CHALLENGES FACED AND OPPORTUNITIES FOR SUSTAINABLE HOUSEHOLD FOOD SECURITY AMONG SMALLHOLDER FARMERS IN MOIBEN LOCATION, UASIN GISHU COUNTY, KENYA

BY

MUKABANE ATIENO DAMARY (B.ED-HOME ECONS)
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NOVEMBER, 2012

DECLARATION

STUDENT DECLARATION

I declare that this thesis is my own original work and has not been presented for a degree in any other university.

Date 5th NOV, 2012

Mukabane Atieno Damary

H60/CE/10665/08

DECLARATION BY THE SUPERVISORS

This thesis has been submitted for review with our approval as University Supervisors:

1. Date 7th Nov. 2012

Dr. Grace Msangi

Department of Community Resource Management and Extension

Kenyatta University

2. Date 5th November 2012

Dr. Florence M. Wakhu Wamunga

Department of Family and Consumer Science

Moi University

DEDICATION

To my husband Jairo Omulako, my children; Wendy, Della and Dale, and my parents for their encouragement, assistance, co-operation and patience.

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ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
ANOVA	Analysis of Variance
CBS	Central Bureau of Statistics
FAO	Food and Agriculture Organization
FEWS	Famine Early Warning Systems
FEWS Net	Famine Early Warning Systems Network
FGD	Focus Group Discussions
GDP	Gross Domestic Product
GoK	Government of Kenya
HIV/AIDS	Human Immuno-Deficiency Virus/Acquired Immune Disease Syndrome
IDRC	International Development Research Centre
IFAD	African Development Bank/International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
KFSSG	Kenya Food Security Steering Group
KIPPRA	Kenya Institute of Public Policy and Research Analysis
KNBS	Kenya National Bureau of Statistics
MDGs	Millennium Development Goals
MoA	Ministry of Agriculture
NGO	Non Governmental Organization
SPSS	Statistical Package for Social Science
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development

UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USD	United Stated Dollars
WFS	World Food Summit
WHO	World Health Organization
WTO	World Trade Organization

ABSTRACT

Attaining food security continues to be a challenge for many nations in the world. Food security; a situation in which all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active healthy life; is affected by a complexity of factors. Moiben location in Uasin Gishu County, Kenya is classified among the high agricultural potential areas yet families experience seasonal food scarcity. A study to investigate challenges and opportunities for sustainable household food security by smallholder farmers was conducted in the location. The objectives of this study were to: evaluate the overall food production among smallholder farmers in Moiben Location; establish the socio-economic challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben Location; determine technological challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben Location; establish the environmental challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben location. The study employed cross sectional descriptive survey design and used a researcher administered questionnaire to collect data from 102 smallholder farmers, interview schedules for the local administration officer and the area Agricultural Extension Officer, and focus group discussion guide. Sampling techniques used in the study were simple random and purposive. Reliability of the instruments was established through pre-testing the instrument. Cronbach's alpha was used to assess the reliability coefficient. The data was analyzed using both descriptive and inferential statistics such as percentages, frequencies, chi-square and Analysis of Variance (ANOVA). The study established that maize was the highest harvested crop in the area followed by wheat and vegetable. Cowpeas and beans were lower among the smallholders. Poultry followed by dairy cows and goats were important livestock in the areas. Milk was the highest followed by eggs and beef among the food items. All the socio-economic factors including sex, age, household size, highest levels of education, occupation and income affected the food crop and livestock production. Food production was higher among females than males and increased with improvement in some socio-economic factors of the farmers. Technology use was low among the smallholder farmers and limited food production. Some of the environmental factors limited food production. The study established that in the recent years, rainfall distribution had become irregular and insufficient thus posing a challenge for the smallholder farmers in the study area. The present study indicate that socio-economic factors, technological and environmental factors, limited food production and improvement in these factors are one of the ways that could enhance food production, hence food security.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

Food is the most basic of human needs for survival, health, and productivity. It is thus the foundation for human and economic development. As is now well known, enough food and much more is produced to meet the needs of all people in the world today. The definition of food security was provided by the United Nations (UN) World Food Summit in 1974. The Summit concluded that food security is the "availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (FAO Expert Consultation on Trade and Food Security, 2002). A definition by the World Food Summit held in Rome in 2009 states that " Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Summit on Food Security, 2009). Yet, the most recent projections from FAO put the number of individuals suffering from hunger at 1.02 billion in the world, one in six of all humanity (FAO, 2009). According to Pingali and Stringer (2011), the global population of some six billion people had 15 percent more food available per capita than had the world's three billion people some four decades ago.

The period from 1996 to 2010, FAO classified 17 countries in Africa as being in protracted crisis (FAO, 2010). Achieving food security is a major concern for many households and governments in Africa today. This situation has been exacerbated by key issues such as the impact of environmental degradation and climate change on food production, rising food prices as a result of reduced production. Ishrat (2012) states that "food security is one of the most urgent issues facing Africa today", and

agrees with Rupiya (2004), who observes that "the African continent is the only region in the world that has not been able to feed itself since the mid – 1970s and is unlikely to do so in the near future unless radical policy changes are made to current practice." The food security situation appears to be worse in the sub Saharan African than in any other place in the world (Kym, 2011). Early gains in hunger reduction achieved in a number of developing regions by the mid 1990's have not been sustained (Stringer, 2000).

Three out of five countries of the East African Community, including Kenya, are also classified as being food insecure (FAO, 2011). In August 2011, Kenya was hit by a severe food crisis, during which 3.75 million people were food insecure (KFSSG, 2011). Although the food crisis was triggered by drought, it was rather poor methods of handling food security situation that turned it into a severe emergency (Foeken and Adel, 2012).

According to the Uasin Gishu District Development Plan of 2002-2008, food production is mainly based on subsistence agriculture. This is because agriculture is the mainstay of the District's economy (Korir, 2008). However, the same plan shows that agriculture had performed dismally over the years with the maize yield being 30-90 kg bags per hectare while the potential is 58- 90 kg bags per hectare. Similarly only 30 bags of wheat were realized compared to the potential 44 bags. The dairy sector experienced hard times resulting from market liberalization. Only an average of 3.5 kg of milk per cow per day was realized against a potential of 7 kg per animal per day. There has been a marked decline in agriculture and dairy production, which led

to a general increase in food insecurity. To solve the problem of food insecurity, there have been several attempts at enhancing production from the smallholder farmers.

Smallholder farmers have been a critical sub-unit of food production system in Kenya (Otieno, 2009). Uasin Gishu is one of the areas leading in food production in Kenya and has been described as Kenya's food basket (Mrema, 2010). As the predominant landholders in much of Kenya, the decisions that smallholder farmers make are simultaneously dependent upon and dictate the condition of the natural resource base for agricultural production and reduction of food insecurity (Nagayets, 2005). Therefore, sustainable management of smallholder production systems is a key food security and a key environmental concern. However, a recent report by Keino (2007) indicates that small holders in Kenya face a number of challenges that may affect their opportunities for increased food from agriculture. As yet, these challenges are wide and varied in areas with high potential food production. This study was therefore designed to determine the challenges faced and opportunities for sustainable household food production by smallholder farmers in Moiben Location Uasin Gishu County.

1.2 Statement of the Problem

Food insecurity continues to be persistent in developing countries because of poor socio-economic conditions, conservative cultural practices, household characteristics, climate variability and inadequate application of technology (Mbega and Konandreas, 2007). Food production in Kenya has been declining over the years and so has been food security. The decline in production of food and the resultant food shortages particularly among smallholder farmers has affected their welfare, socio-economic

conditions and health (Ayaga *et al.*, 2010). Despite government efforts to revitalize agriculture through reduced prices of inputs and improving the price of food commodities, Uasin Gishu County in which Moiben Location is situated still experience food scarcity (KFSSG, 2011). This makes it clear that studies on the challenges of smallholders' food production are required to identify the cause of reduced food production. The concern of this study was to investigate the challenges faced by smallholder farmers as well as the opportunities available for sustainable household food security in Moiben location with an aim of recommending strategies that can ensure household food security in the location.

1.3 Purpose of the Study

The purpose of the study was to determine challenges faced and opportunities for sustainable household food security among smallholder farmers in Moiben Location, Uasin Gishu County, Kenya.

1.4 Research Objectives

The study sought to achieve the following objectives:

1) To evaluate the overall food production among smallholder farmers in Moiben Location,
2) To establish the socio-economic challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben Location,
3) To determine technological challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben Location,

4) To establish the environmental challenges and opportunities influencing sustainable household food security among smallholder farmers in Moiben Location.

1.5 Research Hypothesis

The study sought to establish the following hypotheses;

H_{01}: Socio-economic challenges and opportunities do not influence sustainable household food security among smallholder farmers in Moiben Location,

H_{02}: Technological factors do not influence sustainable household food security among smallholder farmers in Moiben Location,

H_{03}: Environmental factors do not influence sustainable household food security among smallholder farmers in Moiben Location.

1.6 Significance of the Study

In Kenya, smallholders agriculture is widespread and a well-established practice. In the context of growing advocacy for policy support in favour of smallholders' agriculture, it is necessary to provide assessment of the contribution of smallholders' agriculture to food security through food production. The results of the study will thus be useful for government and policy makers in agriculture as it will provide knowledge that contributes to enhancing smallholders' agriculture. Previous studies observed that smallholders' farming plays a critical role towards improved livelihoods of the urban poor in several African countries associated it with few indicators such as improved food security and improved nutritional status (Maxwell and Armah-Klemasu, 2008; Ayaga *et al*, 2010; Drechsel *et al*, 2012). This study explored the

extent to which smallholders' agriculture contributes toward food production, hence food availability.

The findings from this study will also show the food production situation among smallholder farming households in Moiben location. With the recurrent food insecurity, this study provides information for the relevant line ministries to help policy makers address the issue of household food security. Findings of the study will also create ground for researchers interested in the topic, thus contributing to the search for new knowledge and also create an opportunity for implementation of other previous related research and recommendations.

1.7 Scope of the Study

The scope of the study was limited geographically to Moiben Location in Uasin Gishu County. This study explored challenges and opportunities for sustainable household food production by smallholder farmers in Moiben Location. Food security is measured as availability, accessibility and utilization. However, in this study food security was limited to food availability from own farm production. The utilization in terms of nutrition and safety was not included in this study due to the complexity of measuring these variables. The scope involved one research assistant who administered research questionnaires to the targeted groups, the review of relevant literature, development of survey tools and format, sharing of information with focused groups and key informants.

1.8 Limitations of the Study

Food security is determined using four components: access, availability, utilization and stability. This study was limited only to access from own production. Also the study relied largely on the recall ability of farmers and this could limit the conclusions of the study.

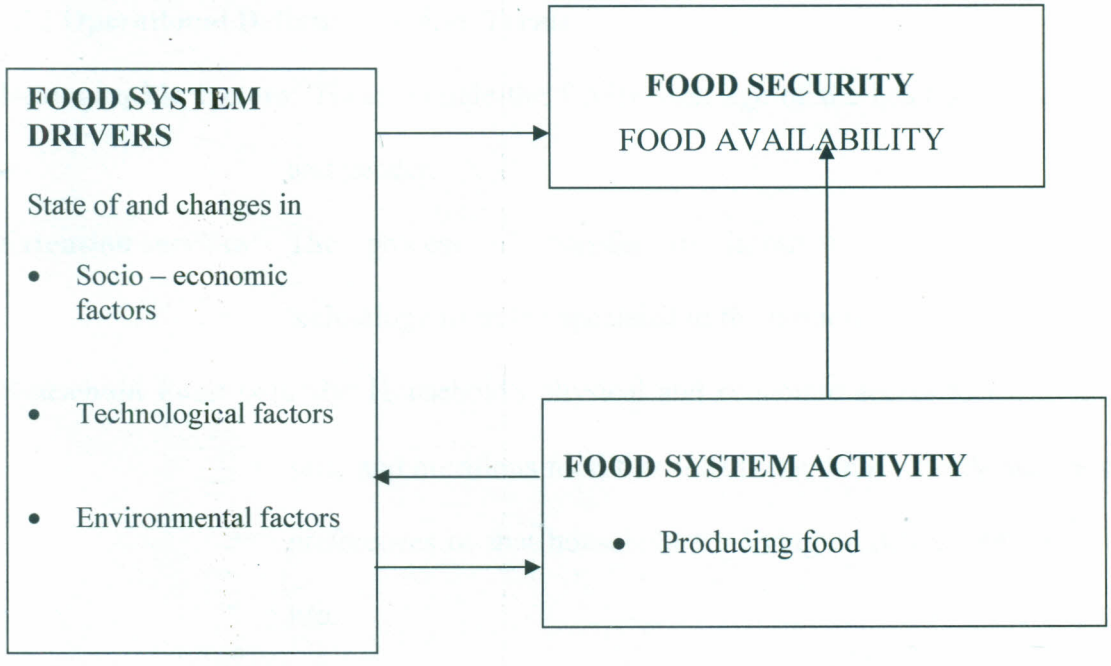
1.9 Theoretical Framework

This study was based on Food Systems theory by Ericksen (2008) which states that: "A food system is as a set of dynamic interactions between and within the biogeophysical and human environments and include a number of activities leading to a number of associated outcomes." Food systems comprise a set of activities and outcomes ranging from production through to consumption, which involve both human and environmental dimensions. Food systems are often described as comprising four sets of activities: those involved in food production, processing and packaging, distribution and retail, and consumption. All these activities encompass social, economic, political, and environmental processes and dimensions. A food system can be more broadly conceived as including the determinants (or drivers) and outcomes of these activities. The determinants comprise the interactions between and within biophysical and human environments that determine how food system activities are performed. These activities lead to a number of outcomes, some of which contribute to food security and others that relate to the environment and other societal concerns. These outcomes are also affected directly by the determinants. Food security is the principal policy objective of a food system (Ericksen, 2008).

Food security outcomes are described in terms of three components and their subcomponents: food availability (production, distribution, and exchange); food access (affordability, allocation, and preference); and food utilization (nutritional and social values and food safety). Although the food system activities have a large influence on food security outcomes, these outcomes are also determined directly by socio-political and environmental drivers. These outcomes vary by historical, political, and social context. By specifically linking activities to outcomes, the food system approach helps understand both linear and non-linear links between activities as part of the outcome analysis (Ericksen and Ingram, 2005). Food systems may or may not result in food security for the unit of analysis of concern; in this case the household.

1.11 Conceptual Framework

Based on the Food Systems Theory, a model was adopted as shown in Figure 1.1.



Source: Adapted from food systems theory by Ericksen (2008)

Figure 1.1: Conceptual framework.

This study integrated the challenges and opportunities to identify important correlates of household food security among smallholder farmers. The factors influencing household food security present challenges as well as opportunities to ensuring household food security. They are socio-economic, technological and environmental. These factors were taken to be the food system drivers or determinants. The state and changes in these factors influence the food system activities, and in this study the activity is producing food. The factors (drivers) also directly influence household food security. On the other hand, food system activities impact the food system drivers. The food system activities a household engages in cause changes in the environment and the economic contexts. The food system activity (food production) then determines the food system outcomes. As indicated in Figure 1.1, the outcome of this study is food availability which then contributes to food security.

1.12 Operational Definition of Key Terms

Demographic factors: These include the family size, age of the head of household and gender.

Extension services: The process of transfer of information on agricultural technology from the specialist to the farmers.

Household Food security: Household's physical and economic access to sufficient, safe, and nutritious food that fulfills the dietary needs and food preferences of that household for living an active and healthy life.

Household head: One charged with the responsibility of decision making and provisioning for the household.

Households: Refers to persons living together under one roof or several roofs within the same compound or homestead and they depend on a common holding as a common source of income and food.

Smallholder farmers: These are farmers who own five acres of land or less.

Socio-economic factors: These are the size of land, education level of the farmer, and capital.

Sustainable household Food Security: Production of food from the smallholders' agriculture for the household throughout the year.

Environmental factor: Issues pertaining to the condition of the surrounding area weather or climate.

Technological factors: Includes technological practices and mechanization of farming in food production.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides literature concerning issues of food security and food production. Literature was reviewed under the following topics: Food security; State of food security in Kenya; Food production Trends; Role of smallholder farmers in agriculture; Socio-economic challenges and opportunities influencing sustainable household food production; Technological challenges and opportunities influencing sustainable household food production; Environmental challenges and opportunities influencing sustainable household food production.

2.2 Household food security

The term food security originated in international development literature in the 1960s and 1970s. Early definitions focused almost exclusively on the ability of a region or nation to assure an adequate food supply for its current and projected population (Maxwell, 2012). The concept has evolved since then and can be used with a focus on many different levels such as global, regional, national, community, household or individual. The World Health Organization (WHO) states that Food Security is achieved "when all people, at all times have physical and economic access to adequate/sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (WHO, 2009). Food and agricultural Organization state that Food security refers to a household's physical and economic access to sufficient, safe, and nutritious food that fulfills the dietary needs and food preferences of that household for living an active and healthy life (FAO, 2006). Food security therefore is not the physical availability of any single commodity; such as maize in the Kenyan context. Neither does it imply just availability but must be

accessible in terms of affordability in adequate quantities, containing essential nutrients.

At household level, it implies that adequate supplies of food are available through domestic production or through imports to meet the consumption needs of all people in a country (AfDB/IFAD, 2009). At the micro level (household or individual), food security depends on a number of factors which are related to various forms of entitlements to income and food producing assets, as well as the links between domestic and external markets (Hamm and Bellows, 2003). Food security is not just a supply issue but also a function of income and purchasing power, hence its relationship to poverty. There are four dimensions of food security that determine the level at which a community is placed in relation to vulnerability to hunger: Food availability; food accessibility; stability and utilization/nutrition.

2.2.1 Household food availability

Food availability has to do with the supply of food. This should be sufficient in quantity and quality and also provide variety (Atieno, 1996). Food availability to the people can be through own production, purchases, food aid or gifts. Food production per capita captures a country's capability to produce food based on current production technology in the country. Food availability, though elemental in ensuring food security, does not guarantee it (Mbega and Konandreas, 2007). For households and individuals within them to be food secure, food at their access must be adequate not only in required quantity but also in quality. It should ensure an adequate, consistent and dependable supply of energy and nutrients through sources that are affordable and socio-culturally acceptable to them at all times (Reardon *et al.*, 2006).

The analysis of average food availability among a representative set of African countries reveals that in one third of African countries, the average daily caloric intake availability is below the recommended level of 2100 Kcal (Ethiopia, Kenya, Rwanda and Tanzania in East Africa, and Angola, Madagascar, Mozambique and Zambia in Southern Africa, Sierra Leone in West Africa) (FAO, 2008). In a few countries (Burundi, Democratic Republic of the Congo, Eritrea and Somalia) the mean availability is below 1800 Kcal, which is considered the minimum intake level. In some countries (Botswana, Burundi, DR Congo, Gambia, Liberia, Madagascar, Senegal, Sierra Leone, Somalia, Tanzania and Zambia) the situation has been deteriorating over the last ten years while in others (Ghana, Malawi, and Nigeria) aggregate figures show some improvement (World Bank, 2008).

2.2.2 Food accessibility and Stability

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security (*http://www.fao.org/bioenergy/21945-090708fc626227c1d17d0bfea0854aeed.pdf*).

Many developing countries for a long period pursued the goal of attaining self-sufficiency in food commodities. In Kenya these included maize, wheat, rice, beans, milk and meat. Self sufficiency in maize was achieved during the 1970s when production was high and the surplus was exported (MoA, 2009). Unfortunately,

attainment of self sufficiency does not automatically imply that household food security is achieved. Empirical evidence shows that solving the food security issue from production (Supply side) point of view, while overlooking the purchasing power (demand side) of the people, does not solve the food security problem, with regard to accessibility of sufficient food by vulnerable groups (KIPPRA, 2007).

As a result of poor transport, high fuel prices and market infrastructure, food either does not reach those who need it most (from surplus regions) or reaches them at excessively high prices. In as many as 17 countries in Africa, conflicts have constrained the flow of food leading to insufficiency even for those who could afford to purchase. In Kenya, 30% of the food consumed by rural households is purchased, while 70% is derived from own production (Pingali and Stringer, 2011). On the other hand, 98% of food consumed in urban areas is purchased while 2% is own production. This emphasizes the strategic role played by the rural households in food accessibility and stability of many African countries. Agricultural policies formulated therefore should focus on how to increase productivity and stability in the rural setups (FAO, 1996).

2.2.3 Utilization/ Consumption

According to World Bank (2008) report, less than 50% of Sub-Saharan African countries have levels of malnutrition under 30% and only three of them are under 10% (Gabon, Namibia and Nigeria). Despite economic growth and food availability, some countries still display increasing malnutrition, as measured by the prevalence of stunted growth among children (e.g. in Mali). In the African continent although cereals, pulses, roots and tubers play a central role in food supply, production has

generally lagged behind the rate of population growth (Reardon *et al.*, 2006). This is partly because priority was put on development of the cereals and pulses leaving behind the root and tuber crops which can survive harsh weather conditions. Those countries that have been able to increase their cereal production and export agricultural products have generally been those in which food security improved. To satisfy demand for food, Sub-Saharan African countries have had to rely increasingly on imports. About 30% of cereal consumption is currently imported compared to 5% in the late sixties (FAO, 2008).

World prices of wheat, rice and maize have increased since late 2007 compared to the previous year. With the increase in oil freight rates' this has sharply driven up the cost of imports for food importing countries. Despite soaring international prices of the cereals imports between 2006 and early 2008, the rate of importation by many countries has been faster compared to the past years. Total import bill for African countries in 2007 was 10,297 million USD compared to an estimated bill of 17,892 million USD for the year 2008 (FAO, 2008).

Food security is a complex sustainable development issue, linked not only to health through malnutrition, but also to sustainable economic development, environment, and trade. There is a great deal of debate around food security with some arguing that: there is enough food in the world to feed everyone adequately; the problem is distribution; future food needs can - or cannot - be met by current levels of production; national food security is paramount - or no longer necessary because of global trade and globalization may - or may not - lead to the persistence of food insecurity and poverty in rural communities (Pingali and Stringer, 2011).

Whether households get enough food, how it is distributed within the household and whether that food fulfils the nutrition needs of all members of the household show that food security is clearly linked to nutrition and health (Stringer, 2000). Agriculture remains the largest employment sector in most developing countries and international agriculture agreements are crucial to a country's food security. Some critics argue that trade liberalization may reduce a country's food security by reducing agricultural employment levels (Barham and Chitemi, 2008). Concern about this has led a group of World Trade Organization (WTO) member states to recommend that current negotiations on agricultural agreements allow developing countries to re-evaluate and raise tariffs on key products to protect national food security and employment (*http://www.ifg.org/pdf/cancun/issues-foodsecurity.pdf*). They argue that WTO agreements, by pushing for the liberalization of crucial markets, are threatening the food security of whole communities.

2.3 The State of Food Security in Kenya

Kenya has a population of about 38 million based on the census of the year 2009 (KNBS, 2010) and about one third of this population are classified as food insecure. The falling food production in Kenya implies that Kenya is nationally food insecure in terms of staple cereal production as well as processed foods. A growing problem of food and nutrition insecurity in Kenya is linked to agricultural production. About 60% of Kenya's population live in the rural areas where smallholder agriculture dominates (Danielson, 2002; KFSSG, 2011).

As a way of responding to the challenge, the Government of Kenya adopted the Sessional Paper No. 1 of 1994 on National food policy (1994). Although the

government has had a specific food policy since 1980, it is still hoped that the goal of food self-sufficiency will be met through pursuance of broader policies on agricultural production. Kenya's food policy since independence has therefore been centered on improving domestic supply of basic foodstuffs, mainly grain crops. Various policies on food security have also focused on expanded agricultural production and extension service, improved physical infrastructure and community health and nutrition education to increase food security *(http://www.foodsecurityportal.org/kenya/food-security-report-prepared-kenya-agricultural-research-institute).* Kenya's past food policies have had limited success in addressing food and nutrition insecurity.

Before independence and in the 1970's through 1980's, Kenya was generally self-sufficient in production of staple food. However in the 1990's the amount of food produced started to decline and thus the amount of imported food increased substantially (Nyangito, 1997). This tilted the better food security situation towards uncertainties. Thereafter, food security has remained a major concern for the country especially the government of Kenya. The current food insecurity problems are attributed to several factors, including the frequent droughts in most parts of the country, high costs of domestic food production due to high costs of inputs especially fertilizer, displacement of a large number of farmers in the high potential agricultural areas following the post-election violence which occurred in early 2008, high global food prices and low purchasing power for large proportion of the population due to high level of poverty (*http://foodnews.lovingspoonful.org/?p=87*). The situation in Moiben is not different.

Also, there has been a shift in taste from traditional crops like cassava and millet to rice and wheat. In high potential areas, cash crops have taken a larger share of the farms of small holders; this has resulted in food shortage rendering households food insecure (K'Okul, 1991; GoK, 1994). Currently over 10 million people in Kenya suffer from chronic food insecurity and poor nutrition, and between two and four million people require emergency food assistance at any given time. Moreover, Hamboldt and Otieno (2012) observed that the availability of food through import provision without ability to increase production from the current farms is not sufficient condition that would favour improved household food security. They therefore suggested quick remedial measures to tackle the increased tendency of food insecurity.

Remedy for the low food production to increase food security has been attempted by the government with little success. The share of agriculture in government budgets between 2002 and 2008 averaged between 3.5% and 7%; far below 10% of their national budgets, pledged at the Maputo (in Mozambique) meeting by African Union (AU) Heads of State and Government in July 2003 (Kamara *et al.*, 2009). The low public spending is a serious concern to improving the food security given the recurrent food shortages in the country. In early 2009, the Kenyan government reported that 10 million citizens were at risk of food shortages, and consequently declared a national emergency and appealed for USD 400 million in aid (FEWS Net, 2009).

One of the major initiatives of the government has been to encourage the smallholders to expand their production through provision of microfinance (Karimi, 2009).

Although micro-finance institutions have taken financial services to millions of previously un-bankable clients due to innovative instruments, they have so far largely failed to reach poorer rural areas and/or smallholder agricultural producers whose livelihoods are characterized by highly seasonal investments, risks, and returns (Peacock *et al.*, 2004). The success of microfinance at improving market among the smallholders is therefore not well documented, but is apparently low.

The foregoing discussion indicates that the food security situation currently is low resulting in widespread hunger and malnutrition. This is particularly true in rural areas which have smallholder farmers with small land sizes capable of enhancing food production. Therefore approaches to enhance food security in Kenya must target the smallholders in these rural areas, which form one of the objectives of the current study.

2.4 Food production trends: Global and local contexts

2.4.1 Global trends in food production

Global food production is one of the most pressing societal issues of our time. It is presently estimated that more than one billion persons, or one out of every seven people on the planet, is hungry and/or malnourished (Barraclough, 2009). Yet the problem of feeding the planet's population is not one of insufficient food production; for the agriculturalists of the world currently produce more than enough food to feed the globe's entire population. Rather, the problem is one of inadequate distribution, with food insecurity arising simply because the world's supply of food is not evenly dispensed among the human population, due to what Conway and Toenniessen (1999) have called "notoriously ineffective" world markets.

An early perspective on the looming food shortage was presented more than a decade ago by Norman Borlaug, father of the Green Revolution and 1970 Nobel Laureate for Peace (Borlaug, 2000). In an article on world hunger, he wrote that "it took some 10,000 years to expand food production to the current level of about 5 billion tons per year," and that to meet the needs of the planet's growing population by 2025, "we will have to nearly double current production again." Given this enormous challenge, Borlaug (2000) wrote that agricultural scientists have a moral obligation to warn political, educational, and religious leaders about the magnitude and seriousness of the arable land, food, and population problems that lie ahead. In fact, "if we fail to do so," he said, "we will be negligent in our duty and inadvertently may be contributing to the pending chaos of incalculable millions of deaths by starvation."

Other researchers have followed in Borlaug's footsteps, echoing concerns about the coming global food crisis. According to those scientists, global food production must increase by 70 to 100 percent by the year 2050, if we are to adequately feed a global population of nine billion people at that time (Bruinsma, 2009; Parry and Hawkesford, 2010; Webb and Block, 2010). So how is it to be done? Or, even more basically, can it be done? Many of the scientists and organizations addressing this problem have concluded that unless there are significant advancements in basic farming techniques and/or reductions in world population, serious food shortages will occur and they conclude they will develop within a decade.

For the world as a whole, the FAO database contains agricultural production data for 169 different crops that have been grown and used by man since 1961; but because more than half of these crops each account for less than 0.1% of the world's total food

production, it was deemed both prudent and adequate to focus on only those crops that accounted for the top 95% of global food production. This was accomplished by taking the production contribution of the most important crop, adding that to the contribution of the second most important crop, and continuing in like manner until 95% of the world's total food production was reached. In addition, since some of the 169 crops increased in their productive importance over the 48-year period of record, while others declined (and some remained relatively unchanged), this analysis was performed for mean conditions over the most recent 15-year period (1995-2009), which should provide the most accurate assessment of the crops most likely to be providing the top 95% of total world food production in the year 2050, since this latter period is the closest to that future date. The results of these procedures produced a list of 45 crops that account for 95% of world food production as shown in Table 2.1.

Table 2.1: The forty-five crops that supplied 95% of the total world food production over the period 1995-2009 globally

Crop	% of total production	Crop	% of total production
Sugar cane	21.240	Yams	0.670
Maize	10.283	Rapeseed	0.662
Rice, paddy	9.441	Cucumbers and gherkins	0.563
Wheat	9.372	Groundnuts, with shell	0.531
Potatoes	4.871	Plantains	0.495
Sugar beet	3.877	Millet	0.461
Vegetables freshness	3.335	Mangoes, mangosteens, guavas	0.433
Cassava	2.979	Eggplants (aubergines)	0.433
Soybeans	2.836	Sunflower seed	0.423
Oil palm fruit	2.247	Oats	0.408
Barley	2.216	Fruit freshness	0.367
Sweet potatoes	1.966	Carrots and turnips	0.354
Tomatoes	1.784	Other melons (inc,cantaloupes)	0.351
Watermelons	1.222	Chillies and peppers, green	0.347
Bananas	1.126	Tangerines, mandarins, clem	0.343
Oranges	0.981	Lettuce and chicory	0.303
Grapes	0.975	Rye	0.297
Seed cotton	0.937	Beans, dry	0.289
Apples	0.936	Pumpkins, squash and gourds	0.287
Sorghum	0.930	Pears	0.267
Cabbages and other brassicas	0.930	Pineapples	0.250
Onions, dry	0.858	Olives	0.248
Coconuts	0.834		
Sum of All Crops = 95.0%			

Source: FAO, 2009

2.4.2 Kenyan production trends of major foods

Over the years, Kenya Government strove to achieve national, household and individual food security throughout the country. The success in this effort has been mixed. The national average maize production stands at 2.8 million tons with the highest ever realized being 3.2 million tons in 2006. National supply for staple foods in 2008 is as follows; maize 2.4 million tons (26 million 90kg- bags) against a national requirement of 3.1 million tons (34 m 90kg-bags), wheat 360,000 tons against national requirement of 900,000 tons, rice 120,000 tons against national requirement of 280,000 tons (MOA, 2009). The country depends on imports to bridge

the gap in these staple foods and especially wheat and Rice; periodically for maize when production fall bellow demand.

The economic review of agriculture 2007 indicates that area under acreage of maize did not change dramatically as was the production but consumption of the same commodity increased over the same period (KNBS, 2010) as provided in Table 2.2.

Table 2.2: Maize production trend in Kenya, 2003 – 2008

Year	2003	2004	2005	2006	2007	2008
Area (Ha)	1,670,914	1,819,817	1,760,618	1,888,185	1,615,304	1,706,814
Prod (90kg bag)	30,120,530	27,249,721	32,423,963	36,086,406	32,542,143	26,230,000
Consumption estimates (90kg bags)	30,150,000	31,135,000	32,120,000	33,105,000	34,098,000	35,121,000

Source: KNBS (2010)
An assumed population growth of 2.5% per year
An average national consumption of 1 bag/person /year

As concerns the wheat production, there was dramatic increase in the area under wheat followed by a decline the preceding year which was reflected in the overall production against an increasing consumption of wheat (Table 2.3). The table indicates that between 2003 and 2004, there was a decline in the acreage under wheat production but increased between 2004 and 2005. After 2005, the acreage under wheat has continued to decline until 2008 as was the overall production of wheat.

Table 2.3: Wheat production trend in Kenya, 2003 - 2008

Year	2003	2004	2005	2006	2007	2008
Area (Ha)	151,135	145,359	159,477	150,488	140,178	127,066
Prod (90kg bag)	4,207,278	4,173,652	4,063,294	3,978,454	3,936,105	3,206,808
Consumption estimates (90kg bags)	9,812,000	9,878,000	9,924,000	10,035,000	10,311,000	10,517,000

Source: KNBS (2010)
Amount of rainfall and its poor distribution over the growing period reduced yields by about 20% compared to last season.

Analysis of rice production in Kenya was also done during the period 2003 and 2008 (Table 2.4). Area under rice production increased between 2003 and 2006, declined between 2006 and 2007 and then increased thereafter in 2008, which was reflected in the production of the same crop. Estimated consumption however, increased over the aforementioned time indicating a shortage was experienced in the year 2007 (KFSSG, 2011).

Table 2.4: Rice production trend in Kenya, 2003 – 2008

Year	2003	2004	2005	2006	2007	2008
Area (Ha)	10,781	13,322	15,940	28,106	16,457	24,166
Prod (90kg bag)	40,500	49,300	57,900	64,800	47,300	63,248
Consumption estimates (90kg bags)	258,600	270,200	279,800	286,000	293,700	301,600

Source: MoA (2009)
Production meets only 20% of national Rice requirement

Information on the production of beans was also sought from the KNBS (2010), as shown in Table 2.5. Analysis of the trend indicate that acreage under beans reduced between 2003 and 2004 upon which there was a dramatic increase in the area under

beans between 2004 and 2005 and thereafter a continuous decline until the year 2008. The trend in areas under acreage was similar to the production patterns while consumption of beans increased progressively.

Table 2.5: Beans production trend in Kenya, 2003 – 2008

Year	2003	2004	2005	2006	2007	2008
Area (Ha)	879,032	872,070	2,034,477	995,391	846,327	641,936
Prod (90kg bag)	4,763,928	2,576,020	4,175,772	5,908,887	4,775,512	2,944,227
Consumption estimates (90kg bags)	4,611,000	3,444,400	4,449,450	5,111,100	5,826,700	6,626,400

Source: MoA (2009)
Poor distribution of rains and pest damage affected crop performance compared to previous seasons.

Production trend of Irish potatoes is provided in Table 2.6. Acreage under Irish potato production increased between 2003 and 2005 before reducing towards 2007 and increased in the year 2008. The production of Irish potato reduced between 2003 and 2004 before doubling towards 2005 and reduced thereafter until 2008. Consumption trends nevertheless increased systematically from the year 2003 to 2008.

Table 2.6: Irish Potato production trend in Kenya, 2003 – 2008

Year	2003	2004	2005	2006	2007	2008
Area (Ha)	126,490	128,484	132,030	120,754	98,401	139,974
Prod (90kg bag)	1,220,620	1,124,235	2,640,600	2,415,080	1,968,020	1,679,688
Consumption estimates (90kg bags)	2,892,300	2,981,780	3,074,000	3,166,220	3,261,200	3,359,000

Source: Source: MoA (2009) and KIPPRA (2007).

Livestock products include milk, beef, mutton, goat meat, pork, poultry and eggs. On average, 4.0 billion litres of milk is produced annually while local milk demand is 2.8 billion litres. The meat sub sector is dominated by red meat (beef, mutton and goat). Red meat accounts for about 70% of the meat consumed locally while white meat (pork and poultry) makes up the remaining 30%. The production of red meat is 430,000 tons against national requirement of 330,000 tons while white meat is 40,000 tons against requirement of 39,600 tons (MoA, 2009).

Table 2.7: Milk and Beef production trend, 2005 – 2007

Product	**2005** Volume	**2006** Volume	**2007** Volume
Beef Production (MT)	414,175	430,000	445,000
Beef Consumption (MT)	310,370	321,750	330,000
Milk ('000' Lts) Production	3,400,000	3,700,000	3,800,000
Milk Consumption ('000' Lts)	2,661,750	2,730,000	2,800,000

Source: Source: MoA (2009) and KIPPRA (2007).

2.5 Role of smallholder farmers in agriculture

The population in sub-Saharan Africa is predicted to increase to over one billion by 2025 (Karugia *et al.*, 2009). In order to meet the food requirements of the increased population and achieve food security by 2015, agricultural production would need to increase by 6% per annum (Webb and Block, 2010). These advances will need to be made where many poor smallholders depend on agriculture for their livelihood and where there are few alternatives of earning a living (Mugo, 1995).

Smallholder production is often characterized by low yields, which are often significantly lower than the potential for the land (Diao and Hazell, 2004). Sustainable smallholders' food production is not only a question of achieving reasonable yields, but of government policy on agriculture, protection of the environmental resource base, social welfare, and the livelihoods of farmers and adjacent rural communities (Ericksen, 2008). Sustainability for the smallholder farmer raises questions of equity, economic viability of their operations and household food security. It is valuable to investigate sustainability at the field scale using both field data and model simulations for an improved understanding of food security at the household level. At the household level it is crucial for the farmer to minimize the fluctuations in household income over time, as well as to maintain or increase a particular wealth level and nutritional status (Njogu, 2002). The smallholder farmer is more susceptible than commercial farmers to climate variability and its impact on yields. A similar situation was observed among the smallholder farmers in Moiben. Therefore this study will provide the role of smallholder farmers in food security in Kenya.

There is a general consensus that households access food mainly through three sources, namely: markets, subsistence production and transfers from public programmes or other households (Hamm and Bellows, 2003; Cook *et al.*, 2008). These sources are also referred to as entitlement categories: production, exchange (barter or purchase) and transfers (Sen, 1981). Recent studies have shown substantial increase in dependence on market purchases on the part of rural households (Webb and Block, 2010; Karugia *et al.*, 2011). As a result food expenditures can be as much as 60–80% of the total income of low-income households (Kamara *et al.*, 2009). In most of sub-Saharan Africa, food insecurity affects the rural households who are able

to exploit natural resources to provide for food or to generate income (Hamboldt and Otieno, 2012).

In rural areas, two crucial components affecting household food security are the ability to earn cash income, and prices of food (Rupiya, 2004). The efficiency of marketing and distribution systems, household purchasing patterns, ability to produce own food affect access to food availability. While farming still remains important for rural households, people are looking for diverse opportunities to increase and stabilize their income (Baiphethi and Jacobs, 2009).

ActionAid believes sustainable smallholder agriculture offers a key solution to tackling hunger, as well as addressing poverty and climate change issues. Sustainable agriculture integrates several goals like environmental stewardship, farm profitability and prosperous farming communities (UNCTAD/UNEP, 2008). It refers to the ability of farms to produce food indefinitely, without damaging soils and ecosystems, or human and social capital (UNEP, 2009). Sustainable approaches aim to maintain healthy soils while reducing reliance on external 'inputs' such as fertilizers, pesticides and herbicides. Sustainable agriculture encompasses approaches such as agro-ecology, low external input, agro-forestry, organic agriculture, integrated crop and pest management and water harvesting in dry land areas (Pingali and Stringer, 2011). These approaches often blend farmers' traditional and local experience with scientific knowledge and innovation aimed at ensuring access to healthy and nutritious food throughout the year. As it relies on local renewable resources and locally-based innovation, sustainable agriculture is particularly well-suited to poor, remote or marginalized communities.

2.6 Socio-economic challenges and opportunities influencing sustainable household food security

The expansion of smallholder farming can lead to faster rate of poverty alleviation, by raising the incomes of rural cultivators and reducing food expenditure, and thus reduced income inequality (Diao and Hazell 2004; Barham and Chitemi 2008; World Bank, 2008). As observed by Ravallion (2001), a rise in average household income by 2 percent leads to a fall in the poverty rates by about 4 percent on average. The 2008 World Development Report also observed that GDP growth originating in agriculture is about four times more effective in reducing poverty than GDP growth of other sectors (World Bank, 2008). Agriculture is the major economic activity for the countries of the Sub Saharan Africa, Kenya included. However, in the recent past there has been capital flight from agriculture to other potentially more profitable sectors of the economy. This will eventually exacerbate the poor performance in the agricultural sector and hence reduce food production and food security.

Various estimates have indicated that there have been positive, though marginal, changes in the poverty profiles of Kenya and other East African countries, but not to the level needed to meet the MDG one - *Eradicate extreme poverty and hunger*. Most of the household surveys conducted in Kenya in the last two decades showed that poverty is more prevalent among rural dwellers where a majority are smallholder farmers. Also, changes in poverty levels by employment across sectors indicate that change in poverty status among rural dwellers engaged in agriculture was higher than among rural populations engaged in other vocations. In addition, change in poverty among farmers and fishing folks in the rural sector was higher than change in poverty level among those engaged in other occupations, except those engaged in paid

employment and self employment (World Bank, 2008). Against these studies, it can be concluded that the modest reduction in poverty witnessed in Kenya can be attributed to the contributions of the agricultural sector, especially smallholder farming. The improvement in the poverty status, however small, has implications for the nutrition of households and consequently feeds back to agriculture.

According to the Kenya Food Security Steering Group, KFSSG (2009), poverty reports in Kenya measures of welfare are based on consumption rather than income. The survey further shows that despite a World Bank estimate, that growth of rural economies accelerates poverty reduction four times faster than other sectors, the proportion of foreign aid allocated to agriculture has fallen from 18% in 1979 to less than 5% in 2007. Narayan *et al.* (2000) reported that food is the major consumption good for the poor since physiological needs of thirst and hunger are the first in the hierarchy of needs. Food insecurity could also be referred to as food poverty. The food poverty line in Kenya is estimated as the cost of consuming 2,250 kilocalories per day per adult equivalent (Republic of Kenya, 2007). The poor, including the smallholder farmers have been described as the most vulnerable to food insecurity because they have a low purchasing power (Nyangito, 1997).

Land is a major production factor in agriculture. The size of the land owned is an indicator of the socio-economic status of a given household. In agricultural areas on the other hand, land is the most important variable for defining poverty (Baiphethi and Jacobs, 2009). The World Bank summarizes the broader importance of owning land as follows: access and control over land shapes equity because land is still one of the major assets held by households; influences efficiency because land is one of the

economy's main productive assets; underlies sustainability of resource use, for its important for agricultural production (World Bank, 2008). Otieno (2009) indicated that most smallholders in developing and developed countries have inadequate farmland and most will depend on backyard gardens.

Transition from agriculture to other sources of income (such as paid-work or self employment and entrepreneurship) presents far higher potential for poverty reduction and hunger alleviation. In this context, many suggest that increase in productivity in agriculture that would allow movement of workers from agriculture to other sources of income and in particular industrialization, are necessary for growth and poverty reduction (Gollin, Parente and Rogerson, 2002). A substantial untapped potential exists also in the form of rural entrepreneurship. This is particularly true for Moiben Location.

2.7 Technological challenges and opportunities influencing sustainable household food security

Access to a regular stream of technologies suitable to specific conditions contributes to increasing productivity, particularly in the context of limited land resources, and thus it is important in ensuring household food security. For example, in arid zones, investment in improved irrigation technology and drought-tolerant crops help reduce price and income variability by mitigating the impact of droughts. Yet irrigation facilities are poor as less than 4 percent of all agricultural output is produced under irrigation in East Africa, compared with about 33 percent in Asia (AfDB/IFAD, 2009). Furthermore, in sub-Saharan Africa, including East African countries, average

post-harvest losses are estimated to amount to over 40 percent, and even up to 70 percent in some fruits and vegetables (UNIDO, 2007).

In Kenya underdeveloped rural roads and other key physical infrastructure have led to high transport costs for agricultural products to the market as well as of farm inputs, reducing farmers' competitiveness. In addition, electricity in rural areas is expensive and often not available; which has reduced investment in cold storage facilities, irrigation, and processing of farm produce. Lack of storage and processing facilities constrains marketability of perishable goods such as fish, dairy products, and vegetables. The infrastructural and logistic constraints are also impediments to trading. Low levels of publicly funded agricultural research and development have severely impeded smallholders' access to productivity-enhancing technologies.

Research and extension services have been disintegrated and ineffective for any technological transformation to take effect. On average, most African countries spend less than 0.7 percent of agricultural GDP on research. On the other hand some countries, especially the developed ones, spend up to 3 percent (Karugia *et al.,* 2009). In Kenya the effectiveness of extension services declined throughout the 1990s due to inappropriateness of the training and visit extension model pursued, delayed adoption of alternative models and sharp reduction in the operational budgets of the sector ministries. Despite various attempts to strengthen them, the linkages between research, extension and training were weak, and collaboration between public and private partners limited. The weak technology diffusion and innovation in Kenya was confirmed by the UNDP Technology Achievement Index (TAI) where it was listed as marginalized with 0.129 scored (UNDP, 2001).

According to Sumberg (2005), existing agricultural institutions whether universities, research organizations, or extension services find it difficult to learn from farmers. This is because they are characterized by restrictive bureaucracy and centralized hierarchical authority. He further recommends that bringing all stake holders into the research process will shift focus from 'research for its own sake' to 'research for development'. A report by the United Nations Environment Programme (UNEP, 2009) shows that an environment-led green revolution is key to future food security in Africa. New technologies should integrate with old technologies to enable the farmers to gradually adopt the new ones (Sulo, 2005). Radical shift has been counterproductive especially when the new technologies do not deliver the expected results. The concern of the current study was to determine the influence of technological factors on household food security among smallholders' farmers in Moiben location. That was to try and find out if those factors were a challenge or an opportunity in ensuring sustainable household food security.

2.8 Environmental challenges and opportunities influencing sustainable household food production

Climate change, resulting mostly from global warming, has been among the major causes of reduced agricultural production and productivity in many parts of Africa, including Kenya. Climate change as evidenced by disasters such as droughts, floods, typhoons have become frequent and unpredictable.

Rainfall in most Sub Saharan Africa is highly erratic, and normally falls in intensive storms, with very high intensity (Rockstorm, 2000). The heavy El Nino rainfall led to huge livestock losses to some 20,000 pastoralists in Wajir (FEWS, 1999).

Consequently are the droughts and intra-sectional dry spells making the major cropping system that mainly includes the rain fed agriculture unsustainable (Danielson, 2002). Drought also leads to high mortality as well as poor body condition of livestock and therefore low livestock prices.

The main environmental factor behind food insecurity in the country is deficient rainfall because agriculture in Kenya is rain fed. Many studies of food insecurity divide the country according to their potential for agriculture, which is usually determined by the amount of rainfall they receive. The vulnerability of a household or area to food insecurity is determined not only by the amount of rainfall a place receives but also the seasonality of the rainfall (Mbithi, 2000). A study by Kigutha (1995) shows that even in high potential areas of Rift valley uni-modal rainfall pattern subject's households to food insecurity during certain months of the year. Drought is seen as the main cause of food insecurity in Kenya. Low production due to drought leads to increased food fluctuations. The study investigated the situation in Moiben location which was not different from other parts of the country.

Equally important is proper land management. With increasing land degradation, land resilience has been reduced and the effects of drought and floods exacerbated. In 2008, Kenya's tea production fell by about 6 percent as a result of early-season drought. In early 2009, the Kenyan government reported that 10 million citizens were at risk of food shortages, and consequently declared a national emergency and appealed for USD 400 million in aid (Karugia *e al.,* 2009). The emergency was caused by a combination of drought; high food prices, and the effects of post - election violence in early 2008 that disrupted farming in the Rift Valley, the country's

breadbasket. Unfortunately, early-warning systems are inadequate. Ground-and-satellite-based systems for forecasting medium-term weather and seasonal agricultural output as practiced in countries like India are rare in East Africa. According to Kimaru and Jama (2005) East Africa sustained gains to agricultural productivity are threatened by land degradation, especially land erosion and loss of fertility.

2.9 Summary of Literature Review

In this review, food security has been established to be a major theme in the 21st century for global, Africa and Kenyan context based on the collated information from the previous studies. It is clear that there is wide variability in the outcomes of the studies, which show wide differences in the global and local contexts. A major conclusion from these reviews is that the food security situation is worsening especially in the developing countries and agricultural productions in these countries are declining. There is also identification of two broad categories of smallholder food production – 1) those practicing subsistence farming to feed their families and 2) entrepreneurial or commercial smallholders agriculture that provides food and income to the family, which differ in their nature and contribution to food security. During the review, it was also noted that socio-economic factors, environmental variables and technology appear to limit agricultural production in Kenya. Yet the extent of these among smallholder farmers in Moiben is not well known. More bleak is the knowledge of the opportunities available for enhancing smallholders' agriculture. Delineating these challenges and opportunities may provide a way forward to enhance food production in these rural areas. Yet, in Kenya, research into this area appears absent or very limited, which has the potential to limit the smallholders' agriculture.

This is what the study endeavored to achieve so as to gain new knowledge and insight into ways of improving this situation.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter gives a description of the processes that were used in carrying out the study. It covers research design, description of the study area, target population, sample size, sampling procedure, pre-testing of research instruments and data analysis techniques.

3.2 Research design

The study used a cross-sectional descriptive research design. A cross-sectional descriptive survey is the systematic collection of information from a group of people in order to describe some aspects or characteristics of the population of which that group is part (Cohen and Manion, 2003). A cross-sectional descriptive survey was chosen because risks and outcomes were measured at the same time. It also facilitated collection of information from a large population of people and was able to identify the challenges faced by and opportunities for smallholder farmers for sustainable household food security in Moiben location within a short time.

3.3 Description of the Area of Study

This study was carried out in Moiben location in Moiben Division of Eldoret East District, Uasin Gishu County. The location is made of two sub-locations namely: Toloita and Moiben; and 16 villages. Farmers are classified in three categories as follows: large scale (owning above 40 hectares), medium scale (owning between 20-40 hectares) and smallholders' (owning below 20 hectares). The focus in this study was on smallholder farmers who possessed five acres (approximately equivalent to two and a half hectares) and below ($\leq$ 5 acres). In other regions five acres would not

be considered as smallholders. The rainfall received in Eldoret East district of which Moiben is a part of, ranges from 900 mm to 1200 mm per year. This occurs in one long season. That is from April to September with peaks in May and August. Dry season normally starts in October and ends in March. The major economic activity is crop farming and livestock production.

3.4 Target Population

Mugenda and Mugenda (1999) define a population as a complete set of individuals, cases or subjects with some common observable characteristics. A target population is that population to which a researcher wants to generalize the results of a study. Moiben location has a total of 2,697 households (KNBS, 2010). From this total population, the number of households that had large scale farms (> 16 ha) were 409, those with medium scale farms (2-16 ha) were 1268 while the remaining 1020 households had smallholder farms (<2 ha). The population that was used in this study therefore was 1020 households. There were other key informants in the community such as the chief, the agricultural extension officer in the location and other community leaders who were part of the population.

3.5 Sample Size

A sample is a small part of a large population, which is thought to be representative of the larger population. As noted by Cohen and Manion (2003), factors such as expense, time and accessibility frequently prevent researchers from gaining information from the whole population. The study sought information from a sample of 1020 households. According to Mugenda and Mugenda (1999), when the sample size is below 1000, then 10% of the sample size is representative and will be

appropriate. In this study taking 10% therefore the sample size was 102 households. From, each household, the household head was selected and included as part of the sample size. The spouses also responded in the absence of household heads. In addition, 2 key informants that is the chief and the agricultural extension officer and 16 community leaders were selected from every village. The area of study was too expansive due to the large farms belonging to large farmers making the smallholder farmers to be far between each other. The sample size was considered representative and adequate to provide reliability because the population under investigation was similar. This size was also considered economical as relates to time and cost.

3.6 Sampling Procedures

For purposes of this study, the researcher made a prior visit to Moiben location to come up with a sampling frame of households that possessed up to five acres of land. Simple random sampling was done to select respondents from the households. The lottery method was used where the names of all 1020 households were written on a piece of paper, the slips folded, then put in a container from which the researcher randomly picked one name without replacement until 102 respondents' names of the households had been picked.

Purposive sampling was used to select 2 key informants; that is the local administration officer (Location chief) and the agricultural extension officer. The location had one agricultural extension officer. Sixteen community leaders within the location who formed 2 focus groups were also selected by purposive sampling. Simple random sampling was done to select 8 members for each focus group. The names of the villages were written on different slips of paper which were folded and

put in a container, from which the researcher randomly placed them in two groups. One leader was selected per village so that every village was represented.

3.7 Research Instruments

The study used four main types of instruments to collect data. These included: structured questionnaires, interviews, focused group discussions and collection of data from secondary sources.

3.7.1 Questionnaires

A questionnaire is an age-old method of research geared towards getting data about people, events, disasters, occurrences, activities, trends, etc. It involves asking rather than watching or sampling behaviour (Mugenda and Mugenda, 1999). The questionnaires were justified because they enabled study coverage of a wider area and extensive contents within a short period of time. The questionnaire type used for this study was for smallholder farmers who headed the households (Appendix I). The researcher administered the questionnaires to 102 households belonging to the smallholder farmers.

3.7.2 Interviews schedule

Interview method of data collection involved presentation of oral-verbal stimuli and reply in terms of oral-verbal response (Peter, 1994). An interview method of data collection also provides in-depth information from respondents. The semi-structured interviews were used to obtain data from key informants on the food production situation (Appendix II). This gave room for offering further explanations, cross-examination, clarifications, etc. The interview schedules were prepared in a manner

that they consisted of semi-structured and structured questions. Interview was conducted with 2 key informants.

3.7.3 Focused Group Discussion

Focus group discussions helped the researcher to get high quality data related to food security in the location from the community leaders in a social context. During this study, two focused group discussions were conducted with eight members in the group. The findings from the discussion were used to verify findings from quantitative data.

3.7.4 Collection of Secondary Data

Secondary data was collected by document analysis. During the course of document analysis, various sources of information, such as specialist literature or other texts, are used. These sources provide the type of information which is relevant to a particular question. In this study document analysis was done to obtain data on the environmental condition in Moiben Location. Document analysis also allows material to be gathered which is not included in tests, questionnaires or observations (Cohen and Manion, 2003).

3.8 Pre-testing of the Instrument

Pre-testing was done before the actual study. Questionnaires were given to a sample of 10 households not included in the study. This was done to ensure validity and reliability. Validity of an instrument or a scale is the success of the scale in measuring what it sets out to measure so that, the differences in individual scores can be taken as representing true differences in the characteristic under study. The instruments for

data collection were sub-divided as per the variables and objectives to ascertain whether the content was comprehensive and representative of the domains that were measured. The major domains in the smallholder farmers' questionnaire were socio-economic, technological and environmental challenges and opportunities.

An instrument is considered reliable when it is able to elicit the same responses each time it is administered. The Cronbach's alpha was used to assess the reliability coefficient that yielded 0.82. According to Mugenda and Mugenda (1999) any value above 0.5 is considered an appropriate threshold. Pre-testing was done to test for difficulty in understanding the questions. Feedback obtained from the pre-testing assisted the researcher in revising the questionnaire to ensure that it covered the objectives of the study.

3.9 Data collection Techniques

The researcher was assisted by one research assistant in data collection. He was trained for 14 days on data collection before beginning the research work. For the purpose of quality control of the data collected, the research assistant was closely supervised and guided by the researcher throughout the study. In few cases, arrangements were made to revisit the homes where the household head was not available. The entire data collection took 28 days. Prior arrangements were made to schedule the focus group discussions appropriately by identifying correct participants and training the research assistant. With the assistance of the chief, the village elders were assembled at the chief's office. They were then grouped into two groups accordingly. Appointments to conduct the interviews with the Chief and the Agricultural Extension Officer were sought before the actual day of research.

3.10 Data Analysis

Both descriptive and inferential data analysis techniques were used to analyze the data. Data processing exercise commenced with the coding of all the responses obtained to facilitate easy analysis using computer Statistical Programme for Social Sciences (SPSS version 17.0) package. The descriptive techniques included: frequencies and percentages. Qualitative data was coded; themes and patterns were established; and eventually merged in a standard format. Data from interviews and focus group discussions was used to validate observations that were made from general survey using the interview schedules.

Inferential statistics were used to draw conclusions and make generalizations based on the information obtained from the sample (Mugenda and Mugenda, 1999). Cross tabulation of the independent and dependent variables was done. Difference in food production due to several opportunities and challenges was analyzed using One-Way ANOVA. Chi-square (χ^2) test was used to analyze the differences between the variables. Chi-square test is a statistical technique used to compare the differences between categorical frequencies when data is categorical and drawn from a population with uniform distribution in which all alternative responses are equally likely. The level of significance (p-value) was predetermined at 0.05 probability level. Independent variables of the study were socio-economic factors, technology and environmental factors. Dependent variable in the study was food security which was measured through food production hence food availability.

3.11 Measurement of Variables

(i) Dependent Variable

The dependent variable was determined by collecting data on the respondents' food production through crop and livestock production.

ii) Independent variables

Selected socio-economic, technological and environmental factors were the main factors likely to cause changes in food production and thus were designated independent variables.

3.12 Ethical Considerations

Ethical measures are principles which the researcher should bind him/herself with in conducting his/her research (Schulze, 2002). In this study, the researcher observed the following research ethics:

3.12.1 Permission to Conduct the Research

In order to conduct research in an institution such as a community, approval for conducting the research was obtained before any data collection (McMillan and Schumacher, 1993). In this study, the researcher first sought permission from the chief in the location under study; obtained field letter from Kenyatta University and a research permit from the Ministry of Education, Science and Technology prior to collecting data in the targeted location.

3.12.2 Confidentiality and Anonymity

A researcher has to be responsible at all times and be vigilant, mindful and sensitive to human dignity. This is supported by McMillan and Schumacher (1993) who stress

that information on participants should be regarded as confidential unless otherwise agreed on through informed consent. In this study, participants' confidentialities were not compromised, as their names were not used in the collection of data. No private or secret information was divulged as the right to confidentiality of the participants was respected. For this reason no concealed media was used. Only the researcher had access to names of the members of the FGDs and the data to ensure the confidentiality of the participants. Names of respondents for the smallholder farmers' questionnaire were not recorded. Research findings were therefore presented anonymously.

CHAPTER FOUR: FINDINGS AND DISCUSSION

4.1 Introduction

This chapter outlines the presentation, analysis and discussion of the data collected from the respondents. Section 4.2 presents information on food production by the smallholder farmers. Section 4.3 presents information on the socio-economic factors influencing household food security. Section 4.4 provides information on the technological factors affecting household food security. The final section 4.5 presents and analyzes data on the environmental factors affecting food security in Moiben Location.

4.2 Overall food production from smallholders in Moiben

The first objective of the study was to determine the overall food production in Moiben from the smallholders' agriculture.

4.2.1 Reasons for engaging in smallholder agriculture

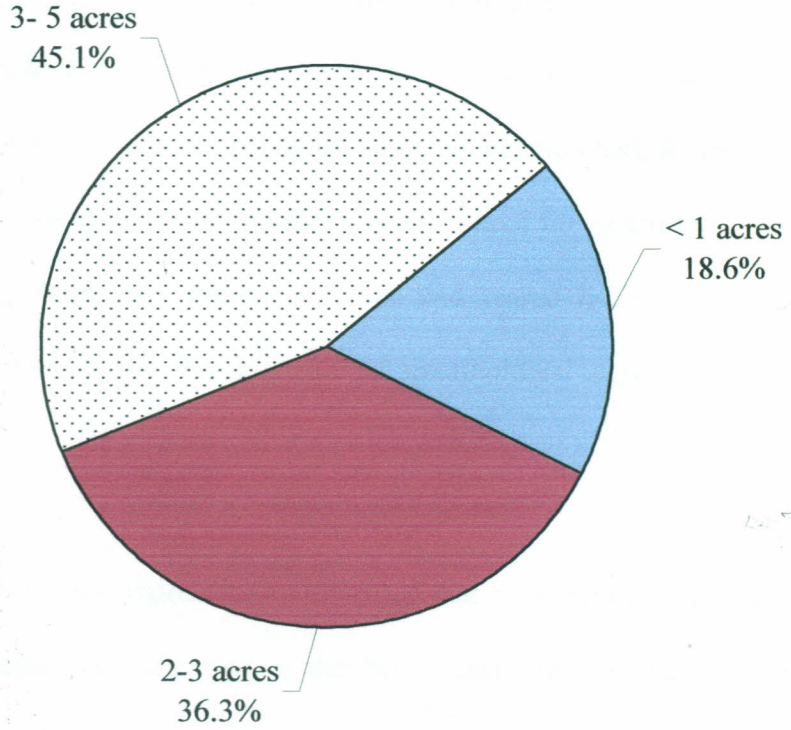
The respondents were asked why they engaged in smallholder agriculture, and the results show that the most important reason for practicing smallholder farming was improvement of family access to food (49.2%). The other reasons cited by the respondents included farming to improve household food supply and nutrition (28.8%), to supplement income (20.3%) and to comply with cultural values (1.7%). Food security among smallholders is an important concern to many smallholders and policy makers and does not only involve just the amount and type of food available but also the element of food quality and safety. The most commonly expressed primary motivation for smallholder agriculture was the need to avert hunger for the smallholder farmers and their families by producing staple crops. Other scholars

interpret the primary motivation for people's involvement in smallholder agriculture as the failure of families' monthly per capita incomes to keep pace with rising food prices (Narayan *et al.*, 2000). For example, if people produce their own food, they can spend less income on food and the money earned from the sales of smallholders' agricultural produce is normally used for other household food needs.

4.2.2 Farm sizes for smallholder farmers

The study determined the farm sizes of the households within the smallholders of Moiben Location, which is useful to determine the nature of smallholders' agriculture activities that may be practiced in Moiben Location (Figure 4.1).

Figure 4.1: Proportion of farm sizes owned by smallholder farmers during the survey in Moiben



Source: Authors' computation from field data, 2011

Up to 18.6% smallholder farmers had less than 1 acre of land, 36.3% of the farmers had between 1-3 acres of land, while the rest (45.1%) had between 3 to 5 acres. This concurs with other studies elsewhere in Kenya where land ownership in smallholder areas was restricted due to the high costs of acquiring land and the high levels of investments that are associated with the land and therefore discourages agricultural production (Keino, 2007; Karimi, 2009)

4.2.3 Land utilization among the smallholders in Moiben Location

The mean farm size in the study area was found to be 4.1 ± 1.1 acres while the mean number of acres under crops was 3.9 ± 2.2, which implies that 60% of the land was under crops. The non-availability of land as a permanent resource to enhance agricultural production was a major source of concern to the farmers and therefore likely to jeopardize agricultural production. In other studies, Otieno (2009) indicated that most smallholders in developing and developed countries have inadequate farmland and most will depend on backyard gardens. Nevertheless, it was established that farmers were able to utilize their small parcels of land for agricultural production. In their parcels of land, they cultivated crops and reared livestock and therefore positively contributed to the development of smallholders' agriculture in Moiben Location.

From the focus group discussions it was revealed that some smallholder farmers had the tendency to lease out their land to the extent that some of them are left with nothing to cultivate. It was noted that young men leased out land and spent the money on leisure activities, leaving their households with very little land to cultivate. Given that most households depended on farming as a source of income, failure to cultivate

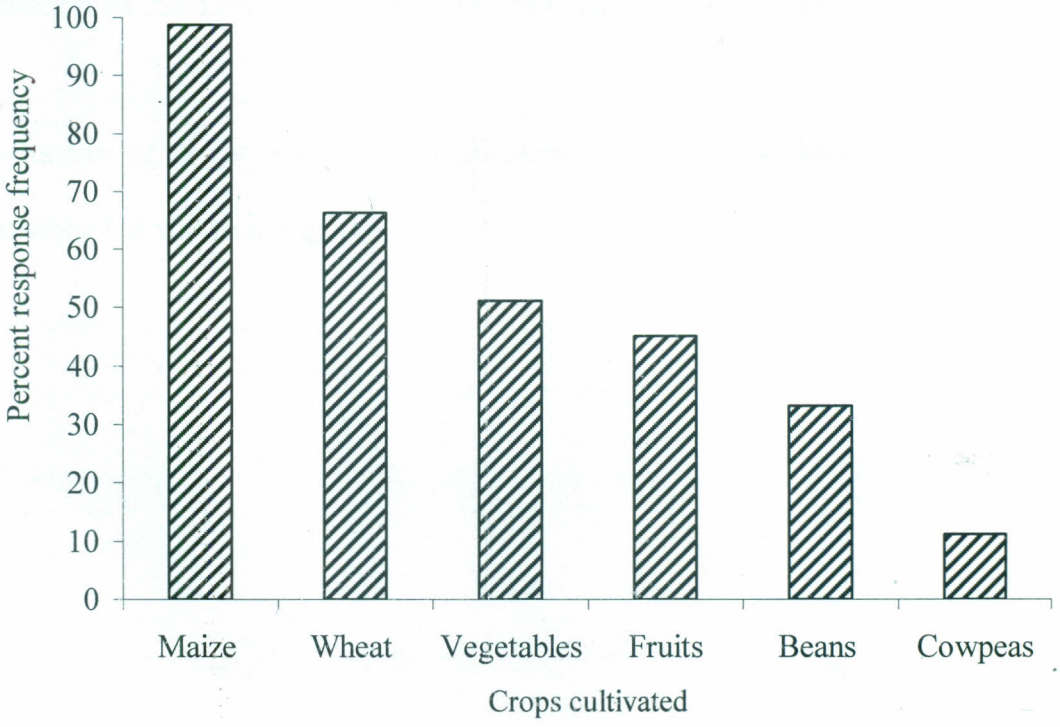
predisposed the household to instability in food production, a challenge to household availability.

> *"... My neighbor's first born after inheriting land from his father leased half out but unfortunately he mismanaged the money through engagement in drinking at the local clubs..."Respondent.*

4.2.4 Food production among the smallholders in Moiben Location

The researcher identified the main types of crops that are cultivated by the smallholder farmers of Moiben Location. The main cultivated crops were maize, fruits, beans, wheat, vegetables and cowpeas. There were significant differences among farmers growing the various types of crops ($\chi^2 = 38.44$, df = 6, p = 0.002). The proportion of farmers cultivating the various types of crops in the area is shown in Figure 4.2.

Figure 4.2: Proportion of farmers cultivating the various types of crops annually

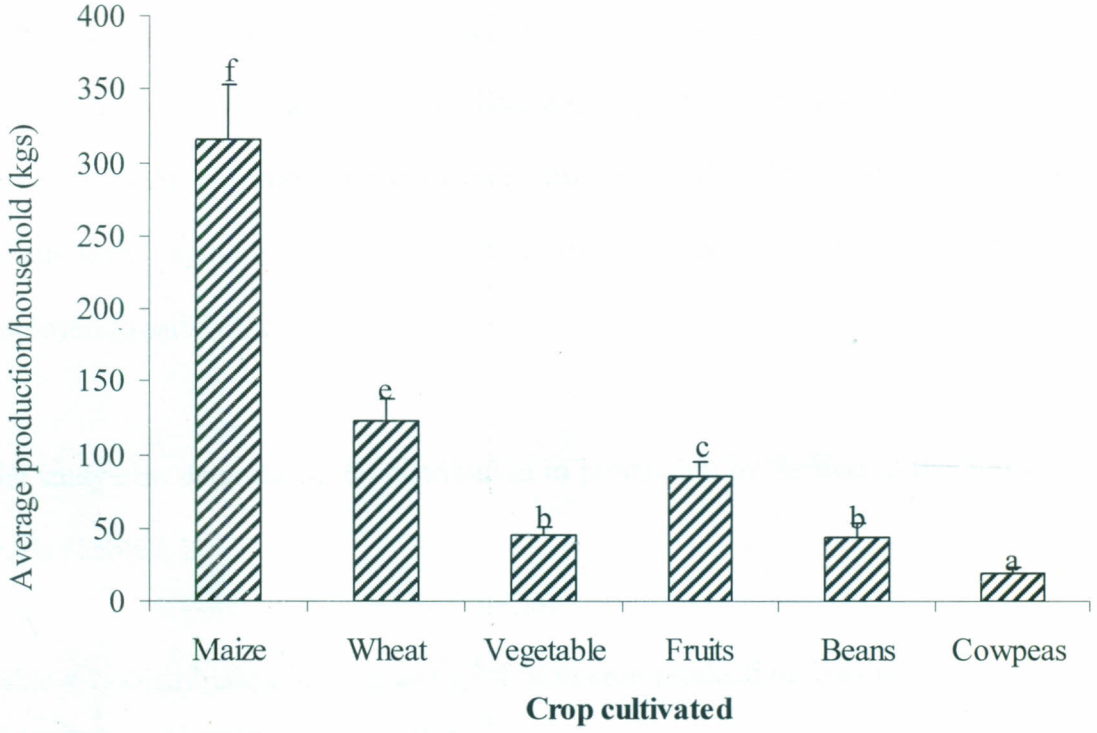


Source: Authors' computation from field data, 2011

All (100%) the respondents cultivated maize in their farms, which was followed by those growing wheat (66.3%) and vegetable (51.2%) while the least number of farmers grew beans (36.5%) and cowpeas (11.2%). Ayaga *et al.* (2010) asserts that smallholders' agriculture improves both access and food intake of fresh foods by growing some of their staple foods in their farms as was determined in the current study. This has been established to provide food security among populations suffering from food insecurity, either through their own self provisioning which reduces market expenditure. Smallholder agriculture is therefore one of the survival strategies poor smallholder residents adopt to reduce poverty and improve their food security (Kimaru and Jama, 2005). In Moiben Location, as in the rest of East Africa, the importance of maize was much evident, which concurs with a study in Malawi, which epitomizes a Malawian adage that "maize is life" (Muzhingi *et al.* 2008). Being the staple food for Moiben Location, maize is the staple food in the region and normally reduces food insecurity levels at both the national and household level.

Production of crops from the smallholders' agriculture in Moiben location was established as shown in Figure 4.3.

Figure 4.3: Mean production of various crops by farmers from smallholders' agriculture in Moiben Location in March 2011.



Values with different letters differ significantly ($p < 0.05$) against other food crops (one-way ANOVA followed by post-hoc Duncan's Multiple Range Test).

Source: Authors' computation from field data, 2011

There were significant differences in the overall production of each crop (ANOVA; $F = 99.212$, $df = 6$, $p < 0.001$). Maize production (315.2 ± 37.2 kgs) was the most abundant food item produced by the farmers, it was also significantly the highest compared to any other crop item, which was followed by wheat (110.4 ± 25.4 kgs) while the least produced food item in the study area by the farmers was cowpeas (20.1 ± 2.7 kgs). Average production of vegetable (45.3 ± 5.5 kgs) and beans (44.1 ± 8.7 kgs) per household were similar ($p > 0.05$). Smallholder farmers produce food crops as part of their survival strategy and their farming activities are not large-scale. Analysis of food production and consumption was done to determine direct

entitlements of harvests from smallholders' farms. This figure was then compared with the country's recommendation that everyone should consume 153 kg of cereal each year as a typical food budget. The results however show that per capita cereal consumption was 91.2 kg per year. This implies that, on average, the households surveyed could not support themselves entirely on the maize they produced on smallholders' agricultural plots. Clearly, several livelihoods strategies are being employed to satisfy their food needs.

The study also determined the distribution in production by farmers at the household levels (Table 4.1).

Table 4.1: Distribution in the quantity of farm crop production from the smallholders' agriculture in Moiben in March 2011.

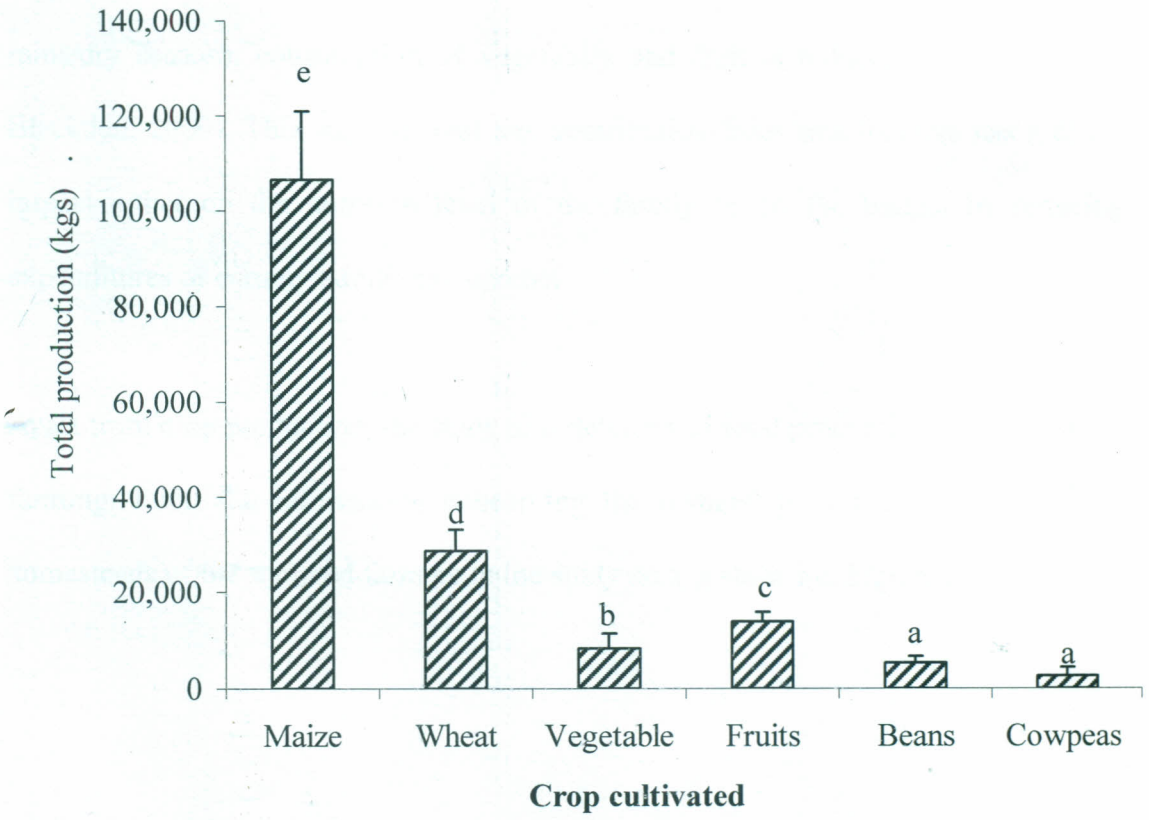
	Levels of production (kgs) n = 102						
	0	1-45	45-90	91-180	181-360	361-1440	> 1440
Maize	10.2	16.3	27.2	18.5	13.5	8.9	5.4
Wheat	25.0	32.4	29.6	8.3	2.8	1.9	0.0
Vegetable	40.7	30.6	16.7	8.3	3.7	0.0	0.0
Fruits	21.3	31.5	26.9	15.7	2.8	1.9	0.0
Beans	42.2	28.4	17.4	9.2	2.8	0.0	0.0
Cowpeas	35.2	29.6	18.5	12.0	3.7	0.9	0.0

Source: Authors' computation from field data, 2011

There were significant differences in production of various food items by the farmers in Moiben Location. Maize production by most of the farmers' respondents ranged

from 45 to 360 kgs (59.2%). Vegetable, beans, wheat and cowpeas production by most farmers ranged between 1 to 90 kgs. Based on the individual farmer's production and with knowledge of the total production obtained during the preliminary surveys, the overall production of various food crop items in Moiben Location is shown in Figure 4.4.

Figure 4.4: Overall total production of various food crops from smallholders' agriculture in Moiben Location in March 2011.
Values with different letters differ significantly ($p < 0.05$) against other food crops (one-way ANOVA followed by post-hoc Duncan's Multiple Range Test).

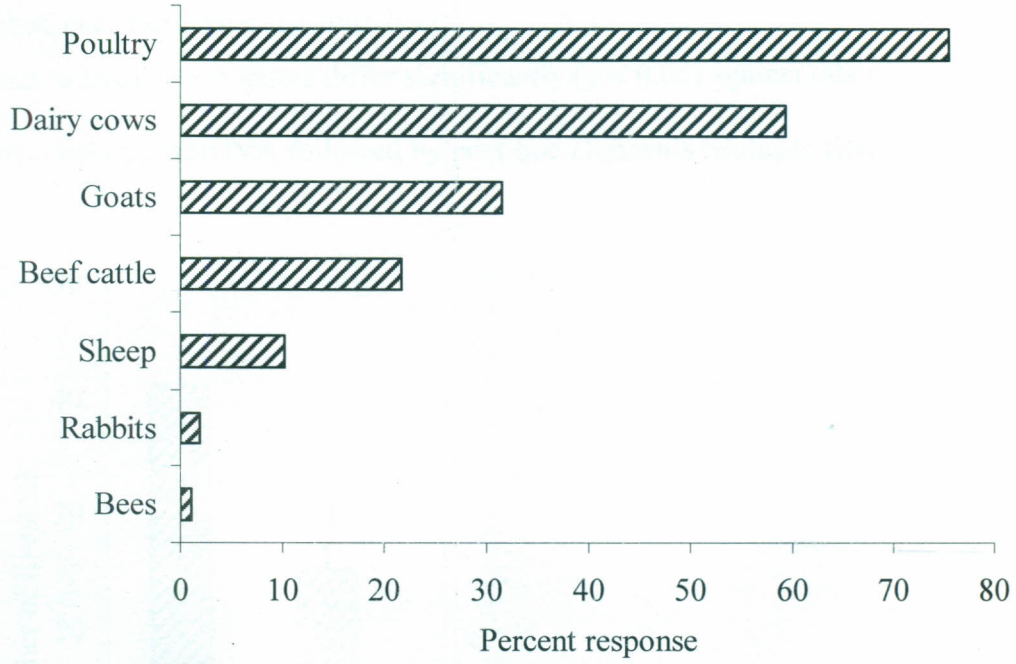


Source: Authors' computation from field data, 2011

Food crop production from smallholders' agriculture in Moiben ranged from 11 tonnes to 111,000 tonnes. There were significant differences in the overall food crop production among farmers in Moiben Location (ANOVA; $F = 102.212$, $df = 6$, $p < 0.001$). Maize was significantly the highest harvested crop in the area (105,943 ± 14,239 kg) followed by wheat (28,641 ± 4,477 kgs) while the harvest of vegetable, cowpeas (2,531 ± 189.2 kgs) and beans (5,088 ± 477 kgs) were overally the lowest among the smallholders' agriculture in Moiben Location. Rockstorm (2000) found that most of the smallholder farmers in Kenya are maize farmers and once they have estimated the amount that will satisfy their basic demands, they engage the remaining farm in production of other food crops such as wheat or any other subsistence crops. During the times of the year in which vegetable production is difficult (heavy rains/dry season), consumption of vegetables and fruit is reduced (Muntemba and Blackden, 2000). This suggests that any contribution from smallholders has a direct impact either on the nutrition level of the family or on the budget by reducing expenditures or earning additional income.

Apart from crop production, the study also determined food production from livestock farming. First, the information concerning the ownership of the livestock in the homesteads of the sampled farmers in the study area is shown in Figure 4.5.

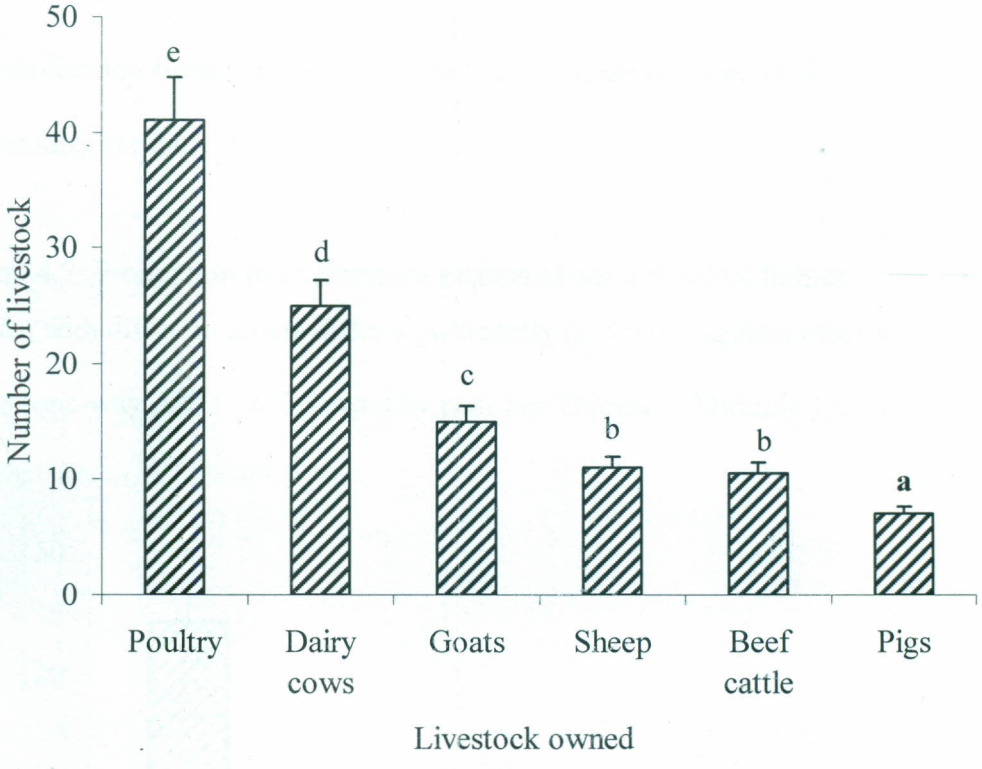
Figure 4.5: Ownership of livestock among the smallholder farmers in Moiben per year



Source: Authors' computation from field data, 2011

In the study area, 29.6% did not own any form of livestock. There were significant differences in the ownership of various types of livestock in Moiben ($\chi^2 = 54.223$, df = 7, $p < 0.0001$). Majority of the farmers owned poultry (75.5%) followed by ownership of dairy cattle (59.3%), then goats (31.5%). Livestock owned by least number of farmers in the study area were pigs (1.9%) and bees (1.1%). The production of livestock and livestock products estimated per individual farmer during the study period is provided in Figure 4.6.

Figure 4.6: Number of livestock owned among the smallholders' agriculture in Moiben per year during the year 2011.
Values with different letters differ significantly ($p < 0.05$) against other livestock items (one-way ANOVA followed by post-hoc Duncan's Multiple Range Test).



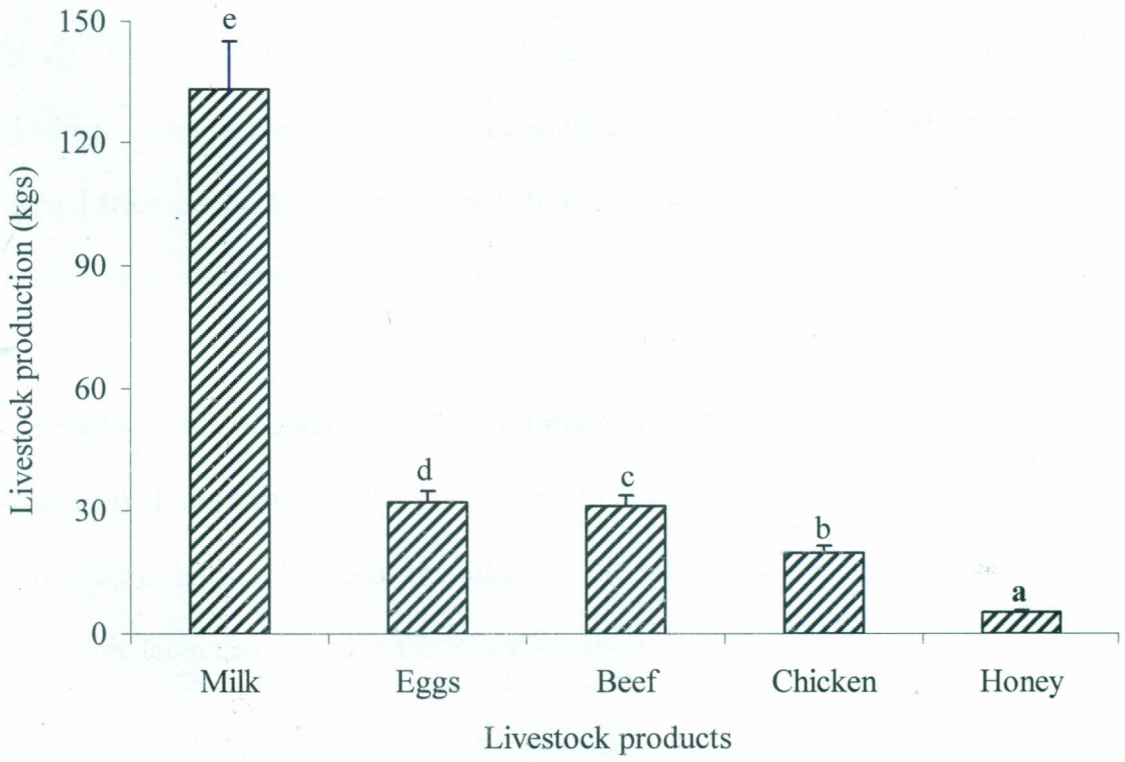
Source: Authors' computation from field data, 2011

Poultry was the most important livestock item owned followed by dairy cows and then goats while pigs were the least. These findings indicate that most farmers prefer to keep the cows as they are considered to be more valuable. The basic benefit was considered to be milk production. The heifers were found in small numbers in few households because most farmers sell them as a coping strategy when they experience poor harvests and during the seasons when they are food insecure. Livestock has been cited as living banks and has a complementary potential in crop production (Parry and Hawkesford, 2010) and food security. The findings further indicate that livestock

farming has not been diversified. This could be an implication that most farmers lack information on production of the other types of livestock. Hence, farmers are deprived of the benefits of diversification as far as livestock is concerned, some of which require little input in their production.

The production from livestock estimated per individual farmer during the study period is provided in Figure 4.7.

Figure 4.7: Production from livestock estimated per individual farmer.
Values with different letters differ significantly ($p < 0.05$) against other livestock items (one-way ANOVA followed by post-hoc Duncan's Multiple Range Test).



In terms of contribution to food items per farmer, milk was the most important livestock product (130 ± 24.3 kgs per farmer) followed by eggs (31 ± 12 eggs per farmer) which was statistically similar to milk production (31.4 ± 8.4 kgs) and

chicken (28.5 ± 8.2 kg). Nevertheless, honey production per farmer was found to be the lowest (5.1 ± 0.9 litres) as was bacon production (4.1 ± 0.8 kgs). A survey conducted by IDRC in Kenya (1994) states that poultry was the most common livestock in all towns, though goats, sheep and cattle were fairly numerous in the smaller towns (Maxwell and Armar-Klemasu, 2008). Very few smallholder households keep fish, pigs and bees. Livestock keepers in the area usually let their animals roam freely, particularly during the dry season, eating grass or whatever they can find. In a study by Mlozi (1998) on low-density home gardens, 65% of the gardeners reported having livestock, 24% had cattle followed by 21% of poultry (broilers/layers) and 19% local fowl. The importance becomes clear by the fact that around 16% of the smallholders milk consumption originates from smallholders production (44% smallholders, 28% imports, 8% Masai herds, 4% others) (Sumberg, 2005). The smallholders' system is characterized as one "which is essentially a sideline economic activity; it is characterized by small herds, feed gathered and grazed from public land or purchased from boys who cut roadside grass, and direct marketing to individual consumers (Webb and Block, 2010).

4.3 Socio-economic Factors and their Influence on Household Food Security

The second objective of the study was to establish the socio-economic factors influencing household food production. The study looked into selected socio-economic factors as shown in the following discussion.

4.3.1 Socio-demographic characteristics of the respondents

In order to establish the nature of the respondents sampled, the researcher established the background information of the respondents. The background information sought

included; age distribution, gender distribution, levels of education, as well as the working condition. The overall results showing the demographic data for the respondents in the current study are indicated in Table 4.2.

Table 4.2: Socio-demographic characteristics of the respondents (n=102)

Demographic	Characteristics	Frequency	Percent
Sex	Male	18	17.6
	Female	84	82.4
Age	20-30	15	14.7
	31-40	49	48.0
	41-50	26	25.5
	>50	12	11.8
Household size	Below 5	10	9.8
	5-10	88	86.3
	Above 10	4	3.9
Highest levels of education	None	2	2.0
	Primary	74	72.5
	Secondary	26	25.5
	College	2	2.0
Occupation	Farming	44	43.1
	Formal employment	6	5.9
	Business	25	24.5
	Casual labour	13	12.7
	Unemployed	14	13.8
Income levels	< 1500	36	35.3
	1501-5000	44	43.1
	5001-10000	11	10.8
	10001-20000	8	7.8
	> 20000	3	2.9

Distribution of the respondents by sex indicated that 82.4% of the respondents were females as compared to the males who were only 17.6%. This was attributed to the fact that men were rarely found in the homesteads as a number of them were to be found in the nearby market places or shopping centres. During the FGD it was pointed

out that men passed time in the shopping centres. Here is a captured response from one of the village elders.

> *".... Most of the men in the village spend the better part of the productive time in the shopping centers in fact you can get some in the shopping centers as early as ten o'clock in the morning, then at lunch hour only few are there. In the afternoon they are in large gatherings..... "Respondent.*

Most of the respondents (48%) were aged between 31 and 40 years. There were few respondents (11.8%) above 50 years. This implied that most of the smallholder farmers in this area were able bodied and strong enough to provide the required labour in food production and hence an opportunity for household food security.

The highest proportion of the respondents, had primary school level of education (72.5%) followed by those with secondary levels of education (25.5%). The level of education has been known to influence the resource utilization by individuals (Njogu, 2002). Low education is a constraint to agricultural production. Research has shown that 4 years primary education rather than none is associated with an increase of about 80% in annual farm input (Nyangito and Okello, 1998). According to Table 4.2 most (72.5%) of the respondents had attained primary school education. The findings reveal low literacy levels among the heads of households which may be attributed to low economic status of the respondents. Low literacy levels are a challenge to household food security. The level of education influences level of resource utilization (Nyangito and Okello, 1998). The analysis based on the categories shown above was important because acquisition of more knowledge and skills corresponds with ones educational level.

A household's income determines the food produced in yields by influencing the amount of money spent on the inputs required. In terms of income levels majority (43.1%) earned between Kshs. 1501 to Kshs. 5000 followed by those earning Kshs. below 1500 (35.3%) the least in proportion were those earning over Kshs. 20,000. In terms of employment, most respondents (43.1%) depended on farming as their main source of income. This agrees with (GoK, 2001) on the main economic activity being agriculture. The income was not regular for most of the households as most were not in formal employment. . Because smallholder dwellers must buy most of their food, smallholders' food security depends mostly on whether the household has adequate effective purchasing power given the prevailing prices and incomes (Garrett, 2000). According to Engel's law on the relationship between income and the amount allocated to food (Duly, 2003), as income increases, the proportion of spending devoted to food decreases. Contrary to this law, the analysis of household monthly income and food expenditure within the sampled households revealed that food expenditure soared with an increase in household income. In general, the findings from literature show that the smallholders spend between 60-80% of their income on food (Parry *et al.*, 2012) and will drastically reduce if they engage in smallholder production.

It was further revealed from the FGD that income was vulnerable to changes due to price fluctuations of farm produce. At the time of the study, the price of a 90 kg bag of maize was Kshs.1000. In the year 2009, at about the same time 1 litre of milk went for as low as Kshs.10 in this area. From the findings dependence on agriculture as a main source of income poses a challenge to household food security. A household's

income is very critical in food production and in ensuring food availability together with other productive assets owned by the household (FAO, 1997).

4.3.2 Effects of socioeconomic status on food production

$H0_1$: There is no relationship between socio-economic factors and sustainable household Food security.

The estimated food production due to the various socio-economic factors in Moiben Location is shown in Table 4.3.

Table 4.3: Socio-economic factors and food crop production among smallholder farmers in Moiben Location

Attributes	Frequency	Overall food production (kg)					
		Maize	Wheat	Vegetable	Fruits	Beans	Peas
Sex	Male	254.1	104.6	42.6	76.9	42.3	17.5
	Female	376.6	141.4	48.0	94.3	46.0	22.5
Age	<18	267.9	101.8	34.5	74.6	32.3	11.2
	18-35	226.6	116.8	46.3	84.2	43.9	19.3
	36-55	355.6	134.5	49.5	98.3	46.7	21.3
	> 55	411.2	138.9	51.0	85.2	53.6	28.2
Household size	Below 5	305.6	118.7	38.4	79.7	41.6	18.7
	5-10	306.2	132.2	46.5	80.6	45.6	21.3
	Above 10	334.2	118.1	51.1	96.4	45.2	20.0
Levels of education	None	298.6	116.5	36.8	61.5	43.9	13.6
	Primary	321.5	121.2	38.5	87.6	44.9	18.9
	Secondary	326.9	124.6	43.6	93.9	45.8	21.6
	College	314.3	129.7	62.4	99.3	41.9	25.9
Occupation	Farming	329.2	124.1	46.9	91.3	55.9	21.3
	Formal	303.6	114.1	45.2	81.3	44.9	17.8
	Business	325.6	117.6	40.1	88.1	45.4	22.6
	Casual labour	289.6	118.7	43.6	76.9	34.3	16.9
	Unemployed	328.7	140.5	50.8	90.3	40.2	21.4
Income levels	< 1500	254.2	108.9	41.6	80.6	30.6	16.5
	1501-5000	312.6	128.7	49.8	88.9	41.3	18.3
	5001-10000	354.6	124.2	55.2	88.6	43.4	23.6
	10001-20000	345.6	128.2	33.5	82.1	45.1	21.3
	> 20000	309.7	125.0	46.5	87.7	60.3	20.3

Based on the results in Table 4.3, production of all the food items was higher among females than males ($P < 0.05$). Production of all the food crops also increased with age of the respondents, levels of education and income levels. Finally respondents who were farmers had significantly the highest production of all the food crops. The null hypothesis was therefore rejected and the conclusion was that there was relationship between socio-economic factors and sustainable household Food Production.

Table 4.4: Socio-economic factors and livestock production among smallholder farmers in Moiben Location.

Attributes	Frequency	Overall food production (kg)				
		Milk	Eggs	Milk	Chicken	Honey
Sex	Male	112.1	25	18	14.7	3.3
	Female	154.1	39	44	24.3	7.1
Age	<18	99.6	19.8	14.5	9.6	2.3
	18-35	126.6	26.8	26.3	14.2	3.9
	36-55	145.6	34.5	39.5	21.3	6.7
	> 55	160.6	46.9	43.7	32.9	7.9
Household size	Below 5	105.6	28.7	28.4	19.7	4.6
	5-10	156.2	42.2	26.5	20.6	5.6
	Above 10	137.5	25.1	38.1	18.2	5.4
Levels of education	None	98.6	26.5	26.8	21.5	3.9
	Primary	136.5	31.2	31.5	23.6	4.9
	Secondary	156.9	24.6	33.6	18.9	5.8
	College	140.4	45.7	32.1	14.0	6.2
Income levels	< 1500	54.6	18.7	23.6	16.9	4.3
	1501-5000	93.6	24.1	29.2	21.3	4.9
	5001-10000	155.6	27.6	30.1	24.1	5.4
	10001-20000	169.2	44.1	36.2	21.3	5.9
	> 20000	192.5	45.5	35.9	13.9	5.5
Income levels	< 1500	54.2	18.9	23.6	15.6	4.6
	1501-5000	112.6	28.7	29.8	18.9	5.3
	5001-10000	154.6	34.2	35.2	18.6	5.4
	10001-20000	145.6	38.2	33.5	22.1	5.1
	> 20000	198.5	40.0	32.9	22.3	5.6

Based on the results in table 4.4, production of all the livestock products was higher among females than males ($P < 0.05$). Production of all the food crops all increased with age of the respondents, levels of education and income levels. Finally female respondents were farmers had significantly the highest production of all the food crops. The null hypothesis was therefore rejected and the conclusion was that there were relationship between socio-economic factors and sustainable household Food security.

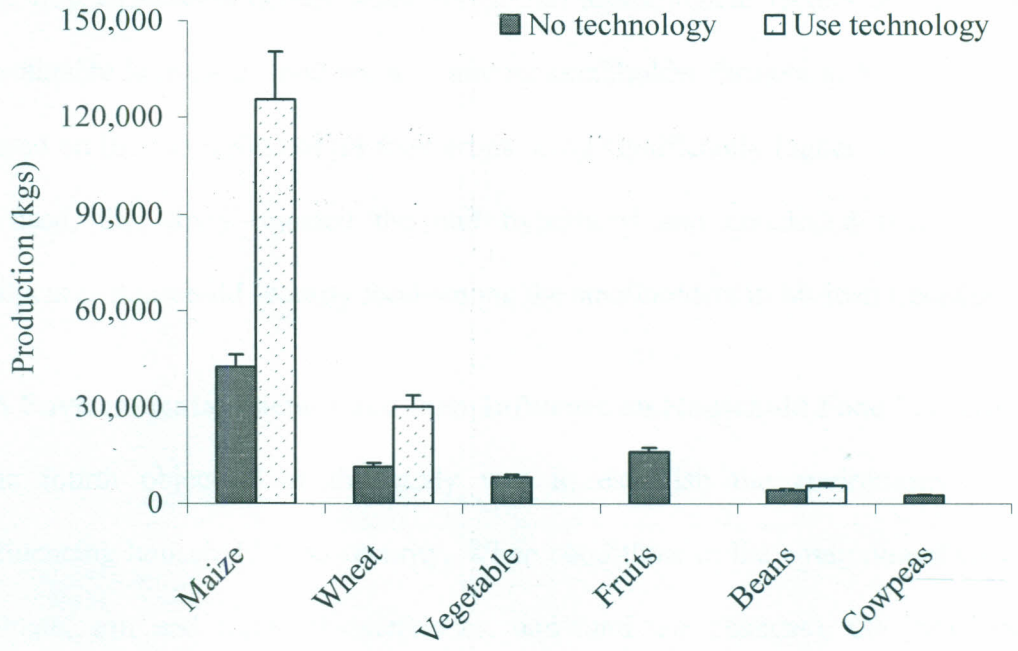
4.4 Technological Factors and their Influence on Household Food security in Moiben Location

The third objective was to determine the technological factors influencing sustainable household food security. This was formulated in form of a research question stating "*What technological factors influence the household food* security *in Moiben Location*?"

First the researcher determined the adoption of technology in the farms. Technology used was mainly use of tractors for land cultivation. Using adoption of technology, the smallholder farmers were classified as: use technology and do not use technology. The results indicated that only 24% of the farmers used technology while the rest (76%) did not use any technology during farming.

The researcher further evaluated the food crop production between technology adopters and non adopters in Moiben Location (Figure 4.9).

Figure 4.8: Food crop production for farmers using technologies and those who do not use technology in Moiben Location



Source: Authors' computation from field data, 2011

There were significant differences in the food crop production between farmers using technology and those who do not use technology ($\chi^2 = 144.332$, df = 10 p = 0.00001). Production of all food crops using technology was significantly higher ($p < 0.05$) than farming without technology among the farmers. Previous studies have shown the importance of technology in increasing farm production (Gregory, 2010). The popularity of technology could be attributed to the fact that it can be conducted in relatively short time and is more efficient compared to human labour. It is a production system that cannot be afforded by the poor smallholders yet the returns from the use of technology is quite high for the farmers (Quisumbing *et al.*, 1995). The characterization of the various smallholders' agriculture farming systems in Kenya is yet to be done. Consequently, inadequate technologies have been developed limiting crop choices and adaptation of production technologies.

The null hypothesis in this study stated that technological factors do not influence sustainable household food security among smallholder farmers in Moiben Location. Based on the production of all food crops being significantly higher when technology is used, this study rejected the null hypothesis and concluded that technology influences household security food among the smallholders in Moiben Location.

4.5 Environmental Factors and their Influence on Household Food Security

The fourth objective of the study was to establish the environmental factors influencing household food security. When conditions in the environment vary (e.g., climate, soil and water characteristics, and land use changes), this can place an additional stress on food production (McConnell and Moran, 2000). Moiben location has experienced environmental changes occasioned by the land use practices as seen from the findings, as well as global climate change factors which are beyond the control of the smallholder farmers.

4.5.1 Environmental conditions

The environmental conditions for the current study obtained from secondary sources are indicated in Table 4.5.

Table 4.5: Environmental conditions for the current study obtained from secondary sources

Environmental factors	Description	Remark
Climatic condition	Variable	The area experiences cool climate. The climatic condition of the area may severally affect crop production
Rainfall (pa)	800-1200 mm	It receives unimodal rainfall with long rains starting from March to September. The rainfall reliability is 50%. Rainfall is erratic and sometimes poorly distributed
Temperature	Range from 20 to 35°C	The mean annual maximum temperature lies between 20°C and 35°C. The hottest months range from January to March
Vegetation		Vegetation in the area is comprised of few stands of trees The area is very green during the rainy season and quite bare during dry season
Pests/diseases	Not common	The area does not experience serious problems of pests/disease but there are occasional outbreaks
Availability of water	Available less frequently	Water is only available when it rains. - In dry seasons, water is fetched from deep wells
Soils	Clay loams with alluvial deposits from tertiary/quaternary volcanic and pyroclastic rock sediments	- Soils have been weathered and eroded from the uplands. - The area experiences soil erosion problems. Soil structure is poorly developed leading to poor infiltration and loss of rainwater and soil through run-off

Source: Secondary data from the government departments

Information on the sufficiency of rainfall was also obtained during the focused group discussion (Table 4.6).

Table 4.6: Sufficiency of rainfall in Moiben Location

Sufficiency Rainfall	n	%
Very sufficient	1	6.25
Sufficient	4	25.0
Insufficient	4	25.0
Very insufficient	7	43.75
Total	16	100

Based on the above table, 68.75% ranked the occurrence of rainfall as either insufficient or very insufficient while 25% indicated that rainfall was sufficient with only 6% of the respondents indicating that the rainfall is very sufficient. Most of the members of the FGD believed that the poor and erratic rainfall caused reduced food production in the area. Climate variability directly affects agricultural production, as agriculture is inherently sensitive to climate conditions; and is one of the most vulnerable sectors to the risks and impacts of global climate change (Parry *et. al.*, 2012). Therefore, understanding the impacts of climate variability, as well as the possible changes in this variability on food production is critical to making improvements in food security. Rainfall is a key variable in agricultural production especially in areas that depend on rain fed agriculture. Mbithi (2000) argues that the impact of low rainfall in food production is aggravated by the fact that food production in Kenya is rain-fed. Furthermore, rainfall has become erratic and unpredictable complicating the situation for the smallholder farmers.

During the focus group discussions and the interviews with the agricultural extension officer and the location chief it emerged that the rainfall pattern in Moiben was uni-modal occurring in one long session. A study by Kigutha (1995) shows that even in high potential areas of Rift valley uni-modal rainfall pattern subjects households to

food insecurity during certain months of the year. This pattern favours the growth of crops like maize which is planted only once a year. This is the reason smallholder farmers felt that rainfall was insufficient. They suggested that they would have been able to plant short season crops if they had irrigation. Because of the limited amount and uneven distribution of rainfall in time, rainfall represents the most limiting factor for agricultural and livestock production. Moiben location experiences long dry spells yearly. The consequences are well known to local population: the drying out of water sources, scarcity of grazing land, shortage of dairy products, poor harvests, and to some extend livestock losses, among others.

On the other hand it was reported in the discussion groups that occasionally the rains were too heavy accompanied by strong winds at times when the crops were flowering. This normally causes logging of crops and loss of pollen which results in poor harvests for the farmers. It further increases costs of production for those who plant wheat as they are required to apply fungicides at very close intervals to prevent rust.

> *"--- In this region the rain patterns is very unpredictable sometimes low others high, if high, we incur high expenses as we purchase fungicides for our wheat and the maize crops performs poorly especially if it was in the flowering stage..."Respondent.*

The agricultural extension officer revealed that climatic changes have been experienced in the recent years. These, she said had impacted negatively on food production and hence food security especially among the smallholder farming households. Crops fail when rain is insufficient and irregular. Climate change is also expected to place a strain on transport systems (IPCC, 2001a). For example, increased heat stress may reduce the life of roads, and windstorms can impact transit at air and sea port terminals as well as damaging infrastructure which may create delays (Perry

and Symons, 1994). During droughts, people are known to move into marginal lands. Most of these marginal lands may not have good road access, and transporting food from such marginal farms poses a huge challenge (IPCC, 2001a).

In Moiben Location food is produced and consumed locally. Hence food utility changes with seasonal variation and food availability changes throughout the year. The hungry season is the time before the planted crops are ready to be eaten. Similarly, at harvest time, there might be festivals and a lot of food consumed. If there has been a drought and food availability is low, the range of food available often decreases, and so the meal frequency can decrease and the balance of nutrients can be inadequate. It is also important to note that climate can have an impact on food utility indirectly. For example, if there are hot dry days, crops and vegetables may be dried so that they can be used later in the year. At the same time as seasonal crop production, many households face fluctuations in cash and in-kind income, both within a single year and from year to year (Parry *et. al.*, 2012). Agricultural households may face seasonal fluctuations in income related to crop cycles. Year-to-year, fluctuations in income results from varying agro climatic conditions and climate variability as seen in Moiben location.

Forests are known to improve humidity, improve soil moisture and act as wind breaks. The agricultural extension and the chief revealed that vegetation cover in the location had reduced drastically. This was attributed to population increase and need to create space for human settlement. From the focus group discussions it was revealed that charcoal burning was lucrative economic activity in this location. Young men could be seen ferrying the charcoal on bicycles to the neighboring shopping

centres and to Eldoret town. It was also revealed that the area experiences strong winds which contribute to drought conditions and at other times cause logging of crops especially maize. These findings imply that the location has a low vegetation cover hence denying the farmers in the area the benefits of forest cover as mentioned above which in turn impacts negatively on food production and hence food security.

Soil is the major production factor in agriculture. This research sought to find out the soil conditions and land use in the location. The agricultural extension officer pointed out that most farms were acidic due to continued use of inorganic fertilizers. However, she noted that with the right knowledge concerning the soil types, smallholder farmers were in a position to correct this. Soil erosion was also noted to be on the increase because of the farming practices employed. Farms were harrowed leaving very fine loose soil particles that were prone to erosion during heavy rains. Even when farmers are aware of soil conservation techniques (Conde and Eakin, 2003), they cannot practice them, because those require strong collective work, so they are forced to develop maize monoculture production in extended areas, which reduces soil productivity and increases the soil erosion processes. The reduction of crop diversity not only increases climatic risks but also reduces the farmers' nutritional opportunities. Hence the smallholder farmers in Moiben faced the same risk given that most of them cultivated same crops every other year with very little crop rotation.

The community leaders who formed the discussion groups revealed that environmental factors had affected food production in Moiben location. The number

of respondents indicating that the environmental factors affect food production is tabulated in table 4.7.

Table 4.7: Role of environmental factors in food production

	Affect food production (n = 16)	
Environmental factors	Frequency	Percent
Climatic variation	11	73.5
Rainfall	15	99.0
Temperature	10	62.7
Vegetation	4	22.5
Pests/diseases	2	10.8
Availability of water	16	97.1
Soils	9	54.9

Based on the information in Table 4.7, the environmental factors that affected food production mostly were climatic variation (73.5%), rainfall patterns (99%), water availability (97.1%) and temperature (62.7%). These factors have been established to reduce yields of crops if they are extreme and outside the tolerable threshold in production of these food crops (Parry and Hawkesford, 2010).

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter is divided into three sections. The first section presents a summary of the research findings; the second part presents the conclusion; and the third presents recommendations of the study.

5.2 Summary of findings

Based on the study the following findings were deduced from the study:

5.2.1 Food production from small holder farmers

The study established that the main crops cultivated were maize, fruits, beans, wheat, vegetables and cowpeas. Maize was cultivated by 100% of the respondents, followed by those growing wheat (66.3%) and vegetable (51.2%) while the least number of farmers grew beans (36.5%) and cowpeas (11.2%). In terms of production, maize production was the most abundant food item produced by the farmers (315.2 ± 37.2 kgs), followed by wheat (110.4 ± 25.4 kgs) while the least produced food item in the study area by the smallholder farmers was cowpeas (20.1 ± 2.7 kgs). Average production of vegetable (45.3 ± 5.5 kgs) and beans (44.1 ± 8.7 kgs) per household were similar. Maize production by most of the farmers' respondents ranged from 45 to 360 kgs (59.2%). Vegetable, beans, wheat and cowpeas production by most smallholder farmers ranged between 1 and 90 kgs. Based on the estimated quantity of production from the area, Maize was significantly the highest quantity of harvested crop in the area (105,943 ± 14,239 kg) followed by wheat (28,641 ± 4,477 kgs) while the harvest of vegetable, cowpeas (2,531 ± 189.2 kgs) and beans (5,088 ± 477 kgs) were overall the lowest from the smallholders' agriculture in Moiben Location.

As for the livestock, Majority of the farmers owned poultry (75.5%) followed by dairy cattle (59.3%), then goats (31.5%). Livestock owned by the least number of farmers in the study area were pigs (1.9%) and bees (1.1%). In terms of contribution to food items per farmer, milk was the most important livestock product (130 ± 24.3 kgs per farmer) followed by eggs (31 ± 12 eggs per farmer) which was statistically similar to milk production (31.4 ± 8.4 kgs) and chicken (28.5 ± 8.2 kg). Nevertheless, honey production per farmer was found to be the lowest (5.1 ± 0.9 litres) as was bacon production (4.1 ± 0.8 kgs). In terms of the production from the location, the highest contribution from the livestock industry was beef that was estimated at 25 tonnes from the smallholders' agriculture followed by eggs, milk and chicken (range 6 tonnes to 10 tonnes for eggs and chicken and 6000 liters to 10000 litres from milk) while the least was honey and bacon (less the 2 tonnes each).

5.2.2 Socio-economic Factors and their Influence on Household Food Security

Distribution of the respondents by sex indicated that 82.4% of the respondents were females as compared to the males who were only 17.6%. Most of the respondents (47%) were aged between 31 and 40 years. There were few respondents (11.8%) above 50 years. The highest proportion of the respondents, had primary school (72.5%) followed by those with secondary levels of education (25%) primary levels of education. In terms of occupation, up to 43.1% of the respondents were farmers while 24.5% were businessmen and 12.7% casual laborers. In terms of income levels majority (43.1%) earned Kshs. 1501 to Ksh. 5000 followed by those earning Kshs. below 1500 (35.3%) the least in proportion were those earning over Kshs. 20000.

Production of all the food items was higher among females than males. Production of all the food crops also increased with age of the respondents, levels of education and income levels. Finally female respondents had significantly the highest production of all the food crops. Production of all the livestock products was higher among females than males ($P < 0.05$). Production of all the food crops increased with age of the respondents, levels of education and income levels.

5.2.3 Technological Factors and their Influence on Household Food Production in Moiben Location

The findings of the study on this aspect indicated that only 24% of the farmers used technology while the rest (76%) did not use any technology during farming. There were significant differences in the food crop production between farmers using technology and those who do not use technology ($\chi^2 = 144.332$, df = 10 p = 0.00001). Production of all food crops using technology was significantly higher ($p < 0.05$) than production without technology among the farmers.

5.2.4 Environmental Factors and their Influence on Household Food Production

On environmental factors, findings indicated that the environmental factors that affected food production mostly were climatic variation (73.5%), rainfall patterns (99%), water availability (97.1%) and temperature (62.7%). It emerged that the rainfall pattern in Moiben was uni-modal occurring in one long session. This pattern favours the growth of crops like maize which is planted only once in a year. The soils in most farms were acidic due to continued use of inorganic fertilizers. On the other hand farms were harrowed leaving very fine loose soil particles that were prone to erosion during heavy rains.

5.3 Conclusion

Based on the findings, the following conclusions were derived:

Most respondents produced food. Maize was the highest harvested crop in the area followed by wheat vegetable, cowpeas and beans were lower among the smallholders. Poultry followed by dairy cows and goats were the more important livestock in the area. In terms of livestock production, milk was the highest followed by eggs and beef among the food items.

Among the distribution of the respondents, females were more dominant, while most of the respondents were aged between 31 and 40 years with most having primary school level of education. Income for majority of the respondents ranged from Kshs. 1500 to Kshs 5000 and most of the respondents were farmers. All the socio-economic factors including sex, age, household size, highest levels of education, occupation and income affected the food crop and livestock production. Production of all the food items and livestock were higher among females than males and increased with improvement of some socio-economic factors of the farmers

Concerning the technological factors, it was concluded that technology use by the smallholder farmers was low. The technological practices made food production highly labour intensive with low levels of food production. The farmers could therefore not benefit from improved breeds and good management practices which meant that the potential for livestock production was not at its optimum. The presence of the agricultural officer was rare among the smallholder farmers. Through access to information on agricultural technology farmers' decision to adopt particular

technology is shaped and enhanced. This led to reduced production which translates to reduced food availability.

On environmental factors, it was evident from research findings that they were a challenge to household food security. The study established that in the recent years, rainfall distribution had become irregular and insufficient hence posing a challenge for the smallholder farmers in the study area. Rainfall just like land is a major production factor in agriculture especially in areas that depend on rain fed agriculture like Moiben location. Reduced rainfall within the study area led to reduced production hence reduced food availability. It was found that the vegetation cover in the area of study had reduced in the past years denying the smallholder farmers the benefits of the same.

5.4 Recommendations

Based on the findings of this study, the following recommendations are made:

5.4.1 Recommendations for Policy

1. While specific statistical findings in this study cannot be generalized beyond Moiben Location, some important points should be considered in other low income smallholder households. This includes the importance and growing reliance on smallholders farming for household food consumption. The success and expansion of smallholders' agriculture will therefore depend on the ability of policy makers, administrators and smallholder farmers to use integrated social, economic and environmental strategies that effectively address food security and smallholders' poverty.

2. Government of Kenya through the Uasin Gishu County should encourage the growth of smallholder farmers through improving of literacy levels, encouraging males to take invest more efforts in the production and through extension services so that they can increase household food production to enhance he overall food security in the country.
3. The smallholder farmers should tap into more recent advances in technology such as the use of greenhouse, use of solar energy, irrigation among other proven production methods should be used to enhance food production among the smallholders' farmers.
4. Environmental conservation should be mainstreamed in agricultural production. Re-afforestation efforts should be intensified by farmers in the whole location.

5.4.2 Recommendations for further study

1. A similar research could be carried out with a larger population in several districts to give a better presentation. This will make it possible to determine whether the findings documented in this study hold the same for all other districts.
2. A study could also be carried out on the challenges faced and opportunities for non- farming communities in ensuring household food security.
3. A study could be carried out on the role of government agencies in ensuring household food security among smallholder farmers.

REFERENCES

African Development Bank/International Fund for Agricultural Development (AfDB/IFAD). (2009). *AFDB/IFAD Joint Evaluation of their agricultural operation and policies in Africa,* Draft Report, Rome and Tunis, African Development Bank.

Atieno, R. (1996). *Role of Rural Infrastructure in Attaining Household Food Security: Research issues and Policy Options with Reference to Kenya.* In Ranaweera N. F. C., Gunasena, H.P.M and Senanayak, Y.D.A. (1995). Changing Agricultural Opportunities: The Role of Farming System Approaches: Proceedings of the 14th International Symposium on Sustainable Farming Systems. Colombo. Sri Lanka.

Ayaga, G., Kibata, G., Lee-Smith, D., Njenga, M. and Rege, R. (2010). Policy prospects for *smallholders agriculture* in Kenya. Urban Harvest, Peru.

Baiphethi, M.N. and Jacobs, P.T. (2009). The contribution of subsistence farming to food security in South Africa. *Agricultural Economics Research, Policy and Practice in Southern Africa.* **48(4)**: 459-482.

Barham, J. and Chitemi, C. (2008). *Collective action initiatives to improve marketing performance lessons from farmer groups in Tanzania.* Collective Action For Property Rights (Capri) Working Paper No. 74.

Barraclough, S. (2009). *An End to Hunger: The Social Origin of food Strategies.* London: Zed Books.

Berry, A.R. (1994). *Research Priorities for employment and enterprise development in rural regions.* In Grindle, M.S., and Waker, S.T. (Eds). (2002). *Priorities for rural development research.* Harvard: Harvard Institute for International.

Borlaug, N.E. (2000). *Ending World Hunger.* The Promise of Biotechnology and the Threat of Antiscience Zealotry. *Plant Physiology.* **24(2)**: 487-490.

Bruinsma, J. (2009). *The resource Outlook to 2050: by how much do land, water use and crop yields need to increase by 2050*? Paper presented at the Expert meeting on how to feed the world in 2050. Rome: Food and Agriculture Organization of the United Nations.

Che, T.N., Kompas, T. and Vousden, N. (2006). Market Reform, Incentives and Economic Development in Vietnamese Rice Production. *Comparative Economic Studies.* **28**: 277 – 301.

Clay, E. (2002). *Food security: Concepts and measurement. In Trade reforms and food security: Conceptualizing the linkages.* Rome: Food and Agriculture Organization of the United Nations.

Cohen, L. and Manion, C (2003). *Research Methods in Education.* London: Croom Helm Ltd.

Conde, C. and Eakin, H. (2003). Adaptation to Climatic Variability and Change in Tlaxcala, Mexico. *Climate change, adaptive capacity and development*, R. K. J. Smith, and S. Huq., Eds., London.: Imperial College Press. *Development Bank, Development Research Brief*, Number 2.

Conway, G. and Toenniessen, G. (1999). Feeding the world in the twenty-first century. *Nature*. **402**: 55-58.

Cook, J.T., Frank, D.A., Casey, P.H., Rose-Jacobs, R., Black, M.M., Chilton, M. (2008). A brief indicator of household energy security: Associations with food security, child health, and child development in US infants and toddlers. *Pediatrics*. **122(4)**: e867–75.

Danielson, A. (2002). Agricultural Supply Response in Kenya: Has Adjustment Really Worked? *African Development Review*. **14**: 98-112.

De Vos, A. S., Strydom, H., Fouche, C. B., Poggenpoel, M., Schaik, V and Schrink, W. (1998). *Research at the grass roots*: *A Premier for the Caring Professions*. Pretoria.

Diao, X., and Hazell, P. (2004). *Exploring Market Opportunities for African Smallholders*, 2020 Conference Brief No. 6. Washington D.C., USA, International Food and Policy Institute.

Drechsel, P., Obuobie, E., Keraita, B., Amoah, P., Cofie, O. and Liqa, R.S. (2012). *Irrigated Urban Vegetable Production in Kenya, Characteristics, Benefits and Risks. IWMI-RUAF*. Kenya.

Duly, M.L. (2003). Analysis of the relationship between income and the amount allocated to food. *Journal of Food Analysis*. **102**: 34-41..

Ericksen, P.J. (2008). Conceptualizing food systems for global environmental change (GEC) research. *Global Environmental Change*. **18(1)**: 234-245.

Ericksen, PJ. and Ingram, J.S.I. (2005). *Global Environmental Change and Food Systems (GECAFS)*. IHDP Annual Report 2004-5. pp. 45-46.

Famine Early Warning Systems (1995). *Current Vulnerability an Assessment Report* on Kenya.

Famine Early Warning Systems (1998). *Current Vulnerability Assessment Report on Kenya.*

Famine Early Warning Systems (1999). *Kenya Vulnerability Update Monthly Report.*

Famine Early Warning Systems (2000). *Kenya Food Security Data* Update June 9, 2003.

Famine Early Warning Systems, NET (2009). *Background Reports · Kenya Food Security Internet Resources.* http://www.foodsecurityportal.org/kenya/resources Cached. Accessed on 10th September, 2010.

Famine Early Warning System Network (FEWS Net) (2009). *Kenya food security outlook update.* Available at: http://www.fews.net/docs/Publications/kenya_FSOU_11_2010.pd.

Foeken, D.W.J. and Adel, P. den Hartog, ed. (2012). *Seasons, Food Supply and Nutrition in Kenya.* Leiden: Africa Studies Center.

Food and Agriculture Organization (FAO) (1996). *Report of the World Food Summit.* Rome. FAO. Food and Agriculture Organization. Rome: FAO.

Food and Agriculture Organization (1997). *Gender, key to sustainability and food security.* Rome: FAO.

Food and Agriculture Organization (1998). *Agriculture, Food and Nutrition. A Resource Book for Teachers of Agriculture.* Rome: FAO.

Food and Agriculture Organization of the UN (FAO) (2002). *Expert Consultation on Trade and Food Security.* Food Security: Concepts and Measurement. Paper for FAO Expert Consultation on *Trade and Food Security: Conceptualising the Linkages* Rome, 11-12 July 2002 http://www.fao.org/alc/legacy/iniciativa/cursos/Curso%202005/3prog/1_1_3.pdf.

Food and Agriculture Organization (2003). *The State of Food Insecurity in the World 2003.* Rome: FAO.

Food and Agriculture Organization (2004). *The State of Food Insecurity in the World 2004.* Rome: FAO.

Food and Agriculture Organization of the UN (FAO) Agricultural and Development Economics Division. (June 2006). *Food Security.* Retrieved June 8, 2012.

Food and Agriculture Organization of the UN (FAO). (2006). *Food Security. Policy Brief.* June 2006, Issue 2.

Food and Agriculture Organization (FAO). (2008). *The State of Food Insecurity in the World 2008.* Rome: FAO.

Food and Agriculture Organization (2009). *FAOSTAT online database,* http://faostat.fao.org accessed on 20 December, 2010.

Food and Agriculture Organization (2009). *The Special Challenge for Sub-Saharan Africa. Issues Brief,* presented at the 2009 High-Level Expert Forum on "How to Feed the World in 2050," (Rome, October 12-13).

Food and Agriculture Organization of the UN (FAO). (2009). The State of Food and Agriculture (2009). http://www.foodsecuritylink.net/index.php?option=com_remository&Itemid=31&func=fileinfo&id=36.

Food and Agriculture Organization of the UN. (FAO). (2010). The State of Food Insecurity in the World. Addressing food insecurity in protracted crises.

Food and Agriculture Organization of the UN (FAO). (2011). *The State of Food Insecurity in the World How does international price volatility affect domestic economies and food security?* Rome, FAO. http://www.fao.org/publications/sofi/en/.

Garrett, D.T. (2000). Smallholders' production overview. *Journal of Food in the Tropics*. **12**: 35-43.

Gollin, D. Parente, S. and Rogerson, R. (2002). The Role of Agriculture in Development", *American Economic Review*, Vol. 92, No. 2, Papers and Proceedings of the 114th Annual Meeting of the American Economic Association.

Government of Kenya (1978). *Development plan 1979-1983.* Nairobi: Ministry of Economic planning and community affairs.

Government of Kenya (1994). *Sessional paper No. 1 of 1994 on national food policy.* Nairobi: Government printer.

Government of Kenya (2000). *Economic Survey 2000.* Nairobi: CBS.

Government of Kenya (2001). The 1999 Household survey and Census. Nairobi. CBS.

Government of Kenya. (1981). *National Food Policy of 1981.* Nairobi: Government Printer.

Gregory, M.L.P. (2010). Role of importance of technology in increasing farm production. *Journal of Agronomy*. **19**: 34-42.

Hamboldt, P.M. and Otieno, D.L. (2012). Situational analysis of food security in Kenya. Paper presented in the 2nd International Conference of Food Security. Tangier, Morroco.

Hamm, M.W. and Bellows, A.C. (2003). Community food security: Background and future directions. *Journal of Nutrition Education and Behavior*. **35(1)**: 37–43.
http://www.ifad.org/operations/food/food.htm, accessed on 23/01/2012

IFAD. (2010). Soaring *Food Prices and the Rural Poor: Feedback from the Field*, Inter-Governmental Authority on Drought and Desertification (1990). *Food Security Strategy Study*; Vol 1, Final Report.

Intergovernmental Panel on Climate Change (IPCC). (2001a). *Climate change 2001: Impacts, adaptation and vulnerability*. IPCC Working Group II, Third Assessment Report.

Ishrat, H. (2012). Trade, aid and investment in sub-Saharan Africa, Policy Research Working Paper 1214, Washington, D.C.: World Bank

K'Okul, R. (1991). *Maternal Child Health in Kenya. A Study of Poverty, Malnutrition and Disease in Samia.* Uppsala. SIAS.

Kamara, A.B., Mafusire, A., Castel, V., Kurzweil, M., Vencatachellum, D. and Pla, L. (2009). *Soaring Food Prices and Africa's Vulnerability and Responses:* An Update. African Development Bank, Working Paper, Number No. 97.

Karimi, L.P. (2009). Enhancing agriculture among small holders through microfinancing. *Journal of Micro Finance and Development*. **12**: 133-140.

Karugia, J., Waithaka, M., Freeman, A., Prabhu, R., Shiferaw, B., Gbegbelegbe, S., Massawe, S., Kyotalimye, M., Wanjiku J. and Macharia, E. (2009). *Responding to Food Price Crisis in Eastern and Southern Africa: Policy Options for National and Regional Action*. Regional Strategic Analysis and Knowledge Support System Re SAKSS) - Eastern and Central Africa Working Paper, No 27.

Keino, K.P. (2007). Revitalization of the smallholders' farming in Kenya: trends and prospects. Paper resented in the 4th International Workshop on Food security in Developing countries. pp. 98.

Kenya Food Security Steering Group (2000). Kenya Food Security Situation Report December 2000.

Kenya Food Security Steering Group (2008). The 2008/09 Short Rains Season Assessment Report.

Kenya Food Security Steering Group (2009). The impact of Rising Food Prices on Desperate Livelihoods Groups in Kenya. http://www.kenyafoodsecurity.org. on 10th January, 2010.

Kenya Food Security Steering Group (KFSSG) (2011). Long and short rain assessments reports. KFSSG.http://www.kenyafoodsecurity.org/index.php?option=com_content andview=articleandid=122andItemid=113.

Kenya Institute of Public Policy and Research Analysis (KIPPRA). (2007). *Kenya Agricultural Sector Data Compendium*; pg. 75

Kenya National Bureau of Statistics (KNBS) (2010). Kenya: 2009 Population and housing census highlights. Available at: http://www.knbs.or.ke/Census%20Results/KNBS%20Brochure.pdf.

Kigutha, H. N. (1995). Effects of Season on Household Food Security and Nutritional Status of Smallholder Rural Households in Nakuru District, Food and Nutrition Studies Programme, Report Number 55/1995.

Kimaru, G. and Jama, B. (2005). *Improving Land Management in Eastern and Southern Africa: A Review of Practices and Policies. ICRAF Working Paper* No. 18, World Agro- forestry Centre (Nairobi: Kenya).

Korir, K.P. (2008). *Development of Uasin Gishu District through agriculture; challenges and opportunities*. Unpublished PhD Dissertation, University of Brunswick. Pp. 201.

Kym, A. (2011). Agricultural Trade Reform and Poverty Reduction in Developing Countries, CIES Discussion Paper 0234, Adelaide: CIES.

Majid, N. (2004). Reaching Millennium Goals: How well does agricultural productivity growth reduce poverty? Employment Strategy Paper 2004 No. 12. Geneva: International Labor Organization.

Maxwell, D. and Armar-Klemasu, L. (2008). *Small holders agriculture* in Greater *Moiben Location. Reviewing Research Impacts for Livelihoods, Food and Nutrition Security*. IDRC Cities Feeding People Report 29F.

Maxwell, S. (2012). Food security in developing countries: Issues and options for the 1990s. *IDS Bulletin*. **21(3)**, July, 2-13.

Mbega, H.L. and Konandreas, D.H. (2007). Assessing Food Security Based on National Aggregates in Developing Countries. In *Food Security for Developing Countries*, edited by A. Valdes. Boulder: Westview Press.

Mbithi, L.M. (2000). Agricultural Policy and Maize Production in Kenya. Unpublished PhD Thesis Submitted to the Faculty Agricultural and Applied Biological Sciences, University of Ghent, Belgium.

Mbogo, G.S. (2003). *An Overview of Major Policy Documents.* Department of Agricultural Economics, University of Nairobi.

McConnell, W.J. and Moran, E.F. (2000). *Meeting in the Middle: The Challenge of Meso-Level Integration* (Eds). LUCC Report Series No. 5. International Workshop on the Harmonization of Land Use and Land Cover Classification. Ispra, Italy, 17-20.

McMillan, J.H. and Schumacher, S. (1993). *Research in Education: A Conceptual Introduction.* 4th ed. New York: Harper Collins College.

Ministry of Agriculture (MoA) (2009). Food Security in Kenya. Government Printer, Nairobi, Kenya.

Mlozi. J.H. (1998). Livestock production from smallholders' farmers in developing countries. *Journal of African Agronomic Practices*. **11**: 101-109.

Mrema, E.R.T. (2010). Toward increased food production from the Kenya's historically endowed agricultural areas. *Journal of Regional Development*. 23: 199-207.

Mugenda, M.O. and Mugenda, G.A. (1999). *Research Methods: Qualitative and Quantitative Approaches*. Nairobi: ACTS Press.

Mugo, K. (1995). *Household Food Security and Nutritional Status of Tobacco and Non tobacco Growers in Marginal Areas of Embu District*. Nairobi University: Unpublished MSc Thesis.

Muntemba S. and Blackden, C.M. (2000). *Gender and Poverty in Africa*. Background Paper for the CAPA/World Bank Conference on Poverty Alleviation in Africa Nairobi, Kenya, March 6-10, 2000.

Muntemba, S. (1995). *Women Spearhead Food Security: Science and Technology an Asset?, in "Missing Links: Gender Equity in Science and Technology Development,"* Gender Working Group, UN Commission on Science and Technology Development, International Development Research Consortium, in association with Intermediate Technology Publications and UNIFEM.

Muzhingi, T., Langyintuo, A., Malaba, L. and Banzinger, M. (2008). Consumer acceptability of yellow maize products in Zimbabwe. *Food Policy*. **33**: 352–361.

Nagayets, O. (2005). *Small farms: current status and key trends. Information brief prepared for the future of small farms research workshop for developing countries*, June 2005. Washington DC: International Food Policy Research Institute.

Narayan, D., and Nyamwaya, D. (1998). A *Participatory Poverty Assessment Study Kenya. February – April 1994*. Report prepared for the World Bank and sponsored by the British ODA and UNICEF.

Narayan, D., Patel, R., Schaft, K., Rademacher, A., and Koch-schuster, S. (2000). *Voices of the poor: Can anyone Hear Us*? New York: O.U.P.

Njogu, E.W. (2002). *Household Food Security and Nutritional Status of Children in Ndia Division of Kirinyaga District*. MSc Thesis. Kenyatta University.

Nyangito, H. (1997). *Farmers response to reforms in Marketing of Maize in Kenya. A case of Trans-Nzoia District*. IPAR. Discussion paper series D.P.No 003/97. Nairobi. IPAR.

Nyangito, H. (1999). Food Policy and its Impact on Food Security In Kenya in Oguminade A. (Eds). *Not by Bread Alone: Food Security and Governance in Africa*, Toda Institute.

Nyangito, H., and Okello J. (1998). *Kenya's Agricultural Policy and Sector Performance 1964-1996*, IPAR, Occasional Paper No. 04.

Otieno, M. (2009). Small farms as a planetary ecological asset: five key reasons why we should support the revitalisation of small farms in Kenya. *Journal of World Development Studies*. **23**: 199-207.

Parry, M., Rosenzweig, C., Iglesias, A., Fisher, G. and Livermore, M. (2012). Climate change and world food security: a new assessment, *Global Environ. Change*. **9**: 51 – 67.

Parry, M.A.J. and Hawkesford, M.J. (2010). Food security: increasing yield and improving resource use efficiency. *Proceedings of the Nutrition Society*. **69**: 592-600.

Peacock, C., Jowett, A., Dorward, A., Poulton, C. and Urey, I. (2004). *Reaching the Poor, A call to action: investment in smallholder agriculture in sub Saharan Africa.* FARMAfrica, Harvest Help and Centre for Development and Poverty Reduction, Imperial College.

Perry, A.H., and Symons, L. J. (1994). The wind hazard in the British Isles and its effects on transportation, *J Trans. Geogr.* 2:122–130. In association with Intermediate Technology Publications and UNIFEM.

Peter, C.B. (1994). *A Guide to Academic Writing.* Eldoret: Zahf Chancery.

Pingali, P. and Stringer, R. (2011). *Food Security and Agriculture in the Low Income Food Deficit Countries*: 10 Years after the Uruguay Round. International Conference, Agricultural policy reform and the WTO: where are we heading?Capri (Italy), June 23-26, 2003

Quisumbing, A.R., Brown, L. R., Feldstein, H. S., Haddad, L., and Pena, C. (1995). *Women: The key to food security*. International Food Policy Research Institute, Washington, D.C.

Ravallion, M. (2001), "Growth, Inequality, and Poverty: Looking Beyond Averages", *Policy Research Working Paper* 2558, Washington D.C. USA , The World Bank.

Reardon, T., Kelly, V., Crawford, E., Jayne, T., Savadogo, K. and Clay, D. (2006). Determinants of farm productivity in Africa: a synthesis of four case studies. Policy synthesis no. 22. Washington DC: United States Agency for International Development.

Republic of Kenya - CBS. (2006). Annual Progress Report: *Investment Programme for Economic Recovery Strategy for Wealth and Employment Creation 2003- 2007*. Nairobi: Government Printer.

Republic of Kenya (2007). *Economic Survey 2007.* Nairobi: Government Printer.

Rockstorm, J. (2000). Water Resources Management in Small Holder Farms in Eastern Southern Africa: An Overview. *Phys. Chem. Earth* (B), 25(3):275-283.

Rupiya, M.R. (2004). Food aid: *The Implications for Food Security in Africa. African Security Review*. **13(1)**: 83-89.

Schulze, S. (2002). *Research Methodology*. Department of Further Teacher Education. Pretoria. UNISA.

Sen, A. (1981). *Poverty and Famines: An Essay on Entitlement and Deprivation.* Oxford: Clarendon Press

Stringer, R. (2000). Food Security in Developing Countries. Centre for International Economic Studies. Policy Discussion Paper No.0011. University of Adelaide.

Sulo, T. (2005). An Econometric Analysis of Food Security in West Pokot, Uasin Gishu and Baringo Districts of Kenya. Unpublished PhD. Thesis (2005), Moi University.

Sumberg, J. (2005). 'Systems of innovation theory and the changing architecture of agricultural research in Africa' *Food policy* 30: 21-41.

Uasin Gishu Development Plan (2002-2008). *Sustaining growth of the district through correct development initiatives*. Government of Kenya. Nairobi, Kenya.

United Kingdom. (1997). *Household Food Security Update of Kakuma Refugee Camp, Turkana District, North-West Kenya*. Nairobi.

United Nations Conference on Trade and Development/United Nations Environment Programme (UNCTAD/UNEP). (2008). *Organic agriculture and food security in Africa*, New York: United Nations, see: http://www.unctad.org/en/docs/ditcted200715_en.pdf.

United Nations. (1998). *Common Country Assessment for Kenya*. New York: United Nations.
Update" *African Development Bank, Working Paper*, Number No. 97.

United Nations Development Programme (UNEP). (2009). *The environmental food crisis,* Nairobi: UNEP. http://www.unep.org/publications/search/pub_details_s.asp?ID=4019

United Nations Development Programme. (2001). *Human Development Report 2001: Making New Technologies Work for Human Development*. New York: United Nations Development Programme.

United Nations Development Programme. (2005). *Mainstreaming Gender in Water Management: A Practical Journey to Sustainability.* http://www.undp.org/water/docs/resource_guide.pdf accessed on 15th October, 2011.

United Nations Industrial Development Organization. (2007). *Food Processing Pilot Centres: An approach to productive capacity building for trade and poverty alleviation in Africa*, Document prepared by Dr. A. Ouaouich, Chief of the Food Processing Unit, Agro-Industries and Sectoral Support Branch, United Nations Industrial Development Organization (UNIDO), Vienna, Austria.

Webb, P. and Block, S. (2010). Support for Agriculture during Economic Transformation: Impacts on Poverty and Undernutrition. *Proceedings of the National Academy of Sciences of the United States*. Doi: 10.1073/pnas.0913334108.

Wheelan, B. J. (1993). *Non-monetary indicators of Poverty. A Review of Approaches.* A Paper Presented at the Conference on Household Food Security panel Surveys. Luxembourg, 1-2 June, 1993.

Wheeler, R. (2003*). Development of Kenya Food Security Co-ordination System (*KFSCS): A Model of Co-ordination.

World Bank. (1995). *Poverty and Hunger: Issues and options for Food Security in Developing Countries,* Washington D.C. World Bank.

World Bank. (2008). *The Growth Report: Strategies for Sustained Growth and Inclusive Development*, Washington D.C., Commission on Growth and Development, World Bank.

World Food Conference General Assembly. (1974). *Universal Declaration on the Eradication of Hunger and Malnutrition.* United Nations. Retrieved 18 June 2012.

World Health Organization (WHO) (2009). Food security [online]. Available at: http://www.who.int/trade/glossary/story028/en/

World Summit on Food Security. (2009). *Declaration of the world summit on food security*. Rome, 16-18 November 2009. http://www.fao.org/fileadmin/templates/wsfs/Summit/Docs/Final_Declaration/WSFS09_Declaration.pdf.

Appendix I: Questionnaire for smallholder farmers

General instructions

The information obtained as a result of response of this questionnaire will be used only for the purpose of this study and will be treated confidentially.

Part I: Overall food production

1. How many acres of land do you own.....
2. Do you engage in smallholders agriculture Yes [ ] No [ ]
3. What is your land size: < 1acre [ ] 1-3 acres [ ] 3-5 acres [ ]
4. What are the main types of crops that you cultivate?: Cowpeas [ ] Beans [ ] Fruits [ ] Wheat [ ] Vegetables [ ] Maize [ ]
5. Estimate the production (in kg) from the above crops

Crops	Production (in kgs)
Maize	
Vegetable	
Wheat	
Fruits	
Beans	
Cowpeas	
Others (Specify)	

6. What are the types of livestock that you keep? Bees [ ] Pigs [ ] Sheep [ ] Beef cattle [ ] Goats [ ] Dairy cows [ ] Poultry [ ] Others (Specify).....
7. Estimate the number of livestock owned

	Number
Poultry	
Sheep	
Pigs	
Goats	
Dairy cows	
Beef cattle	
Others (Specify)	

8. Estimate the production from the livestock above

Livestock product	Overall production
Beef	
Egg	
Milk	
Chicken	
Honey	
Bacon	
Others (Specify)	

Part II: Socio-economic and demographic characteristics of the respondents

1. Indicate your sex: Male [ ] Female [ ]
2. Age: 20-30 [ ] 31-40 [ ] 41-50 [ ] >50 [ ]
3. Household size: < 5 [ ] 5-10 [ ] >10
4. Indicate the highest level of education: None [ ] Primary [ ] Secondary [ ] College [ ]
5. Occupation: Farming [ ] Formal employment [ ] Business [ ] Casual labour [ ] Unemployed [ ]
6. Income levels: < 1500 1501-5000 [ ] 5001-10000 [ ] 10001-20000 [ ] >200000
7. How much land do you cultivate? _____ acres
8. How much land is allocated to food crops? _____ acres.
9. How much land is allocated to cash crops? _____ acres.

Part III: Technological factors

1. Do you use technology in farm production Yes [ ] No [ ]
2. What type of technology do you use.....
   .....
   .....
   .....
3. Does the use of technology enhance your agricultural production
   .....
   .....
   .....

4. Please indicate the production of the following crops based on the use of technology?

	Use technology	Does not use technology
Maize		
Vegetable		
Wheat		
Fruits		
Beans		
Cowpeas		
Others (Specify)		

Part IV: Environmental factors

Tick on the answer that best responds to the statement.

Smallholder farmers' perception on the environmental factors influencing food production.

Statement	**Strongly Agree**	**Agree**	**Disagree**	**Strongly Diagree**
There is sufficient rainfall to support agricultural production in this area				
The vegetation/ forest cover is adequate to mitigate environmental hazards like strong winds				
The soil fertility in this area is adequate for agricultural production				

Appendix ii: Interview Schedule for the key informants

1. What is the food situation in the location throughout the year?

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.....

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2. What technological innovations have you adopted in this location in food production?

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.....

3. Comment on the uptake of those technological innovations by the smallholder farmers in the location

.....

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.....

4. How are extension services carried out in this location? (Probe for impediments)

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.....

6. In your opinion what opportunities do smallholder farmers in Moiben location have in ensuring household food security?

.....

.....

.....

.....

.....

7. In your opinion, what do you think are the main challenges facing smallholder farmers in ensuring household food security in this area? (Probe for socio- economic, technological and environmental).

.....

.....

.....

.....

.....

5. How can household food security in this area be improved?

.....

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.....

.....

.....

6. Do you have any other issues concerning food security that you would like to share with us?

.....

.....

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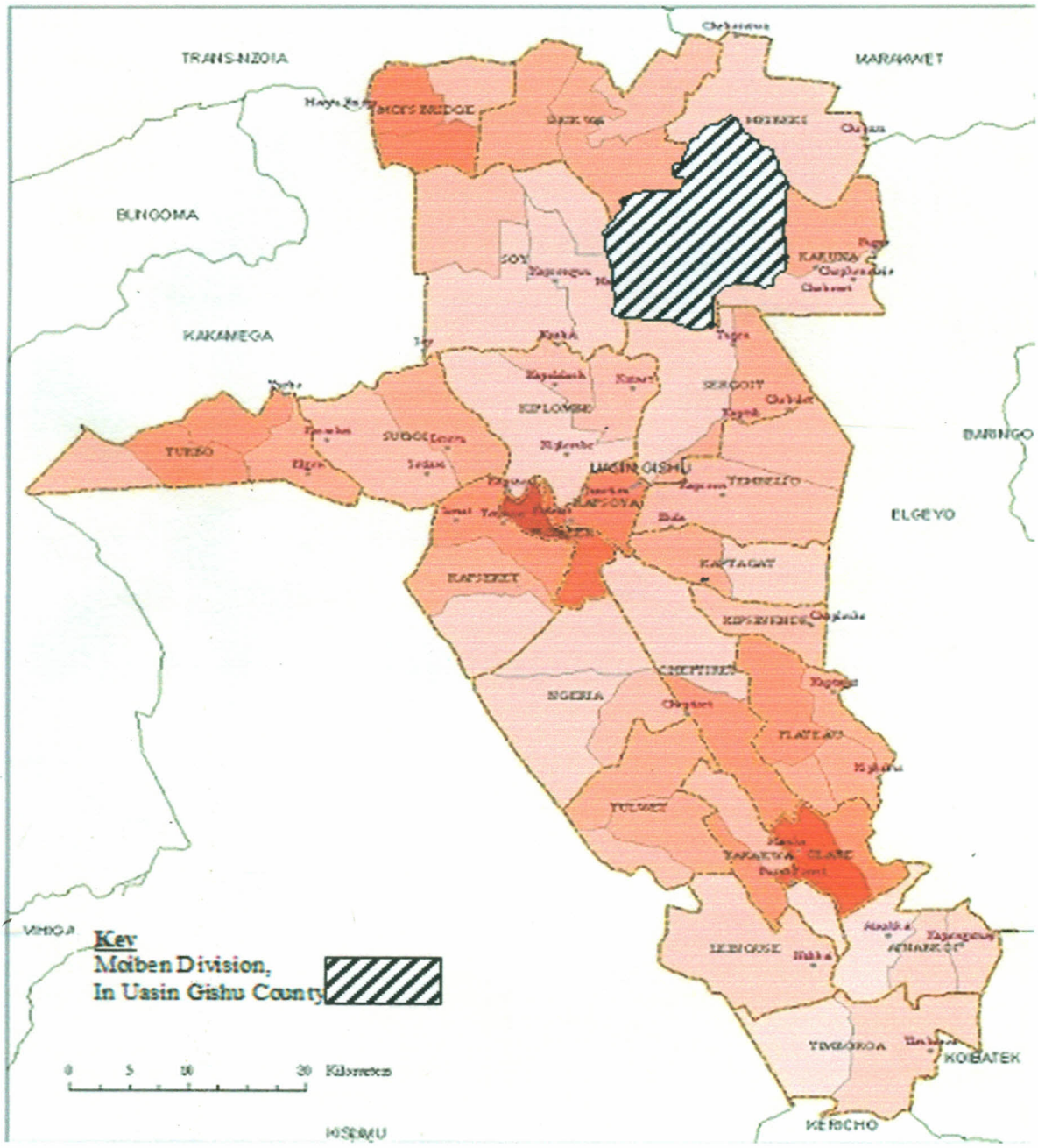
.....

.....

Appendix iii: Guide questions for focus group discussion

1. How would you describe the food situation in this area? (Probe for patterns throughout the year).
2. What do you consider the main factors influencing food security in this area? (Probe for socio-economic, technological and environmental separately)
3. Comment on the roles played by men and women in ensuring house food security in this location.
4. How is the reception of the smallholder farmers to technological innovations in Food production?
5. Comment on the adequacy of agricultural extension services in your location.
6. What opportunities do the smallholder farmers in this location have in ensuring household food security?
7. Give suggestions on improvement of food security among smallholder farmers in this location.

Appendix iv: Map of Uasin Gishu district showing Moiben Division



Source: Uasin Gishu Development Plan (2002-2008).

Appendix v: Research Permit

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THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss. DAMARY ATIENO MUKABANE

of (Address) KENYATTA UNIVERSITY P.O. BOX 43844, NBI

has been permitted to conduct research in .....Location, ELDORET EAST .....District, RIFT VALLEY .....Province, on the topic Challenges & opportunities faced by small-scale farmers for sustainable household food security in Moiben Location, Eldoret East District, Kenya

for a period ending 31ST DECEMBER, 20 11

PAGE 3

Research Permit No. NCST/RRI/12/1/SS-011/243

Date of issue 11/03/2011

Fee received SHS 1,000

Applicant's Signature

Secretary National Council for Science and Technology