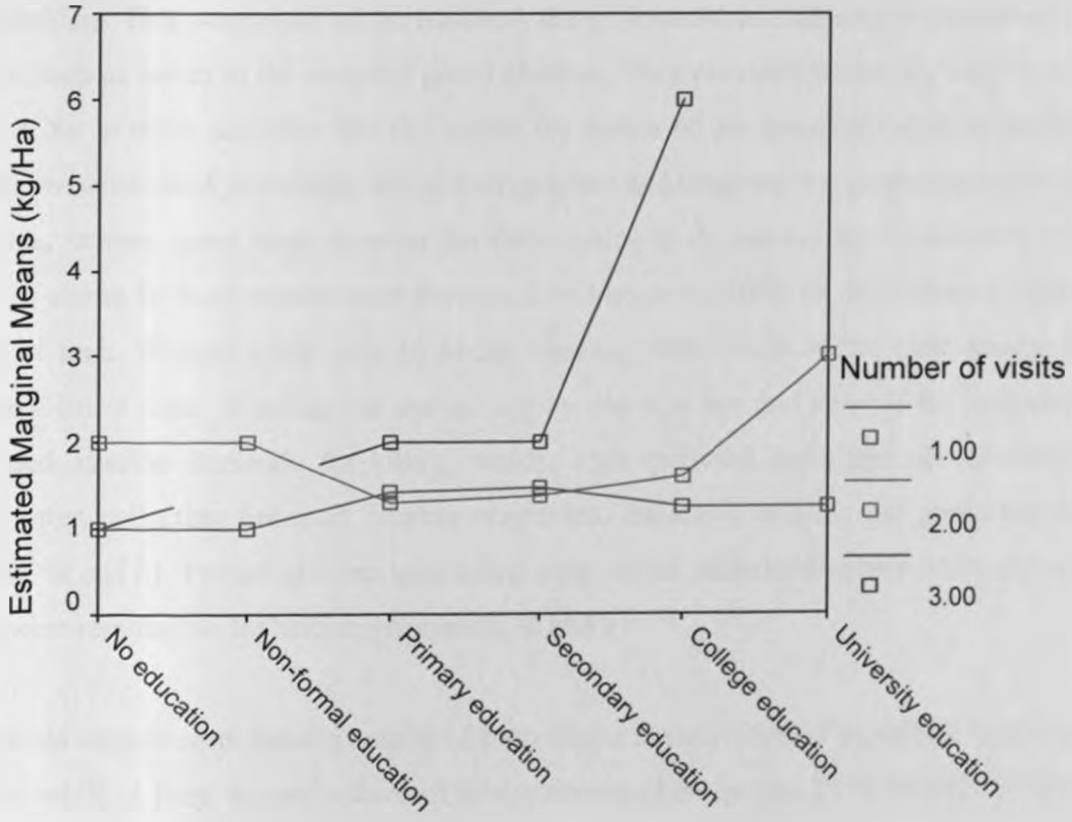
Dependent Variable: maize produced (kg/hectare)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Corrected Model	30.256[b]	15	2.017	2.768	.002	.333	41.527	.989
Intercept	116.023	1	116.023	159.247	.000	.657	159.247	1.000
EDUCA	13.660	5	2.732	3.750	.004	.184	18.749	.920
NOVIST	13.195	2	6.597	9.055	.000	.179	18.111	.971
EDUCA * NOVIST	22.159	8	2.770	3.802	.001	.268	30.414	.982
Error	60.472	83	.729					
Total	309.000	99						
Corrected Total	90.727	98						

a. Computed using alpha = .05

b. R Squared = .333 (Adjusted R Squared = .213)

Source: Household Survey data 2006-2007



Source: Household survey 2006-2007

Figure 5.30: Effect of extension service and education level of household head on maize output

Hypothesis 4

H_0: Human capital has no significant effect on household food security.

H_1: ALTERNATIVE

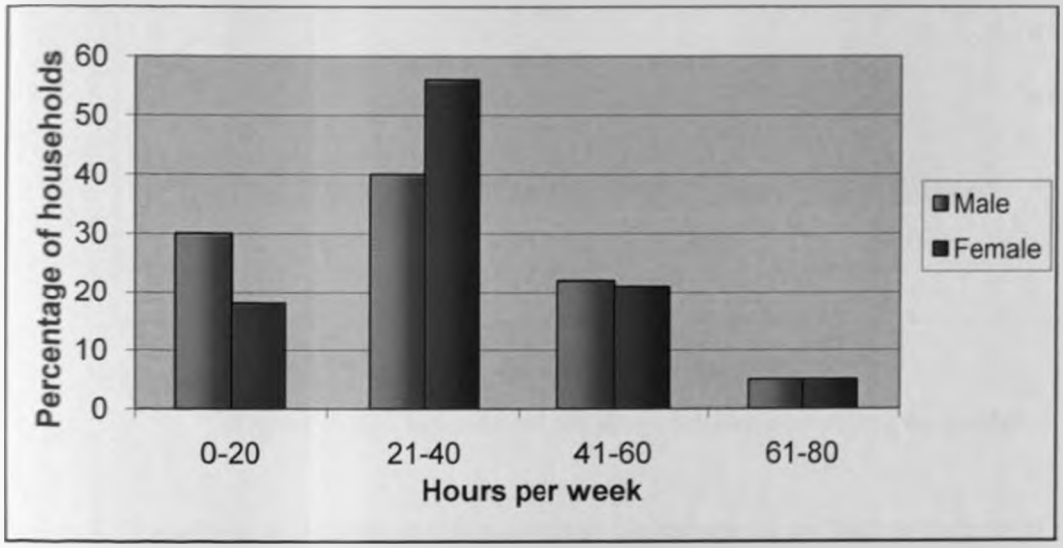
In order to test this hypothesis, we used two way (between groups) ANOVA (Table 5.23).The impact of two independent variables (education level of household head and number of contacts the household had with extension personnel) on one dependent variable (Maize yield) was analysed. The results showed that the two independent variables had a large and significant effect on maize yield ($p \leq .0.05$). On this basis we rejected the null hypothesis that and adopted the alternative hypothesis at 0.05 significance level

5.6.1.2 Household labour

This study established that household labour formed a large proportion of farm labour especially for smallholders. This comprised of the husband, the wife, children and other members of the household such as wives to the sons and grand children. They provided labour not only in food production but in other activities that fell within the sphere of the household such as fetching water and firewood, food processing, sell of farm produce and other income generating activities. On average, women spent more time on the farm during peak seasons as compared to men. Figure 5.31 shows 56 % of women spent between 21-40 hours per week on the farm as compared to 40 % of men. Women spent over 10 hours weeding, which falls within their sphere and consumed a lot of time. Weeding was carried out by use of a hoe and none of the households visited used atrazine herbicide for killing weeds. This excluded household chores such as fetching water, collecting firewood, picking vegetables, childcare, washing and preparing food (Appendix 4a and b). Female children performed some of the household chores while the male children were responsible for herding (Appendix 4a and b).

In Guatemala women contributed a quarter of farm labour in cultivation of traditional and export vegetables while in Peru women's share of labour across all crops was 25 % (IFPRI, 1995). In Zambia Women were responsible for 49 % of family labour allocated to crop production while men and children supplied 39 % and 12 % respectively (Kumar, 1994).

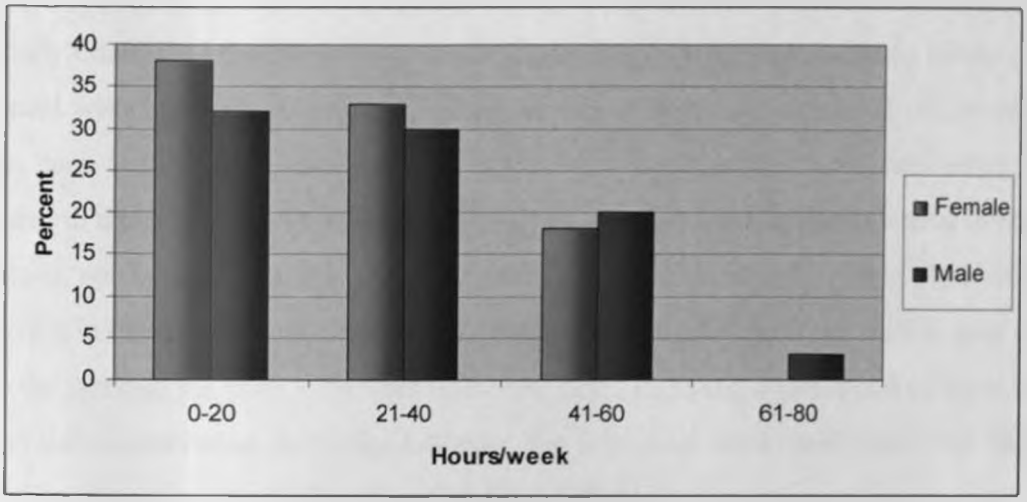
Men spent on average of two hours per day on the farm during peak seasons and they spend more time on off-farm activities. However, since clearing of the land and stumping fell within their domain they spent more time performing these activities.



Source: Household survey 2006-2007

Figure 5.31: Time spent on farm during peak seasons

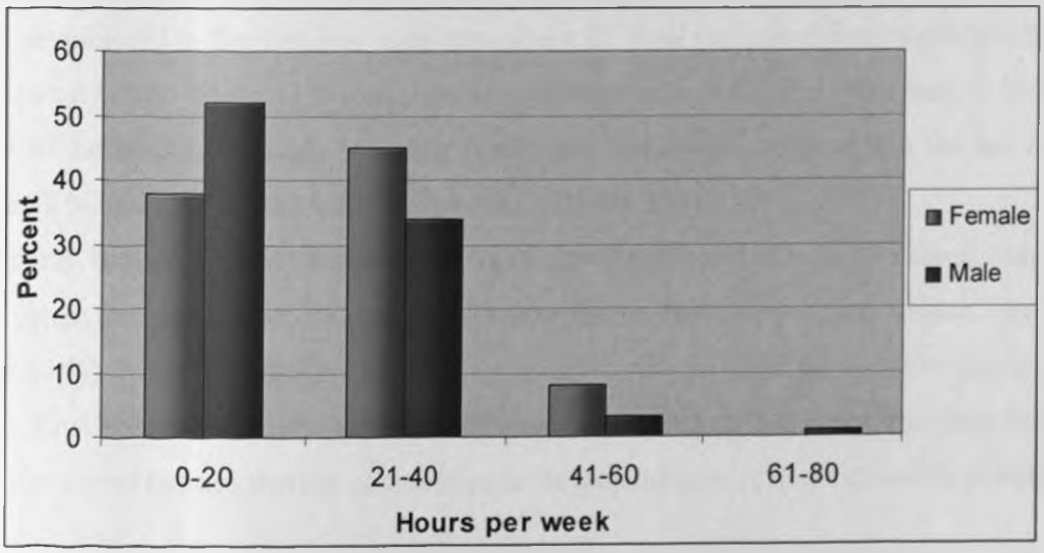
There were also more women than men involved in wage labour as a way of generating extra income for the household. Figure 4.40 shows that women spend more time per week on wage labour as compared to men (0-20 and 21-40 hrs/week), while Figure 4.41 also shows the active involvement of women in wage labour just like men.



Source: Household survey 2006-2007

Figure 5.32: Time spent on wage labour according to gender

Figure 5.33 shows that women spend more time on household welfare as compared to men. Over 50 % of men spent between 0-20 hours per week on household welfare. This is an average of 3 hours per day unlike over 40 % of women who spent over 4 hours per day on household welfare. Household welfare here meant time spent on efforts in provision of food requirements including preparation, storage, meeting nutrition and health needs. In other words, on activities aimed at common good of household members.



Source: Household survey 2006-2007

Figure 5.33: Time spent on household welfare according to gender

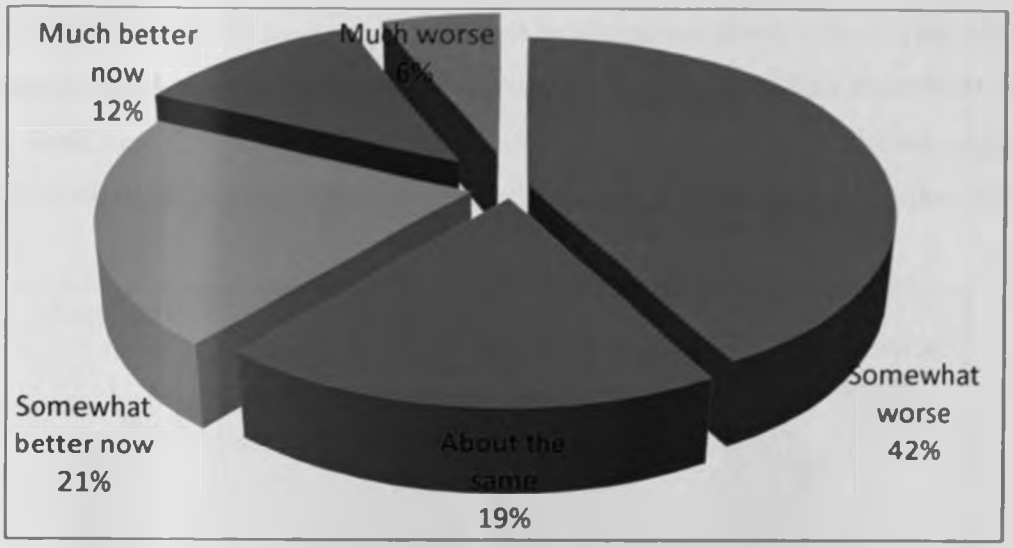
5.6.1.3 Hired labour

This study established that households hired labour during peak seasons due to labour constraints associated with high labour demand. Hiring of labour however, depended on household size, income and farm size. Generally, households that hired labour produced more maize as compared to those who used only household labour. Households who hired labour obtained mean production per hectare in Busia of 541kg and 504kg per hectare in Vihiga. The difference in production in households that hired and those that didn't hire labour in Busia was very noticeable due to the fact that the farm sizes were relatively large, implying a likelihood of more land being brought under cultivation. In Vihiga however, the farm sizes were small hence the difference in production due to increased labour input was not distinct.

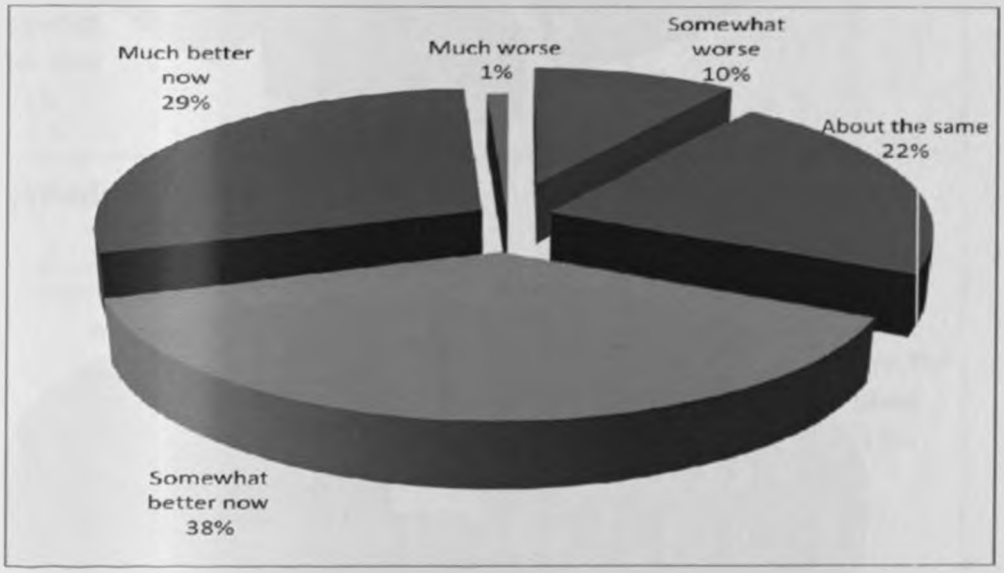
5.6.1.4 Health status and hospital visits

According to the present study, the health condition of household members was crucial in their participation of activities that encouraged production and generation of more income for the household. We used Likert scale to measure the current status of health and food supply within the household. Likert scale was used to measure the attitude of the respondents on health status and food supply in the last five years preceding the study on a scale of 1 to 5. Nearness to 1 implied minimal improvement on health or food supply situation in the household while nearness to 5 indicated greater improvement. In Busia, the health condition of household heads seemed to have deteriorated in the last five years since only 21 % of the respondents said their health was 'somewhat better' while 42 % said it was 'somewhat worse'. On the other hand in Vihiga, only 10 % of the household heads said their health had 'somewhat worsened' in the last five years, while 38 % said their health was 'much better' (Figure 5.34).

The study further revealed that over 50 % of the household heads had suffered from malaria. This meant that disease burden was one of the problems that affected farm productivity. Majority (over 50 %) of the households heads lost up to seven days of farm work due to sickness (Figure 5.34). Eradication of malaria and other diseases associated with poverty can help increase the productivity of farmers thereby contributing to household income and national development.



a) Busia



b) Vihiga

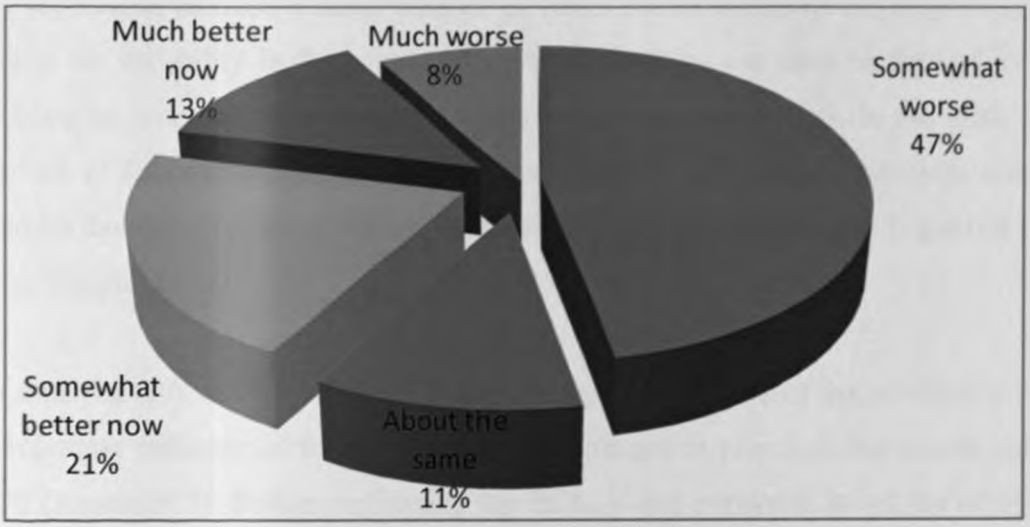
Source: Household survey 2006-2007

Figure 5.34: General perception of health status

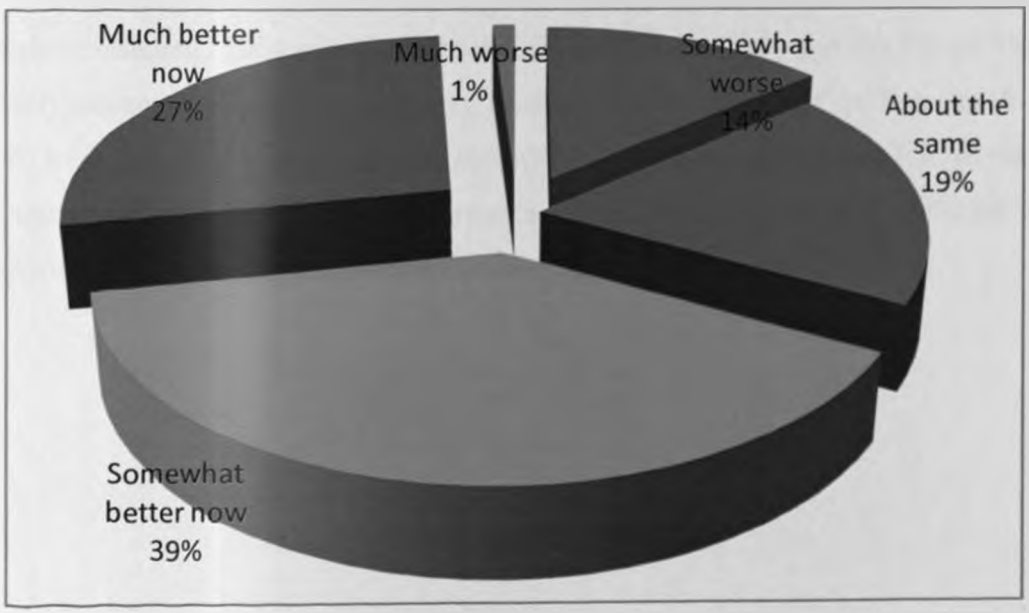
5.6.2.5 Perceptions about food supply

Likert scale was also used to measure the household's perception of their food security situation. They were asked to state whether their food supply had improved or worsened over the last five years preceding the study. In Busia, 47 % said the food supply had worsened while in Vihiga

only 14 %. It seems that the food supply situation in Vihiga was much better despite the fact that the population was denser and farm sizes were smaller. About 39 % of the households in Vihiga said their food supply was 'somewhat better', implying an improvement in food supply to the household either through own production or purchase in the last five years preceding the study.



a) Busia



b) Vihiga

Source: Household survey 2006-2007

Figure 5.35: General perceptions on food security

5.7 FACTOR ANALYSIS OF TECHNOLOGY- RELATED FACTORS THAT AFFECT HOUSEHOLD FOOD SECURITY

Factor Analysis is a data reduction technique which summarizes data using a small set of 'factors' or 'components'. There are two related techniques in factor analysis namely Principal Components Analysis (PCA) and Factor Analysis (FA) (Tabachnick and Fidell, 1996). Although both techniques produce a small number of linear combinations of the original variables that account for variability in the pattern of correlations, PCA was used because of its strength in providing an empirical summary of the data set for the two districts. In this study exploratory approach of factor analysis was used in order to explore the inter- relationships among a set of variables that affect adoption and intensity of use of various technologies in general and on food security in particular.

The nineteen (19) variables (Table 5.24) that affected production of maize which in this study is an important indicator of food security, were subjected to principal component analysis using SPSS (Appendix 3). Before performing the PCA, it was important to test the suitability of the data for factor analysis by examining the strength of correlation using evidence of coefficiencies greater than 0.3. Apart from the coefficiencies, two statistical measures namely Bartlett's test of sphericity (Bartlett, 1954 cited in Tabachnick and Fidell, 1996) and the Kaiser –Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974 cited in Tabachnick and Fidell, 1996) were used. The Kaiser –Meyer-Olkin (KMO) value was 0.662, which is slightly above the recommended value of .6 and the Bartlett's test of Sphericity reached statistical significance supporting the factorability of the correlation matrix.

Table 5.24 Variables that affect household food security

Variable number	*Variable name*	*Units*	*Variable number*	*Variable name*	*Units*
1	Age	No. of years	11	Farm size	Ha
2	Number of children	No. of children	12	Time spent on farm	Hours/week
3	Expenditure on seeds	Ksh/Ha	13	Time spent off farm	Hours/week
4	Expenditure on fertilizers	Ksh/Ha	14	Income from crops	Ksh/annum
5	Quantity of fertilizers	Kg/Ha	15	Income from livestock	Ksh/annum
6	Expenditure on farm equipments	Ksh/Ha	16	Remittances	Ksh/annum
7	Expenditure on labour	Ksh/annum	17	No of visits to FTC	Number
8	Expenditure on manure	Ksh/Ha	18	No.of times visited by Extension personnel	Number
9	Expenditure on pesticides	Ksh/Ha	19	Amount of credit	Ksh/annum
10	Distance to market	km			

Source: Household survey 2006-2007

Complete results of PCA summarized in Table 5.25 revealed the presence of six components with eigen values exceeding 1 explained for 16.6%, 15.4%, 8.6%, 7, 6%, 3% and 5.6 % of the variance respectively (Table 5.25) (Appendix 3). The first factor that accounted for 16.6 % of the variance was age of the household head, followed by the number of children (15%), expenditure on seeds (8.6 %), expenditure on fertilizers (7%) quantity of fertilizers (6.3%) and expenditure on tools of production (5.6%).

Table 5.25 Variance explained by the variables

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
VAR01	3.157	16.615	16.615	3.157	16.615	16.615
VAR02	2.935	15.445	32.060	2.935	15.445	32.060
VAR03	1.635	8.603	40.663	1.635	8.603	40.663
VAR04	1.322	6.960	47.623	1.322	6.960	47.623
VAR05	1.204	6.338	53.961	1.204	6.338	53.961
VAR06	1.070	5.633	59.594	1.070	5.633	59.594
VAR07	.985	5.184	64.778			
VAR08	.879	4.625	69.403			
VAR09	.844	4.444	73.846			
VAR10	.740	3.896	77.742			
VAR11	.703	3.701	81.443			
VAR12	.659	3.466	84.909			
VAR13	.619	3.255	88.165			
VAR14	.489	2.576	90.740			
VAR15	.459	2.415	93.155			
VAR16	.391	2.059	95.215			
VAR17	.356	1.873	97.088			
VAR18	.293	1.540	98.628			
VAR19	.261	1.372	100.000			

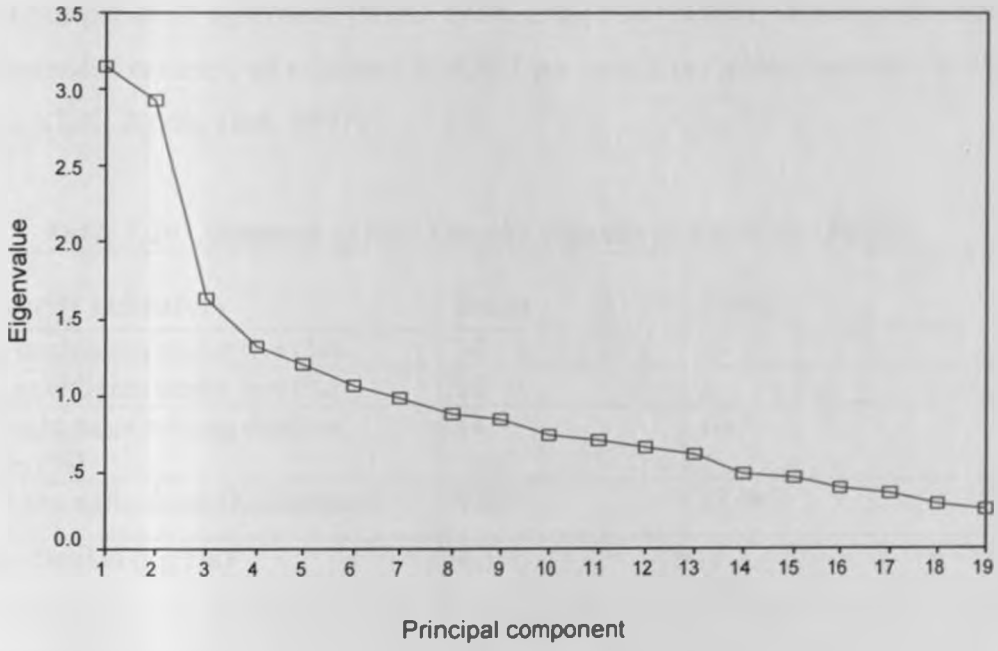
Extraction Method: Principal Component Analysis.

Source: Household survey 2006-2007

An inspection of the scree plot further confirmed the strength of these components (Figure 5.36). To aid in the interpretation, Varimax rotation was performed which revealed strong loading in all the six components (Appendix 3). The six factors explained for a total of 59.59 % of the variance (Table 5.25). The presence of technology related factors namely expenditure on seeds, expenditure on fertilizer, quantity of fertilizer and expenditure on tools of production underscores the importance of technology in accounting for the variance in maize yield. Figure 5.36 shows variables with eigen values of more than one. This helped in deciding the number of variables to retain in the model.

The results of this study are consistent with findings from other studies. For instance in a study on adoption of improved sorghum varieties in North West Ghana, Jatoe, et al (2005) observed that farmer and technology specific characteristics such as farmer age, access to income and

credit, greater access to household labour (demonstrated in number of children) highly influenced farmers willingness to adopt improved sorghum varieties. The results of this study are also consistent with findings from rice production system in Nigeria, where age, farm size and education level of farmer positively affected productivity and income (Bamire et al., 2005).



Source: Household survey 2006-2007

Figure 5.36: Scree plot of principal components and Eigen values.

5.8 SUMMARY OF FOOD SECURITY SITUATION IN VIHIGA AND BUSIA

Several indicators of food security namely nutrition status of children under five, maize production, income, crop diversification and non farm employment were used to provide a synopsis of food security in the two study districts (Table 5.26). The results show that the two districts were both food insecure since current maize yield did not meet the demand. In Busia the maize demand deficit was 10 bags per household per annum as compared to 6.4 bags in Vihiga (Table 5.26). This deficit was calculated on the basis of daily average consumption of maize per household, household size and current production trends in the two districts. In addition, the two

districts had high incidences of malnutrition- a manifestation of food insecurity problem. In a well nourished population, only 2% of children under five are malnourished hence stunting of 37% and 25% in Busia and Vihiga districts respectively is unacceptable and requires urgent interventions to reverse the situation. The income from agriculture was Ksh. 9,637 and Ksh.12, 045 per household per annum in Busia and Vihiga respectively. This income from agriculture, a major source of livelihood was found to be too low to meet the dietary daily requirement of 2,250 calories per adult equivalent (WHO 1986, 2006; FAO, 1996). In Kenya in order to meet the recommended calories, an estimated Ksh.927 per month per adult equivalent is required in rural areas (GoK, 2000b; GoK, 1997).

Table 5.26: Summary of food security situation in Busia and Vihiga

Food security indicators	**Busia**	**Vihiga**
Stunting in children under five (%)	37	25
Wasting in children under five (%)	16	3
Underweight cases among children under five (%)	14	10.7
Income from agriculture (Ksh/annum)	9,637	12,045
Maize production (kg/Ha)	420	503
Maize demand deficit per household (bags/annum)	10	6.4
Farm size	1.3	0.65
Household size	6	4.7
Food crop diversification	Moderate	Moderate
Non-farm employment	Limited	Limited

Source: Household survey 2006-2007

5.9 COMPARISON OF BUSIA AND VIHIGA

Households in both regions were similar in various ways. There was generally low output per hectare of the maize falling below the recommended output in the region and in Kenya in general. This was attributed to 'nutrient mining' coupled with low use of both organic and inorganic fertilizers. It was further observed that DAP was the most widely used fertilizer in the two districts by over 50% of households. Use of traditional seed varieties was also widespread and this was attributed to financial constraints. Generally the nutrition status of majority of women in the two regions was observed to be normal hence there were no serious cases of Chronic Energy Deficiency among women of reproductive age.

Several differences however, were observed between the two regions. There were higher fertilizer adoption rates in Vihiga as compared to Busia. This was attributed to the higher fertilizer costs in Busia probably due to longer distance from suppliers from major towns such as Nairobi and Kisumu as well as higher incidences of poverty that made it difficult for many households to afford. The other reason was the profitability of horticultural crops in Vihiga that made households to fertilize maize intercropped with horticultural crops. For instance 43 % of households in Busia used fertilizers against 61 % in Vihiga. Application rate was also higher in Vihiga at 96kg per hectare as compared to 37 kg per hectare in Busia. There is potential to reduce farm gate prices of fertilizers in both regions by improving road infrastructure.

On average Vihiga households spent more on hybrid seeds (ksh 1,480 per hectare) as compared to Busia households that spent ksh 690 per hectare .As a result of intensive use of farm inputs especially fertilizers, hybrid seeds and labour in Vihiga maize production per hectare was higher. Interestingly despite the fact that Vihiga households produced more maize per hectare than Busia households, the former relied more on market sources to sustain their day-to-day food requirements as compared to the later. On average Vihiga households purchased maize for 8 months in a year as compared to Busia households who bought maize only for 3 months in a year. This was attributed to higher consumption rate associated with high population density in Vihiga and the greater use of sorghum and cassava in the diet of households in Busia.

As a result of variation in use of fertilizers and hybrid seeds in the two regions, maize output was higher in Vihiga at 503 kg per hectare as compared to 420kg per hectare in Busia. Income from crop production also varied averaging Ksh.3, 627 per annum in Busia and Ksh. 4,250 per annum in Vihiga district. This also applied to income from animal husbandry, which was higher in Vihiga (Ksh. 12,045 per annum as compared to Ksh. 9,637 per annum in Busia.

Land preparation technologies were observed to be predominantly ox-drawn plough in Busia (52 %) while in Vihiga only 2 % used the ox-ploughs. The large difference emanated from large farm sizes in Busia (1.3Ha) while in Vihiga the farm sizes were very small (0.6Ha) and labour was plenty due to high population densities.

There were higher incidences of food insecurity in Busia as compared to Vihiga. This was indicated by higher numbers of stunted children in Busia district especially from *de jure* female-headed households. The higher level of food insecurity in Busia was attributed to low food production, limited off farm employment opportunities, low levels of food diversification, climatic constraints and high number of *de jure* female-headed household that lacked productive resources.

5.10 CONTRIBUTION OF THE STUDY TO EXISTING KNOWLEDGE

The study demonstrates that the choice of various farm inputs depends on access and control of productive resources, all which are determined by the socio-economic environment of the households and national agricultural policies. It has also been established that the farmers do not holistically adopt technologies but they do this in piecemeal, not because of cost, but also as a result of historical factors such as their past experiences in use of various seeds and fertilizers.

There is deteriorating soil fertility in the region due to continuous cropping and poor soil nutrient management practices .The use of fertilizers in the two districts is found to be below the recommended rates and combinations and this can be explained by financial constraints, climatic vagaries and lack of technical knowledge on proper use.

The study has demonstrated that female headed households are not all poor and vulnerable. Their status depended on many factors that affected access and control of resources. De facto female headed households invested more on farm inputs as compared to male headed and de jure households. Consequently, they realised relatively higher yields .Additionally, household headship had a significant effect on nutritional status of children hence improving the distribution of resources to all households was crucial for improving household food security.

The study has also shown that use of hybrid seeds and inorganic fertilizers has a significant effect on maize yield and income levels at household level.

Finally, the results of this study emphasize the multifaceted nature of household food security .It involves high productivity in agriculture, improvement of incomes, market access and road infrastructure, access to good health facilities and nutritional information and improvement of decision making opportunities for women at household level.

5.11 DISCUSSIONS

Increased food production is one of the important means through which Millennium Development Goal number one (MGD) of eradicating extreme poverty and hunger could be achieved. This is due to the effect that the agricultural sector has in stimulating agriculture-led economic growth and improving nutrition of most vulnerable groups in rural areas. Policy makers face a challenge of increasing agricultural productivity of smallholder farmers who form a large percentage of the farming community. Increasing output in agriculture is not feasible without increased use of farm inputs especially improved seeds and fertilizers. The study found fertilizer use to be extremely low especially in Busia district (37kg per hectare) but with relatively higher application rate in Vihiga (96 kg per hectare). Although Vihiga households had exceeded the target set by Abuja Fertilizer Summit of 50kg per hectare (Fans and Rosegrant, 2008; FAO world fertilizer outlook), efforts are still required to achieve the 130kg per hectare fertilizer input recommended for the region (KARI) while efforts to increase fertilizer use in Busia should be augmented. There was a distinct difference in yield in relation to expenditure on fertilizer. Households that spend more on fertilizers not only realized high yield, but regression

results showed that fertilizer also accounted for 12 % variation in household income. Yield particularly in Vihiga district doubled when households increased expenditure from Ksh. 5,000-10,000 per annum to Ksh.15, 000-20,000 per annum. More aggressive extension system and friendly credit system is required to ensure increased use of farm inputs. The high distribution costs associated with farm inputs also require urgent improvement in infrastructure and government intervention through subsidies aimed at drastically reducing input prices at farm household level.

The results of the study showed a significant effect of household headship on nutritional status of children. It is interesting to note that even though there was a notable difference in maize yield between modern and indigenous households, this did not affect the nutrition status of neither children nor mothers. It would have been expected that children from modern households would be better nourished than those from indigenous households since the former realized high yield and income. The children from *de facto* female headed households were better nourished as compared to those in *de jure* female headed and male headed households. It is therefore clear that nutrition status of children is not just a matter of increased food production and income but on the place of women on decision making process at household level that affects how on farm produce and income is allocated to various needs. Women, who had access and decision making authority over household resources when their husbands were away, allocated them (resources) to the betterment of their children health and nutrition as compared to when men were present. This clearly showed the potential that exists in increasing food security through gender mainstreaming.

The study revealed high incidences of malnutrition among children between 6 months and 60 months. The results indicated that 4 out of 10 children and 3 out of 10 children in Busia and Vihiga respectively were stunted. Apart from severe cases of underweight, stunting and wasting, many children suffered from mild and moderate malnutrition. Studies have revealed that fifty - six percent of deaths among pre-school children in the Developing countries are due to underlying effects of malnutrition on disease (Pelletier et al, 1994; GoK, 1998). Many intervention programmes had put a lot of emphasis on alleviation of severe malnutrition, however it was becoming clear that both moderate and mild malnutrition pose great danger to children health and future development. Malnutrition increases a child's risk of dying from many

diseases including measles, pneumonia and diarrhoea. On average a child who was severely underweight was 8.4 times more likely to die from infectious diseases than a well-nourished child (Pelletier et al., 1994). Children who were moderately underweight and mildly underweight were 4.6 and 2.5 times respectively more likely to die than well nourished children (Pelletier et al., 1994). Child survival programs should therefore, not only strive to eliminate severe malnutrition but also moderate and mild malnutrition. The most vulnerable households were *de jure* female headed households. Their special needs such as access and control of productive resources should be addressed as a step towards improvement of the nutrition status of children and the general welfare of household members.

The Principal Component Analysis found six variables to be very significant in influencing the link between household food security and technology use. Age was the most important factor that accounted for 16.6 % of the variance in the data .This implies that strategies to improve crop productivity must be targeted towards older farmers who were found to be more non-receptive to improved technologies and who formed the bulk of Kenya's farmers. The number of children was very crucial accounting for 15 % of the variance. This is because labour is the single most important resource in smallholder agriculture after land. Children were not only a source of labour but actual and potential source of income necessary for household provisioning mechanism and for improving production. Expenditure on seeds accounted for 8.6 % of variance further emphasising the need for smallholders to increase the use of fresh seeds in order to achieve high yields. The money the households spent on fertilizers and the quantity of fertilizers used accounted for 7 and 6.3 % respectively. Continuous cropping without fallow period had increased nutrient mining in the area thereby necessitating the use of fertilizers. However, fertilizer use on traditional seed varieties did not bear as much fruit as when used on hybrid seeds. Fertilizers were also applied piecemeal due to its high costs. Majority of households used DAP as a basal and there was very little top dressing that was done. Extension service is required to encourage the farmers to use fertilizers on hybrid seeds in order to realise higher yields as well as educating farmers on better crop husbandry. Expenditure on tools of production was found to account for 5.6 %. In Busia where farm sizes were relatively larger than Vihiga, households that used ox-drawn ploughs produced higher yields due the fact that it led to more land being brought under production.

The findings call for more attention on strategies for increasing technology use among smallholders as a way of improving their general wellbeing. This could include allocation of more resources in Research and Development (R&D) that incorporates a strong commitment to dissemination.

CHAPTER SIX: SUMMARY OF KEY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 THE PROBLEM INVESTIGATED

The study set out to analyse the link between farm technologies and food security in Busia and Vihiga districts. Farm technologies included the use of fertilizers (both organic and inorganic), use of ox drawn ploughs, pesticides and post harvest technologies especially those related to storage of harvested crop. Even though smallholders formed a large percentage of farming community, documentation on the intensity of use of technologies among them was scanty yet any strategies to improve food security were to be based on empirical data.

A gendered approach was used due to the fact that households were not homogeneous units but rather were segregated on the basis of gender, age and position. The heterogeneous nature of households meant that, entitlement to productive resources such as land and capital and benefits accruing from agriculture and non-farm employment depended on the gender, age and position of the member of the household. This affected the amount of food produced, the income available to access food and the nutrition status of household members especially the most vulnerable, the women and children.

This chapter synthesises the preceding chapters by discussing the data used in the analysis, the methodologies followed and the results obtained. The two regions investigated are compared and finally various recommendations are given to policy makers and for further research.

6.2 THE DATA USED

The study used a detailed household level data obtained from a random sample of 282 and 217 households from Vihiga and Busia respectively. The data was collected using a semi-structured questionnaire that was administered to household heads between 2006 and 2007 .Data was

disaggregated according to household headship and technology orientation in order to allow for in depth understanding of intra-household dynamics and how they affected production. Participatory methodologies such as Focus Group Discussions were also used due to their strength in obtaining information more quickly and cheaply from semi illiterate population and the ability to help understand gender related issues that could not be discussed openly at an individual level. Socio-economic survey was integrated with nutritional survey where children between 6 months and five years of age were examined for nutritional status (stunting, wasting and underweight). Likewise women in reproductive age were examined for Chronic Energy Deficiency (CED) using Body Mass Index (BMI)

The socio-economic data was analysed using various statistical techniques with help of SPSS software. They included; descriptive statistics, simple regression analysis, Analysis of variance (ANOVA) and Principle Component Analysis (PCA).The nutritional status data for children (Anthropometrics) was entered and analysed using EPI Info software while women data was analysed using SPSS software.

6.3 SUMMARY OF MAIN FINDINGS

The study observed very low use of farm technologies such as fertilizers, labour saving techniques, certified seeds and crop protection technologies. Consequently this contributed to very low production of food at household level.

There was a significant effect of farm technologies on household food security. Particularly, expenditure on fertilizer and hybrid seeds had a significant effect on maize output consequently increasing the availability of food for the household. Likewise households that spent more on farm inputs realised higher income hence they were able to meet other household needs. The use of ox drawn ploughs translated in higher yields than those who used the hoe. However, the general effect of production tools on maize output was not statistically significant. Production was more influenced by crop husbandry, use of fertilizers and planting of hybrid seeds. Production was enhanced even more when households used inorganic fertilizers on hybrid seeds than on traditional seed varieties.

The effect of household headship on maize output was not significant however, household headship had a significant effect on nutrition of pre-schoolers. Children in *de jure* female-headed households were at high risk of malnutrition as compared to their counterparts in male headed and *de facto* female-headed households. This variation was attributable to the high level of poverty among *de jure* female-headed households especially in Busia district.

There were various factors that enhanced productivity at household level. They included access to credit facilities and number of contacts between household and the extension officers. In particular women who had access to credit realised higher yields as compared to those who did not have access. Women accessed credit through informal organisation as compared to men who borrowed from mainstream financial institutions such as banks.

Households that had more contact with extension personnel recorded higher maize output. Interestingly, although previous studies had indicated that extension service was skewed towards male farmers the opposite was true in the study area. More women than men reported to have been visited by the extension personnel who did not insist on talking to male member of the household, It is now becoming evident that education of household members especially women goes along way in increasing food security. There was a steady increase in maize output in relation to education level achieved with household where the household head had no education receiving the lowest production. Education either through extension system or mainstream institutions increased the efficiency of use of farm inputs thereby having a positive effect on general food security situation of the household.

6.4 CONCLUSIONS

The study has shown that with the diminishing farm sizes associated with high population growth rate, households could still realize high production per hectare through intensive use of farm inputs. The results revealed that even though Busia households had large farm sizes, the production per unit of land was lower than the Vihiga households due to differences in intensity of use of farm inputs such as HYV and fertilizers. As land resources become scarce, intensive

forms of land use and diversification of farm produce to more high value crops (vegetables and horticultural crops) and dairying through zero grazing, together with creation of off farm employment activities in rural environments, will ensure better living standards for rural populations. In areas where climatic conditions are particularly harsh, such as some parts of Busia, traditional crops such as sorghum and cassava were playing a significant role in meeting the calorie requirements of households. Expanding production of such crops as well as exploring avenues for small-scale irrigation activities for purposes of crop diversification would go a long way in improving the food security situation of the areas.

The results of the study are interesting in the sense that, they emphasize the potential that exists in improving the livelihoods of smallholders through the intensive use of farm inputs. Agricultural intensification is a process geared towards achieving optimal economic production of crops and animals using land, labour and agricultural inputs more intensively. It is a process and not an event or technology option, that involves a series of decision making (planned and unplanned) on the allocation of resources for agricultural production. It permits smallholders to produce more food more cheaply from smaller land area. Cheaper food benefits the poor more because they spend more of their income on food. Agricultural intensification has the potential of generating income and off farm employment that impacts on human productivity and socio-economic transformation. Since households face a challenge in allocating their scarce resources to various needs, they should be encouraged to consider investment in farm inputs and better crop husbandry a priority since it was beneficial both in the short and long run.

It is apparent from this study that household headship has a strong bearing on the wellbeing of the household members due to the effect that it has on control and access to various resources necessary for production. Although female headed households have always been seen as the poorest and most vulnerable, the study has shown that women who have access to resources and have decision making opportunity at household level were better farm managers than their male counterparts. *De facto* female headed households in particular, allocated more financial resources on purchase of seeds and fertilizers and they realized more yield than the male headed households. In male headed households the men made all the decisions on production and consumption because they were present throughout the year. However, in *de facto* female headed

households the husband did not live on the farm meaning that the wife made day to day decisions on farming.

The results of this study have shown a relationship between education and extension service and maize output. Increasing the education level of the household head to at least primary school level and strengthening the extension service sector had a potential of improving yield significantly. Since majority of the women in the study area (especially in Busia) had very little or no education, more extension services should be geared towards this group of farmers so that they can efficiently use farm inputs as well as crop protection technologies.

Finally the study has revealed that improved access to credit enables households to not only adopt new technologies but also intensify their agricultural production, in addition to investing in off-farm enterprises. This has potential for increasing income levels necessary for accessing food when household supplies are low and improving the general wellbeing of household members. While access to credit enabled the farmer to afford farm inputs, it should be accompanied by stable and competitive prices for farm produce and improvement of infrastructure in order to improve household's ability to access and pay loans.

6.5 POLICY IMPLICATIONS AND RECOMMENDATIONS

The understanding of food security has evolved over the years through increasingly integrated attention to the social, gender, environmental, technical and economic dimensions of the problem. This study set to analyze the linkages between use of farm technologies and food security at household level. The data on women's access and control of productive resources such as land, capital and labor was analyzed and inference made on how these affected food security in *de facto* and *de jure* households. Generally the study demonstrated that attainment of equity in access to resources by women to produce food, and purchasing power to buy food where it was not produced was an important policy issue.

6.5.1 Policy implications

Specific policy measures are required to address the constraints facing women farmers and special consideration given to the needs of female heads of households as well as smallholders in general. These are;

- There is need for the government through the Ministry of Agriculture in collaboration with research institutions such as Kenya Agricultural Research Institute (KARI) and other actors in the agricultural sector to re-orient agricultural research in technology development and dissemination. Research in technology should incorporate a strong commitment in transfer process based on farmers' needs and circumstances. For instance it was observed that the extension system was particularly inadequate in disseminating existing technologies and encouraging efficient use at farm household level. The dissemination process should be that which responds quickly and effectively to farmers' needs and reactions in order to encourage greater benefits and sustainability.
- The average fertilizer prices varied from one region to the other due to transportation costs. It was considered essential to reduce distribution costs through improvement of infrastructure so that prices at farm level could reduce. This requires the government to allocate more funds towards the improvement of rural infrastructure.
- Improvement of credit system by making it easier for smallholder farmers to access loans and credit facilities from Agricultural Finance Cooperation (AFC) is necessary. Mainstream banks and micro financing institutions that operate in rural settings was found to be crucial in increasing the intensity of use of technologies. This would enable the farmers to access loans to purchase farm implements as well as other inputs such as fertilizers. Bank conditionalities were very unfavourable to smallholders, especially women, many of whom were illiterate and also lacked collateral .In particular, the cooperative movement should be strengthened such that it incorporates those smallholders that grow maize as a cash crop. In addition, in order to relax liquidity constraints of smallholders, it is also important to invest in activities in rural areas that create off farm employment and open opportunities for self-employment. The Ministries of agriculture, Cooperatives and Finance, development partners,farmer associations and Community Based Organisation (CBOs) should work together to achieve better results for farmers.

- There is urgent need for implementation of the new land policy in order to encourage better land management practices and ensure equal rights to land ownership for men and women. The need to put a limit to land fragmentation in high potential agricultural areas cannot be over emphasised. Farm sizes have been reduced to uneconomical levels such that subsistence needs of the households could not be adequately met even with the use of most appropriate technology. Successful implementation of the land policy will require all the stakeholders in agriculture and other related sectors to work together. In addition, to ensure that the needs of disadvantaged groups such as women and children are addressed, it will require greater involvement of these groups in decision making at local and national levels. Women also need to be educated so that they can know and claim their rights since some of the problems associated with land issues in rural settings are due to ignorance.
- Increasing the education level of women by strengthening adult education and extension service is also paramount in order to encourage faster adoption of improved farming techniques among smallholders. Farmer Field Schools (FFS) and similar approaches to adult education and community empowerment have a potential of improving efficiency in the use of technologies with a significant improvement in food production, income and nutrition. Apart from education women require access to labour and time saving devices that could reduce drudgery especially on household chores such as water collection and storage, food processing and preservation and collection of fuel wood. Encouraging farmer- to-farmer exchanges is important avenue of disseminating new skills and ideas among smallholders. This could supplement the role of extension service by providing an opportunity to farmers to learn from one another. Although it has been recognised that farmers are the best teachers to fellow farmers, the role of extension service cannot be overlooked.
- Diversification of crop production is recommended in order to reduce over reliance on maize. There are several high value crops such as groundnuts, beans and horticultural crops that do well in the region but whose production is very low. Enhancing production of these crops through more comprehensive agricultural policy and market growth could go a long way in improving the income levels of smallholders in the region. This can be enhanced by the Ministry of Agriculture through the extension system.
- Disease burden associated with poverty and malnutrition was found to be a major stumbling block limiting productivity in addition to increasing the vicious cycle of poverty. The most

important safety net therefore, for smallholder households, is that which protects their health as well as builds their capacity to manage diseases such as malaria, typhoid and diarrheal diseases that were common in the study area. This should be addressed by the Ministry of Health together with community based organisations.

- Poor nutrition as exemplified in high proportion of stunted, wasted and underweight children under five, requires various programmes that provides supplementary feeding, creates awareness on good nutrition practices and supports access to information for mothers. Improving the education and income levels of the mothers is also crucial to sustain the well being of children in general. This requires a multi-sectoral approach but spearheaded by Ministry of Health.

6.5.2 Future research

A number of interesting aspects of food security came up in the course of conducting this research. This could be covered in future research. They include the following

i. Indigenous crops play an important role in enhancing food security. There is need for thorough investigation on this crops including research on improvement of the productivity not only to increase income and food security but also as a way of cushioning the households against effects of adverse weather conditions resulting from climate change. This is due to the ability of some indigenous crops such as millet, sorghum and cassava to withstand adverse weather conditions.
ii. Informal credit provision systems are filling the gap left by mainstream financial institutions such as cooperatives and banks. Their roles need to be examined with a view of providing empirical information that could be the basis of strengthening them through policy and legal frameworks.
iii. Organic farming is increasingly becoming important among smallholders due to financial constraints that reduce access to inorganic sources of soil nutrients as well as its role in environmental conservation. There is need for more research on this area as well as the role that Conservation Agriculture (CA) can play in enhancing food production as well as its sustainability among smallholder households.

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APPENDICES

APPENDIX I: RESEARCH QUESTIONNARE

RESEARCH QUESTIONNARE

This interview is part of a study being carried out on the impact of farm technologies on food security in Busia and Vihiga districts. Any information you give to us will be confidential. You are giving us this information on voluntary basis.

Your cooperation is very much appreciated

(*To be filled by research assistants*)

Questionnaire No.....

Interviewer's name: .....

Respondent's name: .....

Date of the interview: .....

District:.....

Division.....

Location:.....

Sub location:.....

DEMOGRAPHICS

1. Name of household head
2. Age (years).....
3. Gender:

Female (01)

Male (02)

4. Marital status:

Married monogamous (01)

Married polygamous (02)

Single (03)

5a) Does your spouse live with you?

Yes (01)

No (02)

b) (If no to question 5) where does he live? Or is he dead?

.....

.....

6. Apart from working on the farm, what other job do you do?

.....

7. What are your responsibilities in the household?

.....

.....

8. What are the responsibilities of your spouse?

.....

.....

9. Who is the major decision maker in the household?

Husband (01)

Wife (02)

Co-wife (03)

Son (04)

Daughter (05)

Others (specify) (05)

TECHNOLOGIES

10. Please indicate the food crops you grow starting with the most important

First season		*Second season*		*Crops grown throughout the year*
Main crop	*Second crop*	*Main crop*	*Second crop*	

11. Which of these crops are indigenous/traditional?

.....

.....

12. Why do you plant indigenous crops/traditional?

.....

.....

13. Why don't you plant indigenous crops/traditional?

.....

.....

14. Are any of these crops irrigated?

Yes (1)

No (2)

15. (*If answer to 14 is yes*) which ones?

.....

.....

16. What type of maize seeds do you plant in order of importance?

.....

17. a) Please indicate the types of fertilizers used and cost per year

Type of fertiliser /farm Yard manure	*Cost per unit (Ksh.)*	*Total cost per year*

b) Please indicate the type (s) of farm implements you own and the amount invested for it

Farm implements	*Cost (Ksh.)*

c) Please indicate the type (s) of seeds you grow and the cost per year

Types of seeds	*Cost per unit*	*Cost (Ksh.)*

d) Please indicate the types of pesticides you use and the cost per year

Type of pesticides	*Cost per unit*	*Cost (Ksh.)*

18. Is there any change in production since you started using the technologies mentioned above?

Yes (01) *(explain)*

.....

.....

No (02) *(explain)*

.....

.....

19. Why do you use these technologies?

.....

20. What are the benefits and limitations of using this technology?

Benefits

.....

.....

Limitations

.....

.....

21 a) Are they men or women who use the different types of technologies? (Prompt: farm implements fertilizers etc)

Men (01)

Women (02)

b) Why is this the case?

.....

.....

22. What tools do you use for the following operations?

Clearing

.....

.....

Land preparation (ploughing, seedbed preparation etc)

.....

.....

Planting

.....

.....

Weeding

.....

.....

Harvesting

.....

.....

23. Who makes decisions about the use of technologies?

Husband (01)

Wife (02)

Others (specify)

24. a) What are the social norms influencing technology use on your farm?

(*Prompt for technologies ox plough, hybrids, and fertilizers*)

.....

.....

b) What are the cultural norms influencing technology use on your farm?

.....

.....

25. a) What problems do you face in use of technologies?

.....

.....

b) How do you think these problems could be solved?

.....

.....

26. Does your household own any of the following?

Code	Type of equipment	No	Quantity
1	Ox cart		
2	Ox plough		
3	Human pulled cart		
4	Wheelbarrow		
5	Tractor		
6	Machete		
7	Axe		
8	Hoe		
9	Bulls		
10	Cows		
11	Donkeys		
12	Others (specify)		

27. Does your household own any of the equipments/property above jointly with other households?

Yes (01)

No (02)

28. **If yes to Q 27**, which of the assets in question **26** above are owned with another household

.....

.....

29. What share of these belongs to your household?

.....

.....

CONSUMPTION

Daily expenses

30. In the last seven days has any member of the household spent money on the following items?

Code	Food Item	Quantity (specify units, del Kgs, bags)	Cost per unit	Total cost
1	Maize			
2	Beans			
3	Sugar			
4	Vegetables			
5	Chicken			
6	Meat			
7	Fish			
8	Termites			
9	Beverages			
10	Millet			
11	Sorghum			
12	Rice			
13	Wheat			
14	Bananas			
15	Sweet potatoes			
16	Arrowroots			
17	Others (specify)			

32. How many meals/snacks were eaten by the household members during the past seven days

Meal	*Ingredients*	*Number of meals*	*Value of meal*
Breakfast			
Lunch			
Dinner/supper			
Snack/beverages			

33. Has your household consumed the following in the last seven days

Code	*Item*	*Value of the meal (ksh)*
1	Maize	
2	Beans	
3	Sugar	
4	Vegetables	
5	Chicken	
6	Meat	
7	Fish	
8	Termites	
9	Beverages	
10	Millet	
11	Sorghum	
12	Rice	
13	Wheat	
14	Bananas	
15	Sweet potatoes	
16	Arrow roots	

34. How many months in past 12 months did you purchase food?

.....

35. How much of the food you consumed was produced by the household? (*Specify units*)

.....

.....

36. How much of the food consumed was received as gift over past 12 months?

.....

.....

37. What is the staple food for the household?

.....

38. What are the main sources of staple food mentioned above?

Own production (01)

Purchased (02)

Borrowed (03)

Exchanged (04)

PRODUCTION

39. List the crops you produced last year

Crops	***Total production (Specify units, deb Kgs, bags etc)***	***Total sales last y (specify units)***	***Price per unit***	***Total revenue last year***

40. What do you think are the factors that affect production of food by your household?

.....

.....

b) Where did you sell the food produced on the farm?

Local market (01)

Middleperson/trader (02)

Cooperative (03)

State Corporation (04)

Other specify (05)

c) How did you transport the food to the market?

Human transport (01)

Bicycle (02)

Matatu/bus (03)

Others specify (04)

41. What did you do with the money from crop sales?

.....

.....

42. Who has the right over this money?

Husband (01)

Wife (02)

Children (03)

Others (specify) (04)

43. How much of the maize harvest did you consume at home last year?

.....

44. Was the maize harvests enough to meet your food requirement?

Yes (01)

No (02)

45. If no in **(Q44)** why was this the case?

.....

.....

46. Do you keep any livestock?

Yes (01

No (02)

50. If yes) what were the quantity, production and income from livestock last year?

Livestock	*Quantity*	*Production*	*Income*
Indigenous			
Upgraded cattle			
Sheep			
Goat			
Hens			
Pigs			
Others (specify)			

47. How do you provide the animals with feed?

Grow own feed (01)

Open grazing (02)

Buy feed (03)

Others (04)

FINANCIAL CAPITAL

48. A) Do you have access to credit facilities?

Yes (01)

No (02)

b) If yes, what is the source of credit?

Bank (01)

Moneylender (02)

Cooperative (03)

Kin/friend (04)

Merry go round (MGR) (05)

Others (specify) (06)

49. a) Have you ever taken a loan?

Yes (01)

No (02)

b) If yes, for what purpose?

Production of food crops (01)

Livestock (02)

Cash crops (03)

Consumption (04)

Medical services (05)

School fees (06)

Other specify (07)

c) How did you pay back?

50. a) Do you belong to any cooperative society?

Yes (01)

No (02)

b) If yes, which one?

.....

51. What are the sources of income and cash flows for the households?

Sale of farm produce (01)

Regular employment (02)

Remittance from relatives (03)

Sales from trading and home craft (04)

52 a) To what extent are income and expenditure streams for husband and wife separate or joint?

.....

b) Who benefits (gender, age, and position in household) from output of current enterprise in terms of subsistence, income from sale or other uses?

.....

.....

HUMAN CAPITAL

53. Did anyone in your household visit any agricultural extension office/agent or centre in last 12 months to seek advice on growing of crops

Yes (01)
No (02)

54. How many times in last 12 months?
Times....

55. What type of assistance/information were requested

Use of fertilizer (01)

Irrigation (02)

New seed varieties (03)

Pest infestation (04)

Soil problems (05)

Weather (06)

Marketing (07)

Credit (08)

General (09)

56. Did you pay for the service?

Yes (01)

No (02)

57. How much did you pay?

.....

58. a) Did any agricultural officer visit your household?

Yes (01)

No (02)

How many times?

.....

b) Whom did the agricultural officer talk to?

Husband (01)

Wife (02)

Others (specify) (03)

59 a) how many of these visits were requested by the members

Requested (01)

Unsolicited (02)

b) Did you pay?

Yes (01) No (02)

c) How much did you pay?

.....

d) What kind of service did you get?

.....

.....

.....

Farming operation													
Clearing and stumping													
Planting (Hybrid maize)													
Traditional maize													
Sorghum													
Finger Millet													
Cassava													
Sweet potatoes													
First Weeding													
Finger Millet													
Cassava													
Sweet potatoes													
First Weeding													
Second weeding													
Collecting firewood													
Collecting water													
Cooking													
Child care													
Cattle Herding													
Milking													
Poultry rearing													
Food processing													
Food purchase													

60 a) Who and when are the following operations performed

b) How much time is allocated to household maintenance? (*Specify hours per week*)

.....

c) How much time is allocated to family welfare (childcare, food preparation, fuel and water supply)? (*Specify hours per week*)

.....

d) How much time is allocated to other remunerative or obligatory household production (for sale, trade, off farm enterprises or wage labour)? (*Specify hours per week*

.....

e) What changes in labour allocation are associated with or desirable from modern technology?

.....

61. Do you hire any labour for farm activities?

Yes (01)

No (02)

Are there increases or decreases in labour requirements and who is affected?

.....
.....

62. (If yes to question 63) what is the quantity and value of hired labour per year?

Season	***Quantity***	***cost per labourer***	***Total cost***
Short rains			
Long rains			

PRODUCTIVE CAPITAL

63. Is this your own piece of land?

Yes (01)

No (02)

64. If yes how did you acquire it?

Inherited (01)

Bought (02)

Rented (03)

Permanent gift (04)

Temporary gift (05)

Others (specify) (06)

65a) Is the land adjudicated?

Surveyed (01)

Registered (02)

Titled (03)

b) What is the size of the farm?

.....hectares/acres

66. What is your land tenure status?

Individual ownership (01)

Owner-occupier (02)

Free holding (03)

Sharecropping (04)

Tenancy (05)

Lease holding (06)

Communal ownership (07)

Others (specify) (08)

67. Who owns the land?

Husband (01)

Wife (02)

Son (03)

Relative others (specify)

68. Who has the right to sell the land?

Husband (01)

Wife (02)

Son (03)

Relative others (specify) (04)

69. Who has a right to use the land?

Husband (01)

Wife (02)

Son (03)

Relative others (specify) (04)

70. Under what conditions is the land allocated?

.....

71. Who (wife, husband etc) controls the land and capital resources?

.....

.....

72. Who decides how to spend income from off farm sources?

.....

73. Who decides how to spend income from farm sources?

.....

.....

74. What is the most limiting factor of production?

.....

INTER- AND INTRA-HOUSE HOLDS DYNAMICS AND FOOD SECURITY

75. Who makes decisions in farming activities?

.....

.....

76. Under whose control are important subsistence crops particularly for periods of stress?

.....

78. What factors of production are shared between households?

.....

.....

79. How does the use of factors of production among many households affect productivity and food security?

.....

.....

NUTRITION AND HEALTH

80. Has any member of your household been sick in the last 12 months?

Yes (01)

No (02)

81. If yes what diseases were they suffering from?

Member	*Age*	*sex*	*Disease*	*No. of days sick*

82. a) In last four weeks did any member of your household visit public hospital to obtain health care?

Yes (01)

No (02)

b) If yes fill the table below (if no go to question 102)

Member	*No. of times visi hospital*	*Cost per visit*	*Total cost*

83. How many days of your primary daily activities did you miss due to poor health?

Code	*Days*
1	
2	

84. Compared to five years ago would you say your health is?

Much better now (01)

Somewhat better now (02)

About the same (03)

Somewhat worse (04)

Much worse (05)

85. Compared to five years ago would you say food supply for your household is?

Much better now (01)

Somewhat better now (02)

About the same (03)

Somewhat worse (04)

Much worse (05)

86. Please indicate what support the government gives you in farming

.....

.....

87. Please name any government rules and regulations that affect your farming

.....

88. Please indicate any constraints that you face as a farmer due to government policies

.....

THANK YOU FOR YOUR COOPERATION

APPENDIX IIA: ANTHROPOMETRICS

Instructions

- *This instrument should be used on children between 6 months and 60 months of age.*
- *When child is less than 2 years measure length (i.e when the child is lying on the stadiometer)*
- *When a child is more than 2 years measure height*
- *If accurate age is not possible measure length if child is less than 85cm.*

To be filled by Research assistant

Questionnaire No.....

Research Assistant.....

Date of Measurement.....

District.....

Location.....

Sub-location.....

1. Name (optional).....
2. Sex

   Male (01)

   Female (02)

3. Technology orientation

   Modern 01

   Indigenous 02

4. Household type

   Male headed 01

   De jure female headed 02

   De facto female headed 03

5. When born: Day__Month __ year_

6. Is information provided from birth certificate or other official paper ?

Births certificate (01) Other official paper (specify) (02)

7. This means that ----- is ---years and ---months is this correct?

8. Measurements height ----cm

9. Was height measured standing or lying down?

Standing (01) lying (02)

10. Weight ……kilograms…. fraction

APPENDIX II B: BODY MASS INDEX FOR WOMEN

Instructions

This instrument should be administered on women between 15 and 49 years of age.

To be filled by Research assistant

Questionnaire No.....

Research Assistant.....

Date of Measurement.....

District.....

Location.....

Sub-location.....

1. Name.....

2. Technology orientation

Modern 01

Indigenous 02

3. Household type

Male headed 01

De jure female headed 02

De facto female headed 03

4. When born Day__Month __ year_

5. Is information provided from birth certificate or other official paper?

Births certificate (01) other official document (specify) (02)

6. This means that you are ---years and ---months, is this correct?

7. Measurements height ----cm

8. Weight ……kilograms…. fraction

APPENDIX IIIA: PRINCIPAL COMPONENT MATRIX

Component Matrix[a]

	Component					
	1	2	3	4	5	6
VAR01			.754			
VAR02			.745			
VAR03	.643			-.326		
VAR04	.793					
VAR05	.490					.394
VAR06	.393		.377		-.558	
VAR07		.610		.343	.429	
VAR08	.433			.420		
VAR09				.401		-.436
VAR10		-.576				
VAR11	.600			-.435		
VAR12	.368	.551				
VAR13	.642	.386				
VAR14						.621
VAR15	.428			.487		
VAR16		.752				
VAR17		.483			.488	
VAR18		.691				
VAR19	-.416	.522	.360			

Extraction Method: Principal Component Analysis.

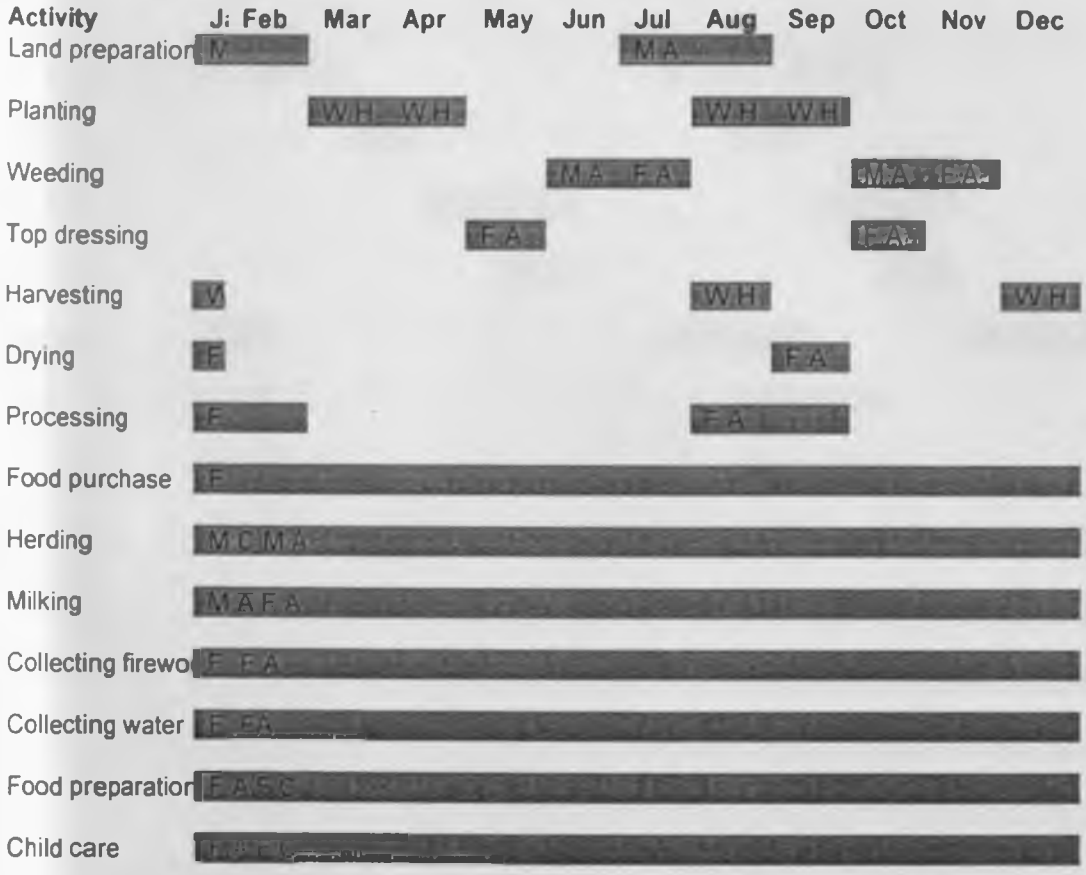
a. 6 components extracted.

Component Transformation Matrix

Compon	1	2	3	4	5	6
VAR01	.012	.720	.614	-.111	-.255	.165
VAR02	.963	-.026	.067	-.143	.216	.031
VAR03	.182	-.175	.262	.859	-.326	-.151
VAR04	-.122	-.578	.574	-.119	.143	.535
VAR05	-.144	.255	.148	.356	.872	-.071
VAR06	-.062	-.226	.444	-.297	.036	-.811

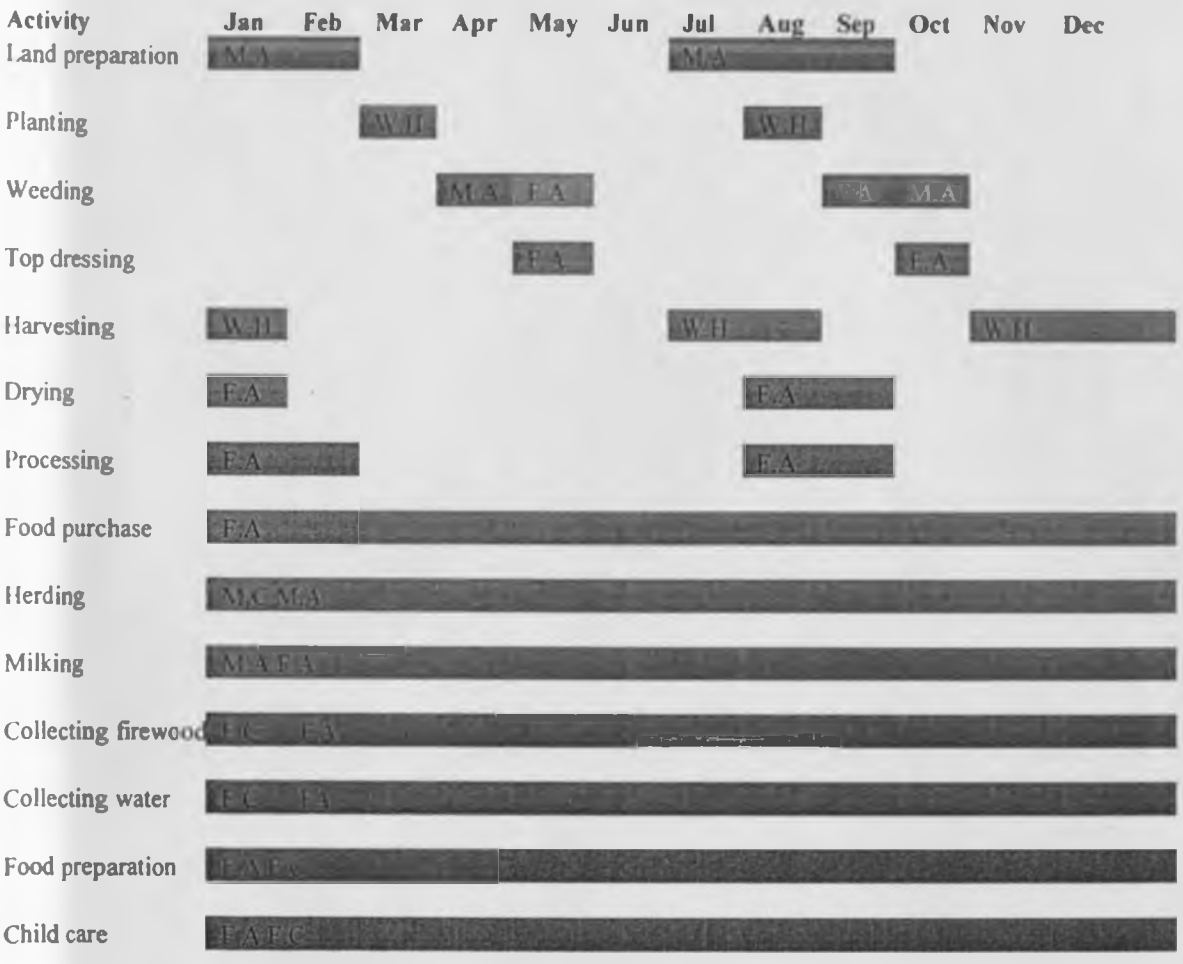
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX IVA: SEASONAL CALENDAR AND DIVISION OF LABOUR IN BUSIA DISTRICT



F.A-Female Adul
F.C Female Chil
M.A-Male Adult
M.C-Male Child
WH-Whole household

APPENDIX IVB: SEASONAL CALENDAR AND DIVISION OF LABOUR IN VIHIGA DISTRICT



F.A-Female Adult
F.C Female Child
M.A-Male Adult
M.C-Male Child
WH-Whole household