EFFECT OF RAINFALL VARIABILITY ON FARMING PRACTICES AND ADAPTATION AMONG HOUSEHOLDS OF KISII CENTRAL SUB COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented for an award of a Diploma or conferment of a Degree in this or any other university.

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Recommendation

This work has been submitted for examination with our recommendation as university supervisors.

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DEDICATION

To my dear wife, Moraa and daughters, Nyaboke and Kemunto: they endured hard times and stood by my side while I laboured on this work.

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May glory be to the Almighty God for his mercy, care, strength and motivation during the entire period of this study. Many thanks go to Egerton University for granting me a chance to fulfill my academic dreams. Special thanks go to the entire Geography Department of Egerton University and to my supervisors, Prof. Kennedy Nyabuti Ondimu and Dr. John Momanyi Mironga for their tireless and invaluable efforts in guiding and supporting me during the entire study and research period. Their concern has been my source of inspiration. I also acknowledge NACOSTI (National Commission for Science, Technology and Innovation) who granted me permission to carry out this study. I am very grateful to HELB (Higher Education Loans Board) who partially financed my tuition fees. My gratitude also goes to all my respondents who dedicated their time and provided the rich data that was used in this study. My appreciation too, goes to my colleagues (Dennis, Pauline and Scholasticah) for their valuable discussions and for sharing with me useful ideas during entire period of study and research.

ABSTRACT

Agricultural productivity in Kenya, as in many developing countries, is significantly affected by rainfall variability. The reliability of the rain for agricultural purposes has reduced in the recent years due to climate variability. In the study area, there is a continued trend of more frequent and intense climate related disasters which is expected to have significant impacts on the livelihood activities. Most studies on the impact of climate variability on farming practices and the response strategies have mainly focused on arid and semi-arid regions of Kenya and have mainly used community level data. Information on actual dynamics of rainfall variability at household in high potential areas like Kisii is scanty. This study therefore aimed at determining the effect of rainfall variability on farming practices and adaptation as perceived by households of Kisii Central Sub County. The specific objectives were to identify the weather shocks associated with rainfall, assess the relationship between households' characteristics and perception of the effects of rainfall variability on farming practices, identify the adaptation strategies adopted by households and establish the relationship between households' characteristics and adaptation strategies adopted to enhance resilience against rainfall variability in Kisii Central Sub County. Structured questionnaires were administered to a proportionate random sample of 120 households from the four administrative wards of the Sub County. Data from questionnaires were also complemented by oral interviews with key informants from Water Resources Management Authority (WRMA), Kenya Agricultural Research Institute (KARI) (currently Kenya Agricultural and Livestock Research Organization (KALRO), Ministry of Agriculture, FGDs and secondary data. Descriptive statistics as well as inferential statistics technique have been used to analyze data with the help of Statistical Packages for Social Sciences (SPSS version 20). Inferential statistics technique employed the use of Chi-square ($\chi 2$) test to analyze data. To make reliable inferences from the data, all statistical tests were subjected to a test of significance at coefficient alpha (α-level) equal to 0.05. Coefficient of determination (R^2) was used to determine inter-annual rainfall variability index. The study reveals that gross changes in rainfall patterns were noticed in the past ten years in the study area. Some of the most severe effect of rainfall variability on the farming practices includes feed shortage for livestock, water resource decrease, pest attack, drought, soil erosion and disease epidemic. This study concluded that gross changes in rainfall patterns have been noticed in the past ten years in the study area leading to a negative effect on the household farming practices. This study recommends that the government (County and national) should realize the urgent need for measures that are geared towards reversing the negative impact of climate change and especially rainfall variability in the study area. There should be efforts in putting in force appropriate measures and policies that are aimed at reducing the farming problems in the study area that relate to feed shortage, water resource decrease, pest attack, drought, soil erosion and disease epidemic.

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LIST OF ABBREVIATIONS AND ACRONYMS

ATPS	African Technology Policy Network
DFID	Department for International Development
FGDs	Focus Group Discussions
GoK	Government of Kenya
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
KARI	Kenya Agricultural Research Institute
KMD	Kenya Meteorological Department
MEMR	Ministry of Environment and Mineral Resources Development
NCCRS	National Climate Change Response Strategy
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organizations
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNESCO	United Nations Educational Cultural and Scientific Organization
WRMA	Water Resources Management Authority

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The effect of climate variability and change on natural systems has emerged as one of the most critical issues faced by humankind (UNDP, 2007; Vaga, Jaramillo, Olanye, Kamonjo & Jaramillo, 2009; Ojwang, Agatsiva & Situma, 2010; Owolabi, Gyimah & Amponsah, 2012; Makenzi, Ketiem, Omondi, Maranga & Wekesa, 2013). Climate change is a global threat and has no geographical boundaries and is a topical issue worldwide because of its attendant problems that are threatening the sustenance of man and his environment. Climate change is projected to disproportionately affect the poor living in both rural and urban environments. Rural subsistence farmers or households are threatened by the changes in climate change. Climate change and variability in Sub-Saharan Africa is already impacting negatively on rain-fed agriculture and livestock systems (Ngeno & Bebe, 2013). Countries in Sub-Saharan Africa are particularly vulnerable to climate change impacts because of their limited capacity to adapt (Bryan, Ringler, Okoba, Koo, Roncoli, Herrero & Silvestri, 2011; IFPRI, 2011).

Kenya experiences a number of natural hazards, the most common being related to adverse weather change (IPCC, 2007; GoK, 2010a). Climate change is increasing inter-annual rainfall variability and the frequency of extreme events (Ojwang *et al*, 2010). Recurrent extreme weather events have high economic implications on the affected households and can trigger food insecurity, thus impacting negatively on the economic wellbeing of the affected communities and can restrict or hamper long term growth (IFPRI, 2011). Climatic variability may affect crop farming and animal production differently, such that it may be favorable to one but unfavorable to the other (IPCC, 2007). Kenyan agriculture is sensitive to climate variability, particularly variations in rainfall. It is therefore important to establish the exact effects of rainfall variability on crop and livestock production in Kisii, a high potential region whose people heavily rely on rain fed agriculture thus making the households vulnerable to the negative effects.

Kenyans rely heavily on rain-fed agriculture for food security, economic growth and employment creation, stimulation of growth in off-farm employment and foreign exchange earnings (NEMA, 2005). Food production is particularly sensitive to climate change, because crop yields depend directly on climatic conditions (Owolabi *et al*, 2012). In the study area, agriculture is highly dependent on rain as irrigation is seldom practiced (NEMA, 2005). Crop productivity depends on agro-ecological factors such as temperature, rainfall amount and distribution, soil characteristics and use of inputs such as chemicals and fertilizers. However, most significant of these factors is the erratic and unpredictable rainfall and elevated temperatures (NEMA, 2005; Barrios, Outerra & Stroble, 2008; Ojwang *et al*, 2010) that will lead to reduced productivity and an increase in production costs.

The effects of climate change will vary based on locality with some regions becoming unsuitable for cultivation of certain crops and some becoming suitable (Gbetibouo & Hassan, 2005; IPCC, 2007; Kurukulasuriya & Mendelsohn, 2007; UNDP, 2010). Therefore climate change does not only come with detrimental effects but also with some opportunities. However, the probability of disruption of agricultural sector is very high. The future effects of climate change and variability will include increases in short term weather extremes. It is therefore imperative to examine the effects of rainfall variability at household level in Kisii Central Sub County.

Research by Thornton (2011) has noted the negative effects of climate change in Kenya. This is due to low adaptive capacity, predominance of rain-fed agriculture and scarcity of capital to adapt (Fischer, Shah, Francesco & Van Velhuizen, 2005; Nnamchi & Ozor, 2009; Speranza, 2010). Over the past years, multiple interrelated factors such as small fragmented landholdings and minimal access to agricultural inputs, reduced employment opportunities, market inefficiencies have contributed food insecurity and gradually weakening households' livelihoods in Kisii region. The agricultural system in the study area is dominated by intensive small-scale mixed farming. Maize and beans are the main food crops while tea and coffee and are the major cash crops (Omosa, 1998; Olden, Thompson, Bolton, Kim, Hickley & Spencer, 2012), which are highly vulnerable to rainfall variability. Kenya is likely to continue experiencing countrywide losses in the production of key staples such as maize due to rainfall variability (Herrero, Ringler, van de Steag, Thornton, Zhu, Bryan, Omolo, Koo & Notenbaert, 2010). Herrero *et al*, (2010) observes that rainfall variability reduces the production of not only staple food crops such as maize but also other major crops such as tea, sugarcane and wheat. It is primarily for this reason that this region must be put on a high research agenda.

Rainfall variability effects include among others; reduced crop yields, emergence of crop and livestock diseases and pests, delayed planting and harvesting, reduced livestock feeds (fodder) and loss of incomes. To cope with these effects of climate change, rural people draw on indigenous knowledge and innovate through local experimentation and adaptation (Nzeadibe, Egbule, Chukwuone & Agu, 2011; UNESCO, 2012). Communities have long been adapting to climate variability and change (Kristajansen, Neufeldt, Gassner, Mango, Kyazze, Desta, Sayula, Thiede, Forch, Thornton & Coe, 2012). A number of households in Kenya already practice a range of adaptation measures and therefore households in Kisii Central Sub County could be adapting to the changing climatic conditions using traditional knowledge, innovations and practices. Olden *et al,* (2012), notes that there is need for households in Kisii to diversify their farming practices as response to climate variability as the effects have already been felt in the region. It is for this reason that this study sought to examine the effect of rainfall variability as perceived by the households and how it has been affecting their farming practices.

1.2 Statement of the Problem

Agriculture remains the major contributor to food security and livelihoods for rural poor households in Sub-Saharan Africa. Agricultural production in Kenya has been facing a challenge of successive crop failures due to drought, excessive rainfall and flooding, crop pests and diseases, declining soil fertility due to lack of proper crop rotation and intercropping, deteriorating soil structure, lack of production-enhancing technologies, and land fragmentation due to increasing population. Given the dependence on rain fed agriculture with low fertilizer application, the future of agriculture in Kenya remains under the threat of increasing temperatures and more erratic rainfall patterns projected for the 21st century. Due to climate change, the reliability of the rain for agricultural purposes has reduced in the recent years, mainly due to high rainfall variability. The seasonality, amount, distribution and the timing of the rainfall is of particular importance to the population that depends on rain-fed agriculture for subsistence. A continued trend of more frequent and intense climate related disasters as a result of climate variability and change especially rainfall variability, is expected to have significant impacts on the livelihood activities of households in Kisii region, especially food production. Despite countrywide studies on the impact of climate variability on farming practices and the response strategies, there is variation in response depending on location, socio-economic systems and environmental conditions of the area. In addition many studies have mainly focused on arid and semi-arid regions of Kenya and have used community level data. Information on actual dynamics of lowest possible level such as a household in high potential areas like Kisii is scanty. It is in this view that this study sought fill the gap by examining the effects of rainfall variability on household' crop and livestock farming practices and their responses or adaptations to this phenomenon in Kisii Central Sub County, a region highly dependent on rain-fed farming.

1.3 Objectives of the Study

1.3.1 Broad Objective

The broad objective of this study was to contribute to an understanding of the effects of rainfall variability on household farming practices, their adaptation strategies and the relationship between households' characteristics and adaptation strategies adopted in Kisii Central Sub County.

1.3.2 Specific Objectives

The specific objectives of this study were to:

1. Identify the variations associated with rainfall that occur in Kisii Central Sub County.
2. Determine the relationship between households' characteristics and perception of effect of rainfall variability on farming practices among the households in Kisii Central Sub County.
3. Identify the adaptation strategies and establish the relationship between the choice of strategies and the household characteristics.

1.4 Research Questions

The following research questions guided this study;

1. Which variations associated with rainfall occurs in Kisii Central Sub County?
2. How do the households perceive the effects of rainfall variability on their farming activities based on their household characteristics.
3. What are the different crop and livestock farming practices/ strategies adapted by households against rainfall variability in Kisii Central Sub County?
4. How is the relationship between households' characteristics and the choice of adaptation strategies in Kisii Central Sub County?

1.5 Significance of the Study

Livelihood activities particularly in Sub Saharan Africa are largely dependent on the natural environment making them highly vulnerable to climate variability particularly variations in rainfall. Rainfall is the ultimate source of water for food production and other uses in rural economies across Kenya. Given the impacts of rainfall variability on livelihoods, the study sought to carry out a meaningful assessment of the effects of rainfall variability on household farming practices and the adaptation strategies that have been adopted by households. The study being based in the rural community revealed the household vulnerability due to rainfall variability and the adaptation strategies available. This study is in line with the aspirations contained in the National Climate Change Response Strategy (NCCRS) on increasing Kenyans' ability to tackle climate change challenges with the view of ensuring a climate resilient nation. This will contribute towards realization of the global Millennium Development Goals (MDGs) and Kenya's vision 2030 that seek to achieve an improved local environmental resources management system and rural livelihoods that are more resilient to climate variability. In addition the agricultural sector, including crops and livestock is a priority in vision 2030. The agricultural sector is a key driver for the delivery of the 10 percent economic growth envisaged in the economic pillar of vision 2030. Lastly, understanding how farmers perceive climate change risk is valuable to other stakeholders such as extension service providers and climate information providers as it provides a link to policy on how to cushion farmers against rainfall fluctuations.

1.6 The Scope and Limitations of the Study

The study was carried out in four administrative wards of Kisii Central Sub County; Keumbu, Township (Getembe), Kiogoro and Mosocho. The study focused on the effect of rainfall variability on the farming practices of the households in the study area while at the same time identifying the adaptations put into place by the affected households in response to rainfall variability. The units of analysis were the households and the subjects of analysis were the household heads. However due to limited resources and time the study did not interview all households involved in farming within the sub county, but only sampled 120 respondents. The study was limited to the perception of the effects of rainfall variability and thus there was scant effort to quantify climate variability and there was no secondary data analysis of the effects. The study also focused on rainfall and did not consider other climate variables such as temperature and humidity. This is because rainfall is the most critical factor influencing farming in the study area and the study being a household survey, data on other climatic variables such as temperature or humidity could not be easily gotten from households.

1.7 Assumptions of the study

The study was undertaken with the following assumptions:

i) All households were involved in some form of farming practice either crop production and/or livestock production.

ii) The households' responses reflected their true understanding of the questions posed to them and that they were representative of the wider community.

1.8 Definition of Terms

Adaptations are actions taken to help individuals, communities and ecosystems moderate, cope with, or take advantage of actual or expected changes in climate conditions (IPCC, 2007). In this study the term is used to describe the farming adjustments (practices) households make or adopt to reduce the risk of rainfall variability.

Climate Change refers to shifts in the mean state of the climate or in its variability, which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere observed over comparable time periods (IPCC, 2007). In this study climate change is indicated by changes in rainfall amounts and distribution. This is the main climate change driver in the study area (Barrios *et al*, 2008; Ojwang *et al*, 2010).

Climate Variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Examples include extended droughts, floods and conditions related to events such as El nino or La nina (IPCC, 2007).

Crop Diversification refers to growing a variety of crops in an area, not just one such that if one crop fails this year the area can still survive and meet the demands through the other crops. In this study it means a household planting different varieties of crops in his/her farm. The varieties comprise both food and cash crops.

Drought refers to deficiency of precipitation over an extended period of time resulting to water shortage for some activity. In this study it means an extended dry spell or less precipitation affecting growth and yield at various stages of crop development or lack of water and pasture for livestock.

Farming Practices refers to the agricultural activities households carry out in their farms. The activities include the kind of crop cultivated, livestock reared and the strategies or innovations they have adopted in the face of rainfall variability.

Household refers to people who live together in a single home and who are involved in crop and or animal production either small or large-scale. In this study the household is represented by the household head who was interviewed to provide the necessary information.

Rainfall Variability refers to the fluctuating inter-annual or intra- or inter-season rainfall regimes as a consequence of climate change. In the study area, it will be indicated by change in rainfall amounts and distribution and associated extremes such as droughts.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

In this chapter, literature review focuses on issues related to climate variability and change. They include climate variability and change and its causes, rainfall variability and its effects on farming and the practices and the innovations that households adopt in response to rainfall variability. This chapter also presents the identified knowledge gaps in climate variability and adaptability studies.

2.2 Climate Variability and Change

Climate change is unarguably the biggest environmental issue of our time (Ojwang *et al*, 2010; Owolabi *et al*, 2012). Climate change is a topical issue worldwide because of its attendant problems that are threatening the sustenance of man and his environment. There is a debate as to whether climate change is human induced, nature caused or man and nature caused. According to IPCC (2007), the world's climate varies naturally as a consequence of the way the ocean and the atmosphere interact with each other, changes in the Earth's orbit and changes in energy received from the sun. However it has been firmly established that human inhabitants are altering the climate as a result of greenhouse emissions (IPCC, 2007; Pender, 2007). It is believed that more than 90% of the increased greenhouse concentrations are produced by human activities such as burning of fossil fuels and deforestation (Pender, 2007). Climate change poses real challenges to agricultural production (IPCC, 2007) and some of these challenges will arise from rainfall variability.

Variability in rainfall, which manifests in spatio-temporal terms may be characterised as variability in seasonal onset and cessation dates, intra- and inter-seasonal distribution and occurrence of extreme or adverse weather events such as drought, floods, and prolonged dry spells. The current climate in East Africa is characterized by large variability in rainfall with the occurrence of extreme events in terms of droughts and floods (Nganga, 2006). Kenya experiences high rainfall variability (Were *et al*, 2006; Ojwang *et al*, 2010). There are already proven changes in Kenya’s climate which affect agricultural production such as delayed rainfall, reduced rainfall, and destructive rainfall (GoK, 2010b). The long-term changes in rainfall patterns and shifting temperature zones are expected to have significant negative effects on agriculture, food and water security and economic growth in East Africa (Herrero *et al*, 2010). Increased frequency and intensity of droughts and floods is expected to negatively affect agricultural production and food security (Kinuthia, 1997). UNDP (2007) notes that increase in extreme rainfall events are already evident in the region. Average annual temperatures in Kenya increased by 1.0°C between 1960 and 2003 and the country has experienced both prolonged droughts and intense flooding every year since 2000 (Thornton, 2011).

The projections of rainfall in East Africa are not uniform. Hulme, Doherty, Ngara, New & Lister (2001) projected that there will be large regional differences of changes in rainfall patterns across East Africa. There is likely to be an increase in annual mean precipitation in East Africa (Christensen, Hewitson, Busuioc, Chen, Gao, Held, Jones, Kolli, Kwon, Laprise, Magaña Rueda, Mearns, Menéndez, Räisänen, Rinke, Sarr & Whetton, 2007). Total annual precipitation projections for Kenya suggest increases by approximately 0.2 to 0.4 percent per year. Within Kenya, however, regional variations in precipitation are vast (Herrero *et al*, 2010). Global Climate Models predict an increase of 40% in rainfall in northern Kenya by the end of the century, whilst a regional model suggests that there may be greater rainfall in the West of the country (Thornton, 2011), where Kisii Central Sub County lies. However increase in amount of rainfall does not always translate to increased agricultural production. For instance, a study carried out in Laikipia East district (Huho, Ngaira, Ogindo & Masayi, 2012) found out annual rainfall amounts increased between the years 1976-2005, but this did not lead to good agricultural production. This was attributed to the changing rainfall patterns in that region. Kenya traditionally experiences two rainfall seasons, March to May for the long rains and October to December for the short rains. In 2009 the long rains did not arrive as expected and this exacerbated the existing lack of rainfall in the country (DFID, 2009). Traditionally the Kisii region has received rainfall almost throughout the year though bimodal (March to May and October to November (Omosa, 1998). But this is no longer the case. In the Kenya Meteorological Department (KMD) report of year 2011, the long rains of March to May performance was generally poor over most of parts of the country including Kisii region. This poor performance was reported in both rainfall amounts and its distribution in time and space. The long rains of October to November began earlier than usual and persisted to late December. In 2012 in Kisii Central Sub County, the low rainfall month of January was characterized by dry than usual conditions. Kisii region is therefore, particularly vulnerable to the impacts of rainfall variability due to overdependence on rain fed agriculture and small fragmented landholdings. Kisii Central Sub County is attractive for this kind of study because households are involved in small scale intensive farming which is rain-fed.

2.3 Effects of Rainfall Variability on Farming

Agriculture is very sensitive to climate variability and weather extremes such as droughts, floods and severe storms (IFPRI, 2009). Climate variability negatively affects agricultural productivity and this has a direct impact on smallholder farmers, who mostly rely on rain-fed agriculture for their production. This is because smallholder farmers, the main contributors of domestic food, mostly rely solely on rain-fed agriculture and have a limited means of coping with this adverse weather variability (Nganga, 2006; Molua, 2007). The major elements of climate that affect herbage growth are the intensity and duration of rainfall, the relationship between annual rainfall and potential evapotranspiration and the year-to-year variation in rainfall (Kabubo-Mariara & Karanja, 2007). According to Kakubo-Mariara (2007), the agricultural sector, which relies heavily on predictable rainfall and temperatures, suffers most following climatic variations, thus affecting the livelihood of most households who rely on rain fed agriculture. Climate change in Kenya is already apparent in changing the precipitation patterns and more frequent and erratic extreme events such as floods, droughts and heat waves (Badege, Neufeldt, Mowo, Abdelkadir, Muriuki, Dale, Asetta, Guillozet, Kassa, Dawson, Luedeling & Mbow, 2013). The increased frequency of these events is projected to affect local crop production in the region (IPCC, 2007). The agricultural sector in Kenya is particularly vulnerable to adversities of weather, not only because it is rain-fed, but because farming is subsistence oriented.

Households in Kisii Central Sub County are mainly small scale farmers and the major farm types are tea, coffee, maize, bananas, dairy and intensive grazing land use systems (Maobe, Wanyama, Njue & Mogaka, 1994). These smallholder households already operate under pressure from food insecurity, increased poverty and water scarcity (Oxfam, 2005; Regassa, Givey & Gina, 2010). Kisii Central Sub County is a high potential region with a high population density; 1009 persons per km^2 (GoK, 2009) and this has seen increased land fragmentation. The households thus practice subsistence agriculture which is already vulnerable to effects of rainfall variability (Irungu, Ndirangu & Omiti, 2009) coupled with continuous cropping of same plots of land and loss of soil fertility due to erosion.

Rainfall variability not only affects the production of stable crops such as maize but also cash crops such as tea and coffee (Herrero *et al*, 2010; Badege *et al*, 2012) thus increasing Kisii Central Sub County households' vulnerability. Crop growth, development and subsequent yields depend on seasonal temperature, rainfall amounts and distribution. Within season variation in rainfall contribute to variability in crop yields with marked effects on quality and quantity. Kabubo- Mariara & Karanja, 2007; Karukulasariya & Mendelsohn.2007) conducted studies on the impact of climate change on crop agriculture. The dominant discourse in these studies is qualitative modeling and the impacts are crop modeled simulations that are run for biophysical adaptations to water and temperature stress. They assume farmers are doing none of the adaptations or full adaptation and thus are non-sensitive to the socio economic characteristics of the farmers. This study thus tried to bridge this gap by investigating relationship between household characteristics and adoption of adaptation strategies in regard to rainfall variability.

Barrios *et al,* (2008) found that rainfall and temperature have significant impacts on agricultural production. However rainfall is the most important climatic factor and determines the spatial yield distribution of crops (Makenzi *et al*, 2013). Agricultural activities follow rainfall patterns especially in tropical regions (Huho *et al*, 2012). In Sub-Saharan Africa rain-fed agriculture, which provides food for the populace and represent a major share of the countries' economy follow precipitation pattern closely (UNEP, 2008). Therefore, short-term as well as long-term variations in rainfall patterns have important effects on crop and livestock farming (IPCC, 2007). Seasonal rainfall is marked by delayed onsets, declining number of rain days and increased intensities altering farming calendars with negative effects on the yields. The impact of climate change and variability on smallholder rain-fed farming has been a subject of debate amongst policymakers and agricultural practitioners (Jokastah, Leahl Filho & Harris, 2013). Despite these widespread debates, not much is known about the smallholder farmers perceptions on the effects of climate change and variability on their agricultural practices. Further still, there has been little focus on the relationship between household characteristics and the perception on the effects of climate variability especially rainfall variability. This study therefore sought to establish the relationship between household characteristics and the perception of the effects of rainfall variability on farming activities in Kisii Central Sub County. This knowledge on farmers' perceived effects of rainfall variability in agricultural practices in smallholder systems will allow researchers, extension educators and farmers to develop research agendas and adopt practical practices that meet present and future farming needs in specific agro ecological zones.

2.4 Farming Practices and Adaptation Strategies to Rainfall Variability

According to Dida *et al*, (2013), most households within the Lake Victoria basin where Kisii Central Sub County lies, rely heavily on crop cultivation and livestock rearing. However, in as much as people in the region likes this easy trend of crop farming, the climatic conditions in most part of the region does not seem to favor it and so there is need for awareness creation and change in farming practices. Farmers in East Africa have always faced high rainfall variability, both within and between seasons, and that their farming systems have not been static (Cooper & Coe, 2011). A study by Bryan *et al*, (2011) found out that farmers are more concerned about greater variability and seasonal changes which hinder their ability to predict rainfall patterns and plan their farming activities accordingly. Communities or households have already noticed changes in weather patterns and thus have employed various coping mechanisms (Kuria, 2009; Macharia, Lugadiru, Wakori, Ng'ang'a & Thuranira, 2010; Kristjansen *et al*, 2012). Evidence of the households' perceived changes is reflected in changes and adaptation of different farming strategies (Meze-Hausken, 2004).

Adaptation to climate variability and change includes many responses such as crop and livestock practices, land use and land management and livelihood strategies (Bryan *et al*, 2011). Some of the practices that communities are adopting to cope with rainfall variability include; crop diversification, adoption of fish farming, kitchen gardening, hay stacking and bio-intensive agriculture (PELUM-K, 2010). Rainfall variability coupled with decreasing land sizes has caused farmers to adopt different farming practices to improve productivity in a worsening atmosphere. Farmers are moving away from the conventional farming practices that were based on growing a single cash crop or two or three for household subsistence. New crops have been introduced, livestock numbers have decreased, they have embraced zero grazing and agro forestry is now widely practiced (Muriuki, Kirumba & Catacutan, 2011). Understanding household-level crop livestock choices can generate important information about how farm households change the riskiness of their crop composition in reaction to rainfall variability.

2.4.1. Rainfall Variability and Household Choice of Crops

Haile (2007) showed that Ethiopian farmers choose crops most suited to a specific rainfall condition as a strategy for coping with unpredictable rainfall. For smallholders in low income countries where rainfall variability is common, households mostly rely on production decisions and crop choices to hedge against weather risk (Kurukulasuriya & Mendelisohn, 2007). In particular, in times of low rainfall, farmers predominantly choose moisture and stress tolerant crops. Hoang, Namirembe, van Noordimjk, Catacutan, Oborn, Perez-Teran, Nguyen and Dumans-Johansen (2014) too notes that households are embracing crops such as bananas, cassava and sweet potatoes that supplement family food needs while also producing animal fodder. A study by Kristjansen *et al*, (2012) show that households that are more innovative in changing their farming practices are likely to be more food secure. However these studies do not show how household characteristics influence the adoption such improved farming practices such as informed crop choices.

2.4.2. Rainfall Variability and Household Adaptation Strategies

Katz and Brown (1992) and Selvaraju, Subbiah, Baas & Juergens (2006) found some adaptation practices commonly used by farmer in response to rainfall variability to include water harvesting, early planting, deep planting, planting of cover crops, application of mulch to conserve moisture, planting of drought tolerant crops, planting of early maturing crops, alley farming, and enterprise diversification. Various studies (UNDP, 2010; Idrisa, Ogunbameru & Amaza, 2010) recommend that appropriate/indigenous technologies should be promoted for adaptation by farmers. Although several studies have been carried out on adaptation to climate change in developing countries (Selvaraju *et al*, 2006; Nhemachena, 2007; Badi, 2010; Ojwang *et al*, 2010; Mandleni and Amin, 2011; Huho *et al*, 2012), these studies do not look at community or household specific coping strategies for high potential regions and how they respond to rainfall variability. Therefore there is need for research to focus on high potential regions and how the respective communities perceive the effects of rainfall variability and their specific coping strategies and adaptations. This is because communities have an inclination to use their traditional knowledge systems to adapt effectively (UNEP, 2009). It is therefore important to understand what is happening at household level in a high potential region like Kisii Central Sub County. This is because households are the most climate-vulnerable group.

Rainfall variability is one of the persistent stresses that communities in rural areas have to cope with. The seasonality, amount, distribution and the timing of the rainfall is of particular importance to the population that depends on rain-fed agriculture for their subsistence. Given the pervasiveness of weather uncertainty and the almost exclusive dependence of smallholders on rainfall for productivity, a number of studies have looked into the impacts of rainfall variability on farming (Klein and Roehing, 2006; Ojwang, 2010; Shisanya, Recha &

Anyamba, 2011; Recha, 2011; Bezabih, De Falcao & Yesuf, 2011; Huho *et al*, 2012). It should be noted, however, that most of these studies focused on arid and semi-arid regions and medium potential areas. While there appears to be many practices available to farmers that provide multiple benefits in terms of productivity, adaptation, and mitigation, the extent to which farmers in Kenya are adopting these practices will vary based on farm household characteristics, the biophysical and socioeconomic environment (IPCC, 2007; IFPRI, 2011). Adoption of agricultural technologies in agriculture is considered to be synonymous with the adaptation strategies that farmers undertake in fight against the adverse effects of climate change (Nhemachena & Hassan, 2007) and as a result, the adoption literature can be applied in studies regarding climate change adaptation. A variety of factors are known to influence households' response strategies to climate change, which include among others; age, gender, level of education, income levels and agro ecological zones. This study focuses on how some of this factors influence perception of the effects of rainfall variability.

Studies on agricultural technology adoption by Adesina & Forson (1995) and Gbetibouo (2009) observe that there is no consensus in the literature as to the exact effect of age in the adoption of farming technologies because the age effect is generally location or technology specific and hence, an empirical question. On one hand, age may have a negative effect on the decision to adopt new farming technologies simply because older farmers may be more risk-averse and therefore, less likely to be flexible than younger farmers. On the other hand, age may have a positive effect on the decision of the farmer to adopt because older farmers may have more experience in farming and therefore, better able to assess the features of a new farming technology than the younger farmers. These studies have not focused on how age influences perception. Experiences from and perceptions of past events can influence future events (Smelton *et al*, 2011). This study thus sought to find out how age influences the perception of effects of rainfall variability and choice of adaptations.

In relation to gender, Asfaw & Admassie (2004) note that households headed by males have a higher probability of getting information about new farming technologies and also undertake more risky ventures than female headed households. A similar observation is made by Tenge & Hella (2004) who point out that female headed households are less likely to adopt soil and water conservation measures since women may have restricted access to information, land, and other resources due to traditional social barriers. Nonetheless, Nhemachena & Hassan (2007) have contrary results to the effect that female headed households are more likely to adopt different methods of climate change adaptation than male headed households. These studies have not shown how the relationship between gender and the perception of the effects of rainfall variability.

With regard to education, Norris & Batie (1987) argue that farmers with more education are more likely to have enhanced access to technological information than farmers with less education. Furthermore, Igoden, Ohoji & Ekpare (1990) and Lin (1991) observe a positive relationship between the education level of the household head and the adoption level of improved technologies and climate change adaptation. As such, farmers with higher levels of education are more likely to perceive climate change and adapt better. Related study by Nhemachena & Hassan (2007) indicate that farming experience, just like farmers' education level, increases the probability of uptake of adaptation measures to climate change.

This study is therefore not only focused on a high potential area, Kisii Central Sub County but also would help establish the relationship between households' characteristics and adaptation strategies adopted to enhance resilience against rainfall variability in Kisii Central Sub County.

2.5 Summary of Gaps Identified From Literature Review

From the literature reviewed, the main gaps that were identified include:

1. Most of the studies on rainfall variability (Shisanya *et al*, 2011; Recha *et al*, 2012; Makenzi *et al*, 2013) that have been carried out have mainly focused on arid and semi-arid regions of Kenya. This study therefore tried to narrow that gap by carrying a study in a high potential region like Kisii Central Sub County
2. Most of the impact studies' dominant discourse is quantitative modeling (Kabubo-Mariara & Karanja, 2007; Karukulasariya & Mendelsohn 2007; Makenzi *et al*, 2013). The climate impacts are often crop modeled simulations that are run for biophysical adaptation to water and temperature stress while assuming farmers to either doing none or full adaptation and thus are non-sensitive to socio economic factors farmers are in.
3. Most of the rainfall variability studies (Kabubo- Mariara & Karanja, 2007; Bezabih *et al*, 2011; Makenzi *et al*, 2013) have mainly focused on crops and yet most households combine both crop and livestock farming. This study thus tried to bridge this gap by

investigating how households' livestock practices too, are affected by rainfall variability.

2.6 Conceptual Framework

Agricultural production is carried out through the selection of crops and livestock suitable for the climate of a specific region and application of proper farming methods. The impacts of climate change on the crop production are made known by changes including the change of planting and harvesting seasons, poor quality produce, and shift of areas suitable for cultivation while in the livestock sector the effects include pests, diseases and unavailability of pasture. Therefore, farming is a climate dependent activity as agricultural practices are constrained and shaped by climate (Mooney & Arthur, 1990). In this study climate change will be considered at the level of rainfall variability. Farmers suffer from significant yield reduction and major losses in rain-fed agriculture due to delayed rainfall, erratic rainfall pattern; increased occurrence of drought, dry spells and shifts of the rainy season. Given the climatic zone of Kisii, rainfall is the main climatic variable that determines the growth of plants including cash and food crops and livestock. Farming practices in the Sub County are strongly dependent on rainfall and therefore follow rainfall patterns. For instance total rainfall is crucial for the crops, likewise the distribution of the annual rainfall, for example scarce rainfall in the beginning of planting season stunts growth and result in poor yield, whereas late rainfall into the time of harvesting spoils the harvest and result in lower output. Other effects arising from rainfall variability include; crop and livestock pests and diseases, water and livestock feed (fodder) shortages, loss of household income, livestock losses among others.

Rainfall variability is a stress or stimuli to which a system or household unit is exposed to and thus will perceive the effects. The households react to the perceived effects through various adaptation or response strategies. According to Meze-Hausken (2004), evidence of peoples' perceived changes in rainfall is reflected in the changes and adaptation of different farming practices. Farming practices, therefore would depend on households' recognition of rain variability as a problem that will affect their livelihood and thus the need to adapt to by adopting farming practices such as crop diversification, drought resistant crops, water harvesting, irrigation and tree planting (agro-forestry) (Smith, Matino, Cai, Gwany, Janzen, Kumar, McCarl, Ogle, O'mara, Rice, Scholes & Sironteko, 2007). Adaptation can greatly reduce vulnerability to climate change by making rural communities able to adjust to climate change and variability, moderating potential damages and helping them cope with adverse consequences (IPCC, 2001).

Communities have long been adapting to climate change, but these adaptations are typically discrete and reactive (UNDP, 2010). The choice of coping options depends on social and biophysical elements such as socio-economic characteristics of farm households (age, level of education, gender and length of stay), access to extension services, credit supply and the existing resources. This means that different communities and households use different strategies and that the strategies are a reaction to the actual or perceived effects. All these strategies aim at assisting households to remain as resilient as possible in the face of climate change impacts and increase food security. The fact that the coping range drops significantly under climate change is one of the reasons why the adaptive capacity of the households should be improved. However the choice of farming practice is not influenced by rainfall variability alone, but other factors such as households' characteristics (age/gender/education of the household head, wealth (on and off-farm income), land size, support programs and technological influences.

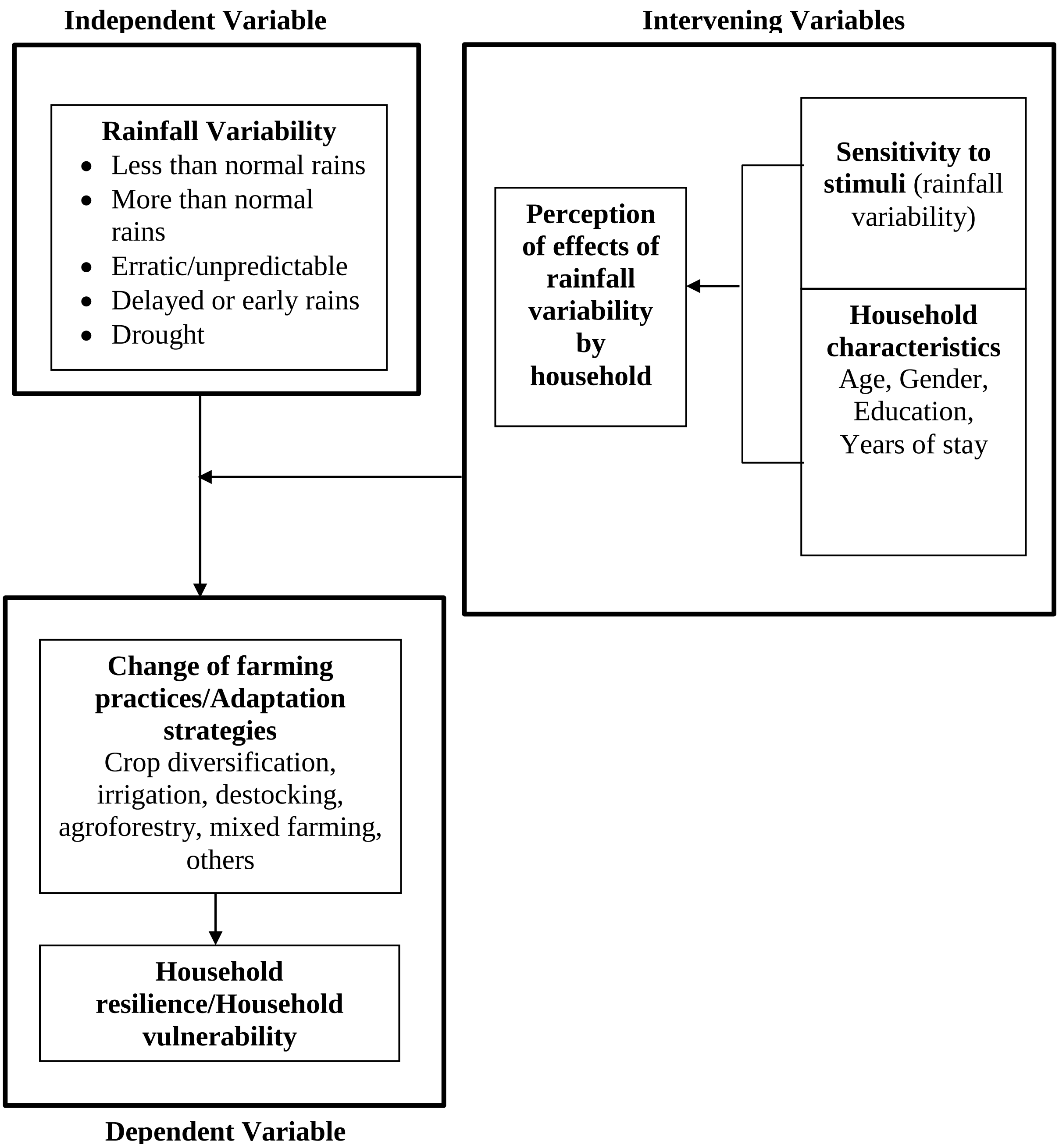

Figure 2.1: Conceptual framework.

Adopted and Modified from Ajibola (2014).

CHAPTER THREE
STUDY AREA AND METHODOLOGY

3.1 Introduction

This section outlines the methodology that was used to attain the objectives of the study. It presents the description of the study area, the research design, the study population and sampling procedure. Includes also is the instrumentation, validity and reliability of the instrument, data collection and analysis.

3.2 The Study Area

The study was conducted in Kisii Central Sub County of Kisii County, South Western Kenya (Figure 3.1). It lies between latitudes $0^0 30^l$ and $0^0 58^l$ south and longitudes $34^0 42^l$ and 35^0 05^l east (Kumba, Wegulo & Otieno, 2015) The Sub County has a population of 365745 persons covering an area of 362.5km^2 making it one of the most densely populated Sub counties in Kenya with 1009 persons per km^2 (GoK, 2009). Kisii Central Sub County is characterized by a hilly topography with several ridges and valleys. The Sub County can be divided into three main topographical zones. Zone one covers area below 1500m above sea level mainly in Mosocho ward. The second zone is one with an altitude of between 1500m to 1800m above sea level and is mainly found in Keumbu ward, while the third zone is one with an altitude of above 1800m also mainly found in Keumbu ward. Soils in the sub county are generally fertile. Existence of natural vegetation is very limited as over 90% of the total land is under cultivation and homesteads (Mironga, 2010).

The area lies on highlands west of the Rift Valley and has an equatorial type of climate. The area has traditionally received rainfall almost throughout the year though it is bimodal - March to May and October to November. The average rainfall is over 1500mm and temperatures can range from 10º to 30º C (Maoga, 2010). The Sub County's economy is largely derived from rain-fed agriculture with tea, coffee and sugarcane being the main cash crops while maize, beans and vegetables being the key food crops in the area. Bananas double as both a cash crop and food crop. As far as livestock farming is concerned, cattle and poultry farming is the most popular. Land is over portioned with a single household owning averagely less than 2 acres (Onura, 2013). Due to the high population density almost all land is put into maximum agricultural use (Maoga, 2010) and notably several of the valleys and wetlands that contained vegetation have been cleared to pave way for cultivation due to a burgeoning population (Mironga, 2006). Kisii Central Sub County covers Upper Midland (UM1, Lower Highland (LH1 and LH2) Agro Ecological Zones (AEZs) (Kumba *et al*, 2015).

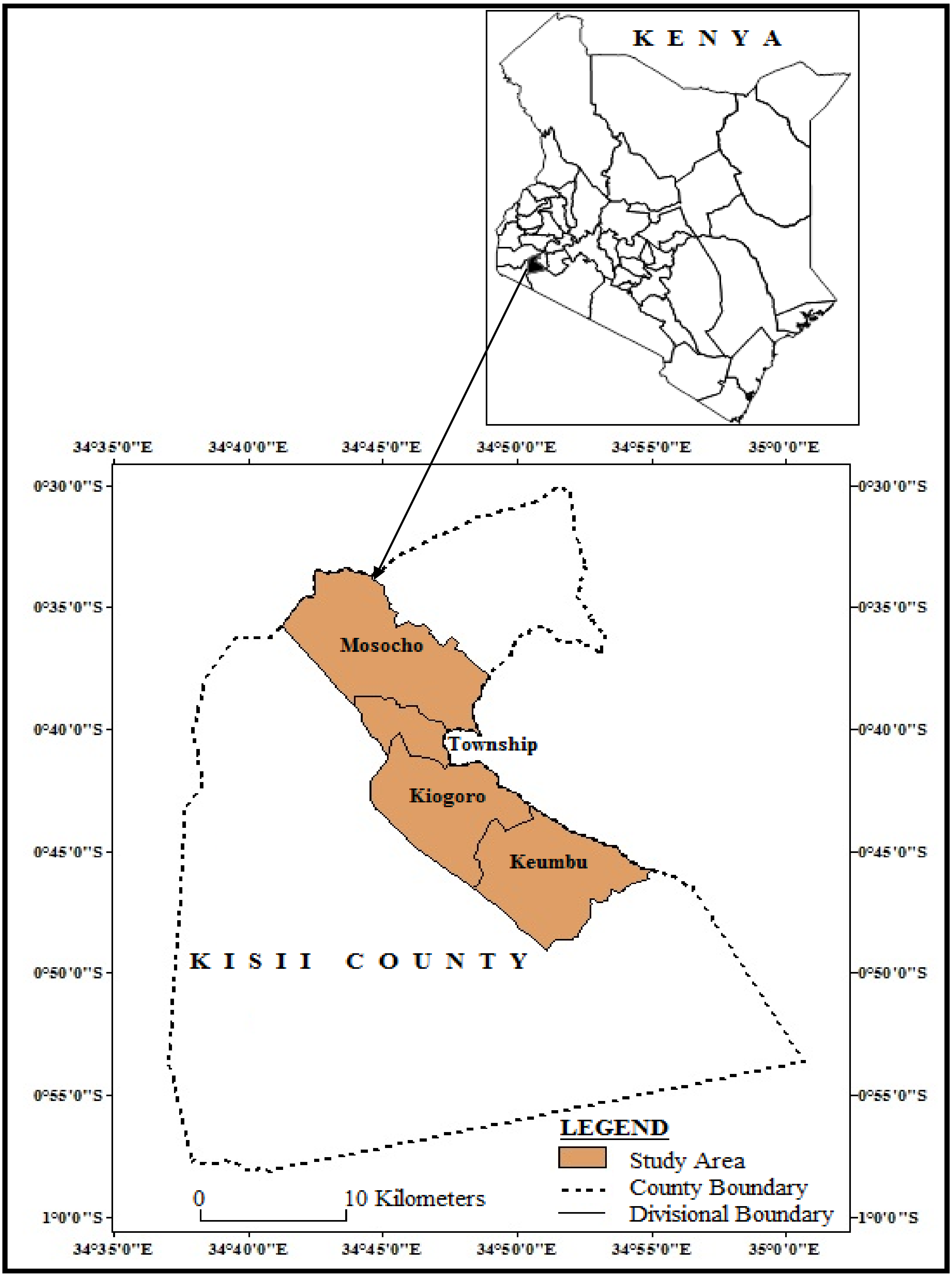

Figure 3.1: Map of Kisii County Showing Wards in Kisii Central Sub-County

Source: Kisii County Government, 2013

3.3 Research Design

This study used a descriptive survey and qualitative research design. Descriptive survey is a method of collecting information by administering a questionnaire to a sample of individuals (Orodho, 2003). It describes the state of affairs as they exist. Descriptive research design is suitable in covering issues relating to climate change (Nachmias & Nachmias, 1997) and may often result in the formulation of important principles of knowledge and solutions to significant problems (Kerlinger, 1973) such as climate change. This design enabled generalizing the findings to a larger population of households in Kisii County due to its high degree of representation. The study also used qualitative research design by employing FGDs (Focus Group Discussions) and key informant interviews. In deciding the unit of analysis, the household always seemed the logical choice: in most studies of coping strategies the household is taken as the unit of analysis because it is assumed that decisions about production, investment and consumption are primarily taken at the household level. The study targeted household heads since they were the ones who make decisions in their farms and deemed suitable to provide the relevant information about practices in their farm.

3.4 Sampling Procedure and Size

The target population for the study consisted of 58617 households in Kisii Central Sub County (GoK, 2009). A sampling design is a definite plan for obtaining a sample from a given population (Kothari, 1996). Kisii Central Sub County is divided into four main administrative wards. Being a descriptive survey, all the four wards were included in the study.

The following formula was used to come up with appropriate sample for the study. It is as proposed by Nassiuma (2000).

$$n = \frac{NC^2}{C^2 + (N - 1)\, e^2}$$

Where: n = Sample size,

N = Population,

C = Coefficient of variation,

e = Standard error.

The sample size was calculated at 25% coefficient of variation, 2% margin of error and a population of 58616 households.

Twenty five percent (25%) coefficient of variation was used to ensure that the sample size is wide enough to justify the result being generalized for Kisii Central Sub-County. Two percent (2%) margin of error was used because the study was a cross sectional survey, whereby the independent variables were not to be manipulated. Using the above formula, a sample of 120 respondents was selected.

Substituting the values: C=25% is acceptable according to Nassiuma (2000), e = 0.023 and N =58616, resulted to a sample of 120 respondents as shown below.

$$n = \frac{58617 * 0.252^2}{0.252^2 + (58617 - 1)0.023^2}$$

$$n = \frac{58617 * 0.0635}{0.0635 + (58616)0.000529}$$

$$n = \frac{3722.41}{31.07}$$

$$n = 119.80 \approx 120 \text{ households}$$

Proportionate stratified random sampling was used to obtain the sample from different wards (strata) in the Sub-County. The method was used to ensure each ward and thus agro ecological zones were represented. Table 1 shows the target population and the percentage proportion for each ward (strata) in Kisii Central Sub-County. It also shows the calculated sample size for each ward and the total sample size for the study.

Table 3.1: Number of Households in Each Ward and Sample Size

Ward	Population	Sample size
Kiogoro	16923	35
Mosocho	15077	31
Township(Getembe)	14853	30
Keumbu	11764	24
Total	**58617**	**120**

An FGD was held in each ward to collect qualitative information on the farming systems/ practices and farmer perceptions on effects of rainfall variability. A total of four FGDs were held (i.e one in each ward) comprising 11-15 mixed households (mixed in terms of gender, age, resource endowment and level of education and community leadership). The FGDs enabled community perspectives to be captured and provided a more holistic picture of the survey area in terms of farming practices and climate variability related issues.

3.5 Instrumentation

The instruments used in this study were structured questionnaires and interview schedules (Appendix B and C respectively). The questionnaire was designed so as to contain all the items that could help in achieving the objectives of the study. The questionnaire is considered the most suitable to elicit information from the respondents on climate variability and change causes, effects and mitigative/adaptive measures (Neuman, 2006). This is in line with UNEP (2006) observation that the questionnaire survey can be used to gauge the opinions, capabilities of key stakeholders on climate change. The questionnaire was used to solicit background information, socio-economic characteristics and the perceived effects of rainfall variability, the respondents' farming practices and the adaptations the households have adopted in response to rainfall variability in their farms. The questionnaire was pre-tested first to ensure that it elicited reliable, valid and accurate data. In addition to the use of household questionnaire, interview guides were used to collect qualitative information from two key informants from KARLO (then KARI), WRMA and Ministry of Agriculture.

3.5.1. Validity of the Instrument

Validity refers to the extent to which a research instrument performs what it was designed to do. Correct sampling was done to allow generalization to other people, times and contexts and hence give it external validity. Pilot survey was used to validate the instruments. This was to ensure that the items were clear, concise, complete, comprehensive and unambiguous. Content validity measures the degree to which the test items represent the domain or universe of the trait or property being measured (Mugenda & Mugenda, 2003). Face validity refers to the appearance of the instrument.

3.5.2. Reliability

According to Mugenda & Mugenda, (2003), reliability is the measure to which an instrument yields consistent results over repeated trials. Reliability of the questionnaire used in this study was assessed by pre-testing 20 questionnaires in one ward within Manga Sub County, which had households with similar characteristics as those in the target study area. The purpose of piloting was to detect possible flaws in the measurement procedure and to identify ambiguously formulated items. The instrument used in this study was considered reliable because it achieved a reliability coefficiency of 0.84 using Cronbach Alpha's (1951) scale obtained on a sample of 20. A reliability coefficient of 0.7 or above as suggested by Nunnally (1978) made the instrument reliable and acceptable for a study in Social Sciences.

3.6 Data Collection

The study utilized both primary and secondary data sets. Primary data was collected through questionnaires, interview schedules and observation. Information on socio-economic characteristics of households, perceived effects of rainfall variability on farming practices and adaptation strategies to rainfall variability was collected using questionnaires. The households involved in the study were visited in their homes and given the questionnaire to respond to. Once the respondent completed the questionnaire, it was collected on the spot to ensure high response rate. Primary data was also collected by conducting face to face interview with purposefully selected two key informants from KARLO (then KARI), WRMA and Ministry of Agriculture and an FGD from each of the four wards. The interviews were used to collect detailed information on farming practices, effects of rainfall variability and adaptation strategies in the study area. Secondary data was also sought to supplement the primary data. This included documented information on rainfall figures of the study area and the agricultural activities in the study area. The sources of this information included the Ministry of Agriculture and Kisii Meteorological station. The researcher made attempts to reconcile information on questionnaire with on-ground observations in the study area.

3.7 Data Processing and Analysis

Once the measuring instruments were obtained from the respondents, the raw data was systematically organized through coding to facilitate analysis. The data collected was analyzed and presented to facilitate answering of the research objectives and questions. Analysis of the data was by use of both descriptive and inferential statistics. Descriptive statistics included the use of means, percentages, and frequencies and the results presented graphically using charts and tables. Descriptive statistics are suitable in this study because they enable the categorization of the respondents based on socioeconomic characteristics, farming practice and response strategies. Objective 2 and 3 that sought to establish the relationship between households' characteristics and perception of the effects of rainfall variability and adaptation strategies adopted to enhance resilience against rainfall variability in Kisii Central Sub County were analyzed using Pearson's Chi-square analysis. Chi-square analysis was suitable in this study as it helped determine the association between household characteristics and perception of effects of rainfall variability on household farming practices. The rainfall data from the Kisii Meteorological station was subjected to coefficient of determination test (R^2) to determine its variability index from 1995 to 2014.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The study examined the effect of rainfall variability on household farming practices in Kisii Central Sub County. This chapter presents results on the themes driven from the three objectives of the study.

4.2 Characteristics of the Survey Respondents

The subjects for the study comprised of heads in 118 (two respondents failed to return questionnaires) randomly selected households in Kisii Central Sub County. This implies a response rate of 98.3% which the study considered as satisfactory. The study gathered information on a variety of respondents' attributes. These attribute encompassed gender, age, level of education, years of stay in the area and primary activity.

4.2.1 Gender of the Respondents

Table 4.1 shows that majority (56.8%) of the respondents were male. The proportion of female respondents was only 43.2%. This implies that majority of the households in the area are headed by males and consequently are the ones who make majority of the farming decisions. In most African societies men make decisions as women's voices are often muted in family or community decision making (Quisumbing, 2003)

Table 4.1: Gender of the Respondents

Gender	Frequency	Percent
Male	67	56.8
Female	51	43.2
Total	**118**	**100.0**

Source (Field Data, 2014)

4.2.2 Highest Level of Education of the Respondents

The findings of the study indicate that majority of the respondents (63.6%) had attained secondary education. The results further indicate that 17.8% of the respondents had college level of education. This was closely followed by 16.1% of the respondents who had primary level of education. It was only 2.5% of the farmers who had no formal education. These results generally imply that most farmers had adequate education that could enable them to carry out agricultural activities with better knowledge on how to cope with the effect of rainfall variability in the study area. The distribution of the respondents' highest level of education was as shown on Table 4.2.

Table 4.2: Highest Level of education of the household head

Level of education	Frequency	Percent
No formal education	3	2.5
Primary level	19	16.1
Secondary level	75	63.6
College education	21	17.8
Total	**118**	**100.0**

Source (Field Data, 2014)

Norris & Batie (1987) argue that farmers with more education are more likely to have enhanced access to technological information than less educated farmers. Igoden *et al*, (1990) and Lin (1991) in their studies too, observed a positive relationship between the education level of the household head and the adoption level of improved technologies and climate change adaptation.

4.2.3 Age of the Respondents

The study was interested in the average age of the household heads represented in this study. The ages of the household heads were categorized into 18-30 years, 31-40 years, 41-50 years, 51-60 years and above 60 years. Table 4.3 shows the summary of the results.

Table 4.3: Age of the Respondents in Years

Age in years	Freq	Percent
18 – 30	18	15.3
31 – 40	58	49.2
41 – 50	21	17.8
51 – 60	17	14.4
Above 60 years	4	3.4
Total	**118**	**100.0**

Mean Age = 37.83, Std. Deviation = 11.28, n = 118

Source (Field Data, 2014)

It was found that majority (49.2%) of the household heads were aged between 31 - 40 years (mean age of 37.83). However, 17.8% of the respondents were aged between 41 - 50 years which was closely followed by 15.3% and 14.4% of the respondents who were aged between 18 – 30 and 51 – 60 years respectively. It was just 3.4% of the respondents who were aged above 60 years.

According to Mintewab, Abe, Zenebe, & Livousew (2013), the age of a farmer is correlated with experience necessary to understand various aspects of climate variability that has implication on the farming practices. Older farmers are more likely to have had an opportunity to witness majority of the climatic variability issues as well as the variability of its variables. Adesina & Forson (1995) and Gbetibouo (2009), in their respective studies, too observed a positive relationship between age of the household head and the adoption of improved agricultural technologies. They have noted that older farmers have more experience in farming and are better able to assess the attributes of modern technology than younger farmers. Hence, older farmers have a higher probability of perceiving and adapting to rainfall variability.

4.2.4 Years of stay in the area

This study was interested in the length of stay in the study area of the household since it had an implication on the respondent's knowledge on matters related to rainfall variability. The results are summarized in Table 4.4.

Table 4.4: Duration of Stay in the Area

Duration in Years	**Frequency**	**Percent**
Less than 10 years	18	15.3
10 - 19 years	41	34.7
20 - 29 years	24	20.3
30 - 39 years	20	16.9
40 years and above	15	12.7
Total	**118**	**100.0**

Note. Mean Duration (years) = 15.94, Std. Deviation = 7.65, n = 118

Source (Field Data, 2014)

The findings in Table 4.4 indicate that majority of the households had lived in the study area for between 10 – 19 years as represented by 34.7% of the respondents. About 20.3% of the households had been in the study area for between 20 – 29 years which was closely followed by 16.9% and 15.3% of the households who had lived in the study area for 30 – 39 and less than 10 years respectively. These results imply that majority of the respondents were in a position to understand the climatic issues in the area and could easily bear witness of the state of rainfall variability in the area within a period of past ten years which was the recall period adopted in this study.

According to Jokastah *et al*, (2013) farmers with more than 10 years duration of stay in an area (or farming experience) can be suitable for study that examine the effect of rainfall variability on household farming practices since the data to be collected from such group could give a clear representation of the required perception and full information about the climatic changes and variability in the study area.

4.2.5 Primary Activities Undertaken by the Respondents

Table 4.5 shows the distribution of household heads primary activities undertaken. These included farming, business, salaried employment and students.

Table 4.5: Primary Activity Undertaken by the Respondents

Primary Activity	Frequency	Percent
Farming	58	49.2
Business	17	14.4
Formal Employment	41	34.7
Students	2	1.7
Total	**118**	**100.0**

Source (Field Data, 2014)

Table 4.5 depicts that majority of the households were engaged in farming as the primary activity as represented by 49.2% of the respondents. Some household heads were however on salaried employment (34.7%) or were engaged in business (14.4%). A few of the household heads were full-time students (1.7%). The variety of primary activities undertaken by respondents could partly be as a result of adoption of coping strategies that enhance resilience under rainfall variability.

4.2.6 Size of Land and its Allocation to Food Crops and Cash Crops

The findings of the study showed that households had generally small parcels of land that was mainly used for both food crops and cash crops. The distribution of mean acreage under food and cash crop production is shown in Table 4.18.

Table 4.6: Households Mean Land Size

Farm Enterprise	Minimum	Maximum	Mean	Std. Deviation
Cash crop acreage	.00	2.50	1.168	.57286
Food crop acreage	.20	4.00	1.204	.68006

Source (Field Data, 2014)

The results in Table 4.18 show that the mean size of land that was under cash crop and food crop production was 1.168 and 1.204 acres respectively. These findings agree with Onura, (2013) that land is highly fragmented with a single household owning averagely less than 2 acres.

According to Obasi, (2007), small land holdings invariably lead to more intensive land use systems. As a result, several types of crops are grown in the study area as food and/or cash crops.

There are different types of crops (both cash and food crops) grown in the study area. The popularity of the cash crops grown in the study area is indicated in Figure 4.1:

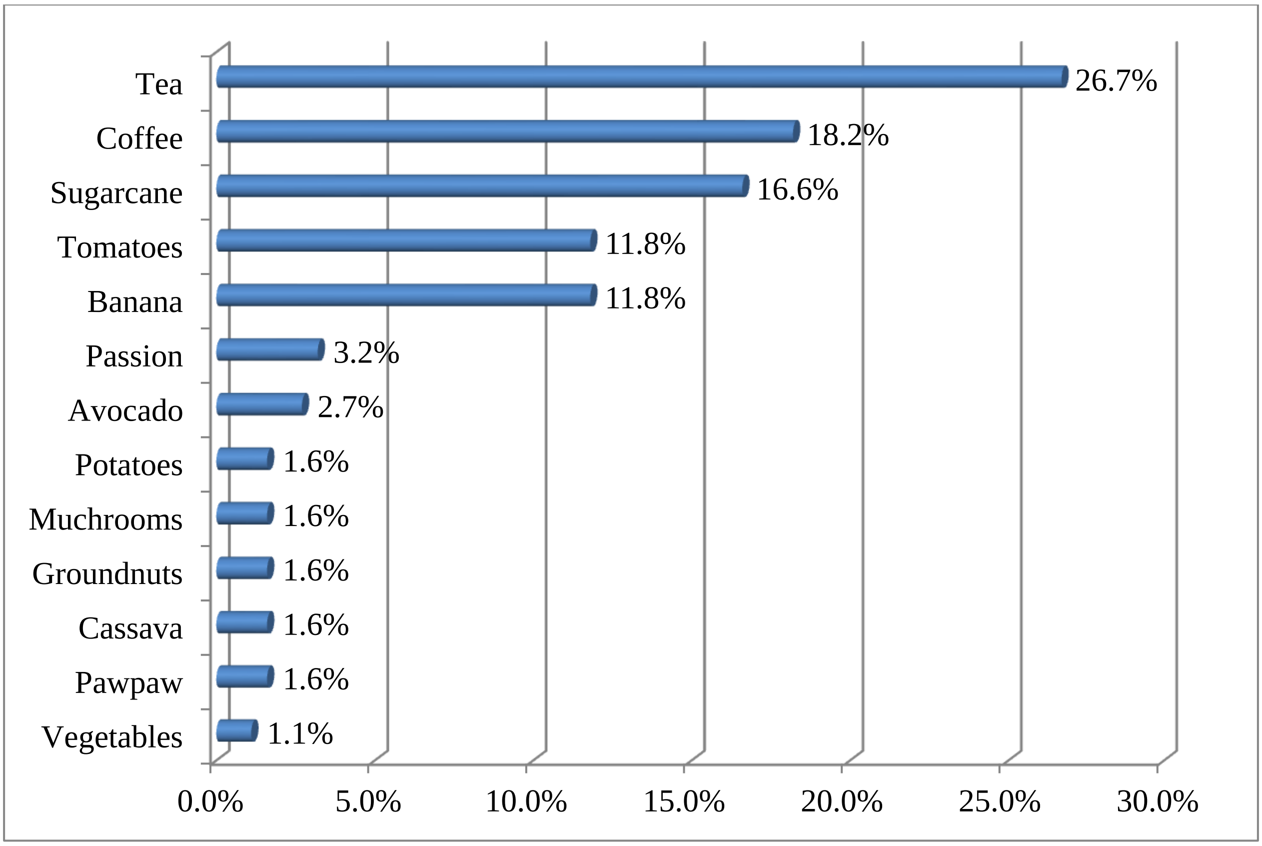

Figure 4.1: Types of Cash Crops Grown In the Study Area

Source (Field Data, 2014)

Figure 4.1 shows that the most common cash crops grown are tea (26.7%), coffee (18.2%), sugarcane (16.6%), tomatoes (11.8%) and banana (11.8%). Other cash crops grown included: passion (3.2%), avocado (2.7%), potatoes (1.6%), mushrooms (1.6%), groundnuts (1.6), cassava (1.6%), pawpaw (1.6%) and vegetables (1.1%).

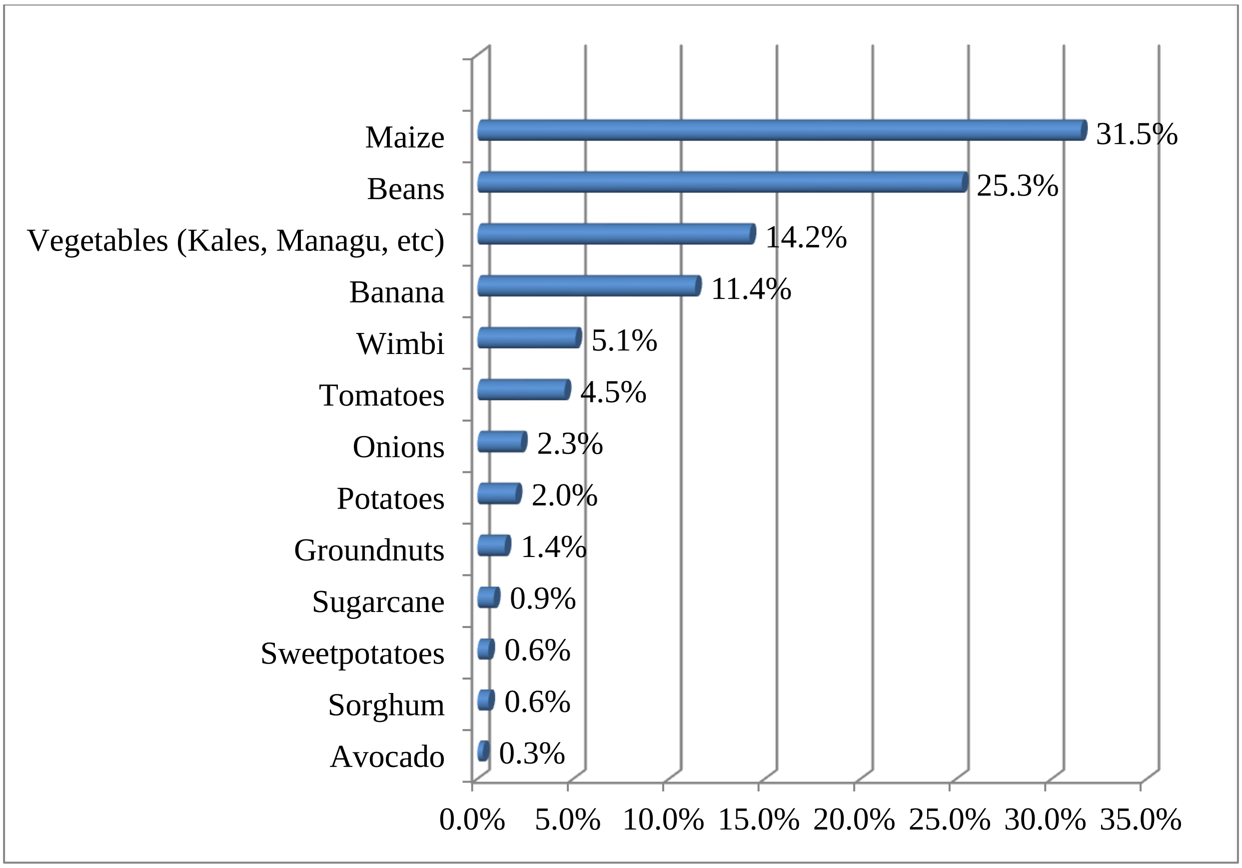

Figure 4.2: Types of Food Crops Grown In the Study Area

Source (Field Data, 2014)

Results in Figure 4.2 show the different food crops grown in the study area. The most popular food crop in the area is maize, as grown by the majority of respondents (31.5%) and was closely followed by beans as grown by 25.3% of the total respondents.

The popularity of vegetable (Kales (*sukumawiki*), black night shade (*Managu*), spider flower (*Saga*), etc) production in the study area cannot be overemphasized with approximately 14.2% of the total respondents indicating to be growing the food crops. About 11.4% of the farmers were growing bananas as food crops in the study area. Other food crops grown in the area includes: *wimbi* (5.1%), tomatoes (4.5%), onions (2.3%), potatoes (2.0%), groundnuts (1.4%), sugarcane (0.9%), sweet potatoes (0.6%), sorghum (0.6%) and avocado (0.3%).

4.3 Short term weather shocks/variations associated with rainfall in Kisii Central Sub County

The first objective of this study sought to understand the short term weather events associated with rainfall in Kisii Central Sub County and determining how frequent the events occur. To achieve this objective, respondents were first requested to indicate whether they have noticed any changes in rainfall patterns in the past ten years in the area. Their responses were as indicated on Figure 4.3:

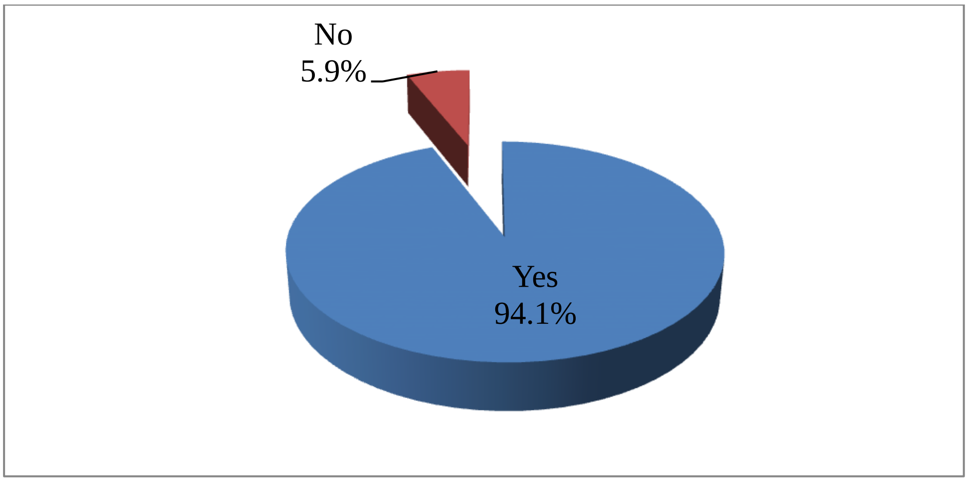

Figure 4.3: Knowledge on changes in rainfall patterns in the past ten years

Source (Field Data, 2014)

The results presented in Figure 4.1 shows that an overwhelming majority of the respondents (94.1%) were in agreement that gross changes in rainfall patterns had been noticed in the past ten years in the area as compared to 5.9% of the respondents who were of the contrary opinion. Studies on assessing farmer perceptions on climate change in Kenya have reported similar findings (Bryan *et al*, 2010; Rao *et al*, 2011; Thorlakson, 2011; Jokastah *et al*, 2013). Farmers' rainfall variability perceptions are likely based on an observed decline in water availability are due to temperature increases as well as other environmental and social drivers such as an increase in population density as is the case in the study area. This could also be due to the fact that rainfall variability tends to be the dominant source of livelihood and production risk affecting smaller holder farmers or households.

The FGDs results revealed that there is varied understanding of climate change and variability depending on education, livelihood activities and age. The local understanding though, was that climate was changing especially in the form of rainfall amount and patterns. The members' perception of changes in precipitation is accredited to noticeable changes in their environment like reduced stream and river volumes, delayed rainfall and frequent dry spells. Majority of the interviewees in the FGDs linked the changes in rainfall patterns to climate change while a small number of them especially the above 60 years age bracket felt the changes were as result of disregarding traditional or cultural practices such as invoking the rainmakers

These findings also concur with Moyo, Mvumi, Kunzekweguta, Mazmimavi, Craufurd & Dorward (2012) who in a study in Zimbabwe found out that most farmers belief that the climate is changing and that the changes are mainly associated with rainfall amount, distribution and temperature. These results are also consistent with Jokastah *et al*, (2013) who in their study of smallholder farmers' perception of the impacts of climate change and variability on rain-fed agricultural practices noted that agriculture to a large extent is affected by different production factors, both natural and man-made; one such factor being rainfall variability

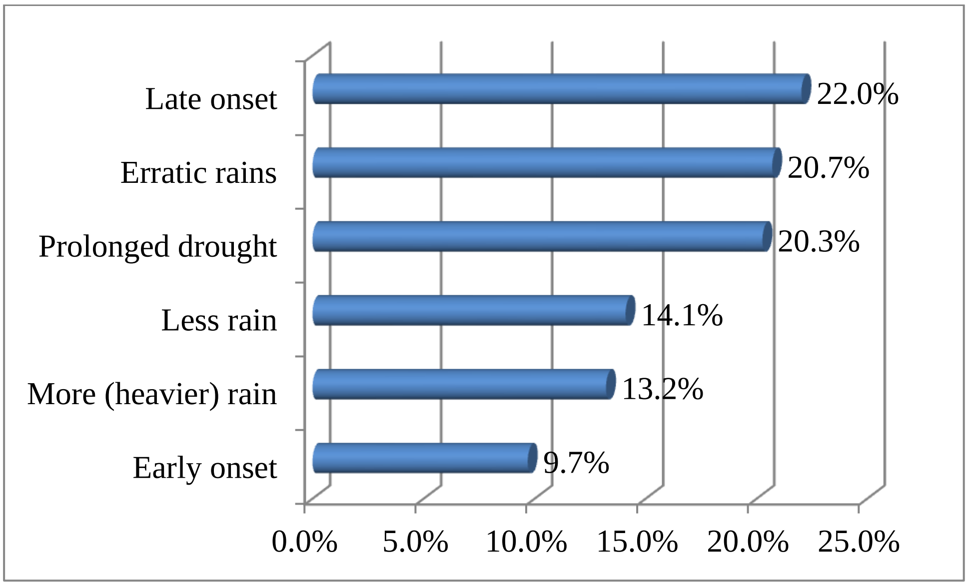

Figure 4.4: Changes in rainfall patterns in the past ten years

Source (Field Data, 2014)

The results presented in Figure 4.4 shows that changes in rainfall patterns in the past ten years was mainly noticed in form of late onset (22.0%), unpredictable/erratic rains (20.7%)

and prolonged droughts (20.3%). Other significant changes in rainfall patterns that were cited to have occurred in the past ten years include less rain (14.1%) and early onset (9.7%). This implies that the agricultural activities in the study area may be at a great risk and therefore farmers may be realizing very little and erratic returns from their undertakings.

These results are consistent with Jaetzold, Schimdt, Hornetz and Shisanya, (2009) and Businge, (2011) among other studies that documented that Kenya, like the rest of the world, is experiencing climate change and variability and the associated adverse impacts. An analysis of trends in rainfall patterns, extreme events and slow onset events points to clear evidence of climate change in the country. A study carried out in Zimbabwe (Moyo *et al,* 2012), showed that farmers perceived climatic and weather patterns to have changed over the past decade or two, as indicated by erratic rainfall patterns, decreased rainfall and temperature increases, leading to crop productivity decline and increased livestock morbidity and mortality. The annual variation, including the onset, intensity, duration and cessation of rainfall greatly impact on agricultural productivity (Unganai, 2000).

Results from key informants show a general consensus that there are changes in precipitation patterns and amounts. These are indicated by rainfall patterns that are no longer clear, delayed or rainfall coming early, rains that are sometimes heavier than normal and longer dry spells. The informants seemed to agree that the change is attributed to climate change and variability due to natural processes and destruction of the natural environment especially due to population explosion. While the FGDs results do support the findings of the household survey, they also show that farmers place greater emphasis on rainfall variability when making decisions about their farming activities. Furthermore, they suggest that farmer’s perceptions of long term decreases in rainfall from the household survey are actually based on their experiences with rainfall variability, and particularly changes in timing and distribution of rainfall, rather than average quantity of annual rainfall. This again explains why farmers’ perceive a decrease in rainfall associated with climate change despite the fact that actual climate data have not necessarily shown a decreasing trend. Equally noted as a major concern by the informants was the eucalyptus trees planted along the river courses. These are believed to decrease stream river volumes and drying of wetlands and thus a likely cause of reduced water resource

The study also sought secondary data (Appendix H) from Kisii Meteorological station to ascertain if rainfall variability existed in Kisii Central Sub County and if so, how big the problem was. Rainfall in Kisii Central Sub County is varying in the past eighteen years as records can show (Figure 4.5 and 4.6). Since 1995 rainfall was found to be varied such that during this period, some years recorded high rains whilst others recorded low rains as can be seen in Figure 4.5. Figure 4.5 shows that coefficient of determination (R^2) is 0.7 and this is a reflection that rain in the Kisii Central Sub County is highly variable with time. The variation in rainfall can perhaps be explained by many factors such the reduction in area covered by forests, wetlands as a result of agricultural activities, urbanization and upcoming settlements in Kisii Central Sub County. Clearing of trees will increase temperatures of the area and consequential increase in evapotranspiration. Warm temperatures cause increased rain variability by increasing atmospheric moisture and altering cycling of water in the atmosphere (Held & Snoden, 2006, Patricola & Cook, 2010).

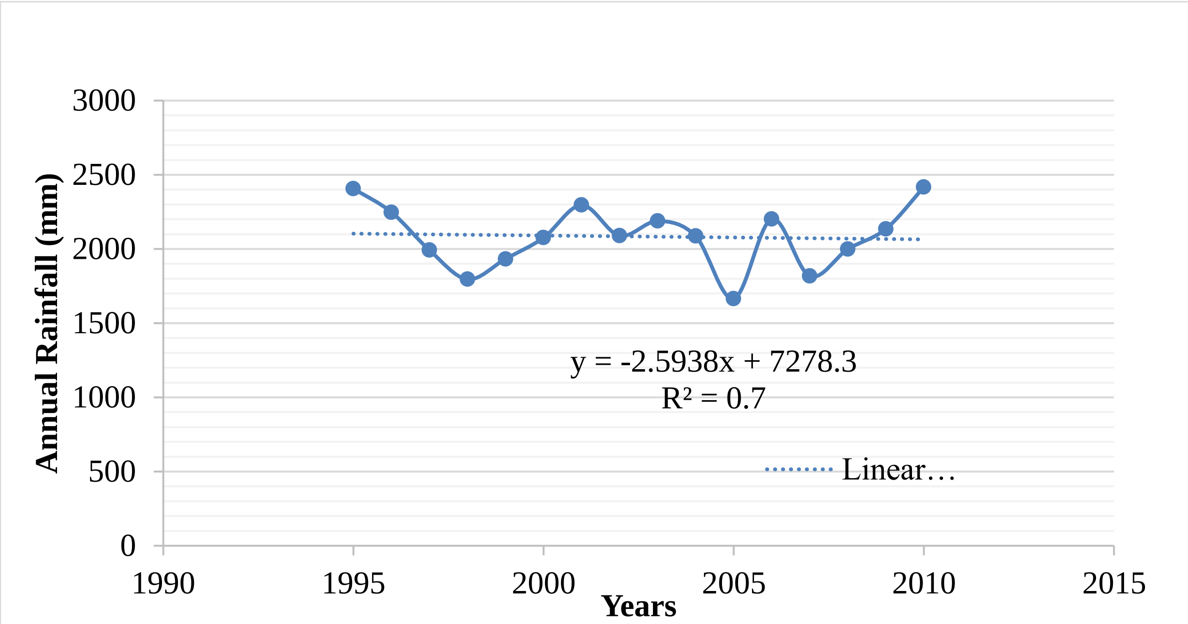

Figure 4.5: Rainfall variability in the Kisii Central Sub County

Figure 4.6 too, shows that rainfall in Kisii Central Sub County is varying with time with coefficient of determination as R^2=0.0705 for maximum monthly rainfall and R^2=0.1101 for minimum monthly rainfall and R^2=0.87 for mean monthly rainfall. Thus minimum rains are the most variable with time.

From figure 4.6, it is concluded that maximum rainfall of 663.7 mm was skewed and of excess kurtosis of 8.2 and as such was treated as an outlier. 90th percentile had 447.07 mm, 75th percentile had 368.23 mm, 50th percentile had 324.8 mm and 10th percentile had 245.35 mm of rainfall. The mean rainfall was 341.33 mm and was very close to the median which was 324.8 mm. The rainfall range was very large (430.5 mm) because of the high value of maximum rainfall and low value of minimum rainfall.

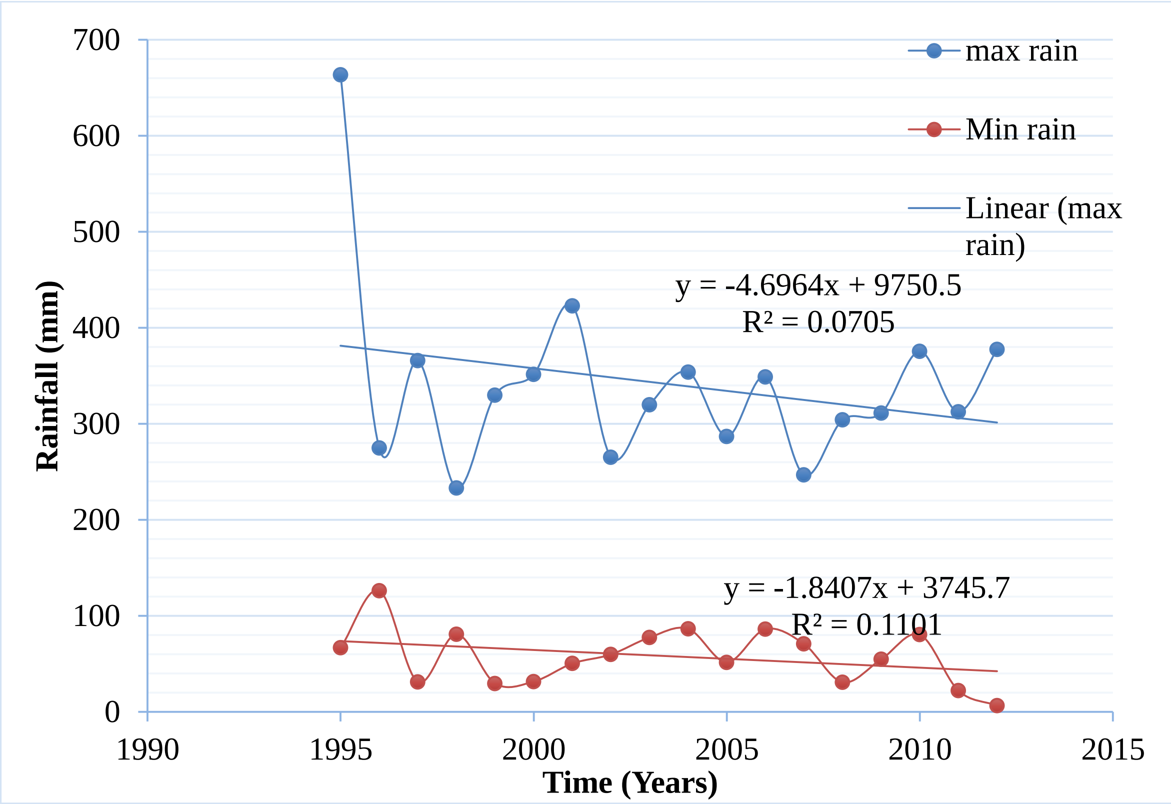

Figure 4.6: Monthly Maximum rainfall and minimum rainfall in the Kisii Central Sub County in the period 1995 to 2014.

Generally both maximum rainfall and minimum rainfall show a decreasing trend over the years. This can perhaps be explained by weather changes brought about climate change and variability.

This study investigated the incidences of extreme or unusual weather events(s) associated with rainfall that were witnessed in the past ten years in the study area. The respondents were first asked to state whether they have seen incidences of unusual weather events. The results are summarized in Table 4.7.

Table 4.7: Respondent's perception on occurrence of unusual weather events in the study area

Response	Frequency	Percent
Yes	114	96.6
No	4	3.4
Total	**118**	**100.0**

Source (Field Data, 2014)

The findings in Table 4.7 show that overwhelming majority of the respondents (96.6%) had indeed experienced extreme weather events associated with rainfall in the past ten years. However, about 3.4% of the respondents indicated to have not experienced any extreme weather event.

Moyo *et al*, (2012) says that households use personal experiences of the past which could sometimes be unreliable. Households' memory of past events can be faulty due to failure to differentiate between climate (statistical expectation) and weather (what they get) patterns. In farming, the amount of rainfall is important and is an indicator of long term changes in the climate system. However, of more importance to farmers is the pattern of the rainfall (Falaki, Akangpe & Ayinde, 2013). If the rain falls in the right amount and then it ceases for a long period before the next rain, the long dry spell can be devastating to farmers and therefore a bad season to the farmers. If however the rain falls in small amount but at the expected time and spread over the period of planting, it is a good season for farmers and thus no unusual event. Generally households prefer to learn from experience instead of statistical descriptions and this may lead to flawed interpretation of what is observed.

It was important to consider the farmers' experience of extreme weather events with rainfall because an increase in the total quantity of rainfall does not always capture the impact of rainfall variability (including when, where and how much of the rain falls each time), which has serious implications for the capacity of the population to adapt (Gordon, Jaspat & Situma, 2010), A study carried out in Laikipia East district (Huho *et al*, 2012) supports this observation. It was found out that annual rainfall amounts increased between the years 1976-2005, but this did not lead to good agricultural production. This was attributed to the changing rainfall patterns that disrupted farming activities.

Respondents were asked to state the most recent extreme event(s) that have taken place in the area in the past ten years (2003 – 2013) and the results are as shown in Figure 4.7.

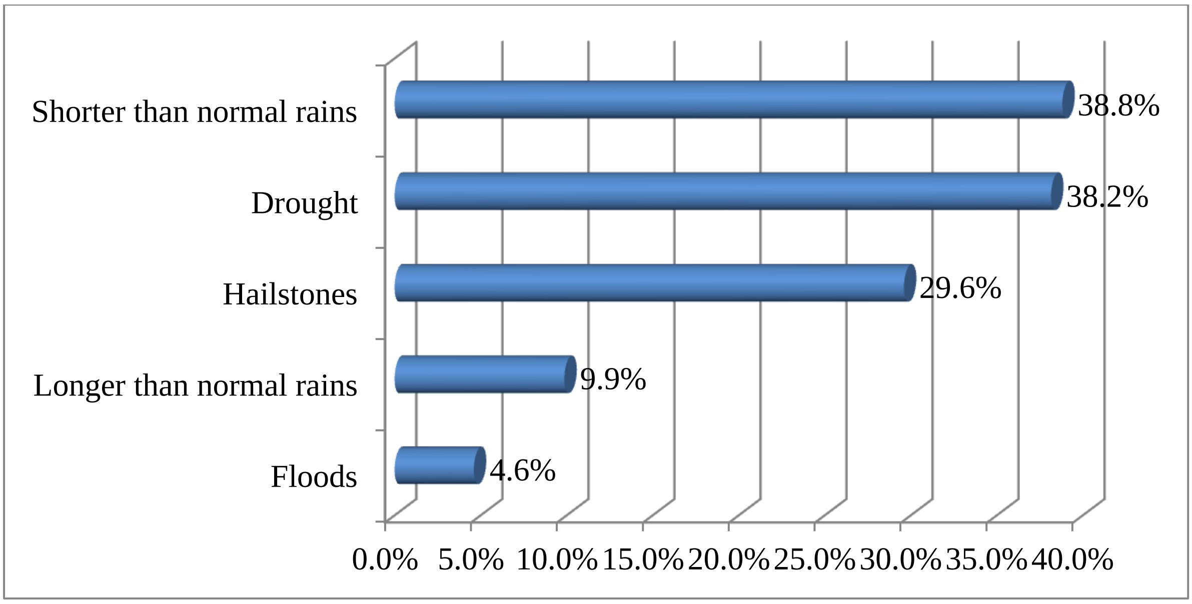

Figure 4.7: Most recent extreme events that have taken place in the past ten years (2003 – 2013)

Source (Field Data, 2014)

With regard to unusual rainfall events that had occurred in the study area, the most recent extreme event associated with rainfall variability in the last ten years identified was shorter than normal rains as cited by 38.8% of the total respondents. This was closely followed by drought and hailstones as cited by 38.2% and 29.6% of the respondents respectively. Some respondents however cited the occurrence of longer than normal rains (9.9%) as well as floods (4.6%). Kisii Central Sub County's topography is mainly highland and this is possibly the reason why floods rank lowly.

A study by Thorlakson (2011) in western Kenya also found that most farmers interviewed had noticed changes in the normal rainfall patterns beginning early 1990's. The farmers said they had noticed that rainfall variability had increased substantially, that is, rainfall fail to come more frequently or come suddenly at abnormal times of the year. This study is also consistent with findings on farmers' perception of climate change in Sub Saharan Africa that rainfall patterns have changed (Gbetibouo, 2009). Households perception that drought has been increasing in frequency over the last ten years are also consistent with other research

(Sheffield & Wood, 2008; Gamble, Campbell, Allen, Barker, Curtis, McGregor & Popke, 2010).

The drought as defined by households during FGDs includes a wide range of events than those defined meteorological data alone. These findings are therefore consistent with Sledgers & Stroosnijder (2008) that drought should not be defined only as a physical event. This is because even land degradation process can cause drought like conditions to occur and thus reduce the efficiency of the rains received. Generally there are mixed findings among studies comparing farmer or household perception to meteorological trends such as rainfall variability. However, most studies agree that farmers overemphasize the recent changes in the last ten or so years when discussing observations in the long term climatic trends (Thorlakson, 2011) and this could be the case in Kisii Central Sub County.

4.4 Relationship between households' characteristics and perception of effects of rainfall variability on farming practices in Kisii Central Sub County

The second objective of this study sought to assess the relationship between households' characteristics and perception of impact of rainfall variability on farming practices among the households in Kisii Central Sub County. Table 4.8 shows the household head's perception on effects of rainfall variability.

Table 4.8: Effects of Rainfall Variability

	Yes		No		Totals	
Effects of Rainfall Variability	**Freq.**	**Percent**	**Freq.**	**Percent**	**Freq.**	**Percent**
Increased crop yields	6	5.1%	112	94.9%	118	100.0%
Reduced crop yields	79	66.9%	39	33.1%	118	100.0%
Reduced water availability	50	42.4%	68	57.6%	118	100.0%
Increased weed attacks (infestations)	18	15.3%	100	84.7%	118	100.0%
Delays in planting and harvesting	93	78.8%	25	21.2%	118	100.0%
Increased crop disease and pests	21	17.8%	97	82.2%	118	100.0%
Emergence of livestock diseases	34	28.8%	84	71.2%	118	100.0%
Emergence and re-emergence of human diseases	24	20.3%	94	79.7%	118	100.0%

Source (Field Data, 2014)

Delays in planting and harvesting and ultimately reduced crop yields seem to be the greatest fear to the households as represented by 78.8% and 66.9% of the households, respectively. This is in line with Moyo *et al*, (2012) whose study also revealed that the perceived climate changes led to changes in agricultural productivity, mostly a decline in crop production. These results too, agrees with Jokastah *et al*, (2013) who noted that most smallholder farmers in semi-arid and the Sub-humid regions of Kenya had witnessed a reduction of crop production attributed to either low rainfall or erratic rainfall patterns coupled with other factors such as hailstones, floods and longer than normal rainfall. Households were asked to rate the severity of the effects of rainfall variability in the study area as they had experienced the issue in the past ten years. About 42.4%, 28.8% and 20.3% of the households reported to have been affected by reduced water availability, emergency of livestock diseases and emergency/re-emergence of human diseases, respectively. Some of the effects that are less serious in the study area as reflected by the households' heads perception include increased crop diseases/pests, increased weed attacks (such as black jack, Mexican marigold, oxalis/sorrel, double thorn, thorn apple, couch grass, nut grass, wandering Jew, sow thistle, devil's horsewhip, MacDonald's eye/gallant soldier and Sodom apple) and increased crop yields.

The effects of this changes in rainfall amounts and patterns identified by the FGDs include; reduced crop yields, reduced milk production, low quality produce, increased pest infestation, increased disease attacks on livestock and crops, reduced incomes, shortage of livestock pasture and water, increased weeds, increased cost of production (due chemicals and weeding expenses) and soil erosion. The FGDs associated the decline in food production to climate variability especially delayed rains and occasional dry spells. The dry spells of January and February were of major concern as their duration has increased and this coincides with the planting season of maize and beans and *wimbi* (millet). Maize happens to be the staple food in the study area, besides other foods such as bananas and *wimbi*. However they also noted that the decrease in yields would also be due to other non-climatic related factors such as declining soil fertility (due to continuous cropping), pests and diseases such as the maize lethal necrosis disease currently affecting maize plants in the study area, over fragmentation of land, inadequate extension services and poverty which restrains many households' ability to purchase farm inputs.

This study was also concerned about the variations on households' perceptions on effects of rainfall variability along their background characteristics (gender, age and educational level). The cross-tabulation in table 4.9, 4.10 and 4.11 shows these results.

Table 4.9 shows the relationship between household heads' perception on the effects of rainfall variability and gender.

Table 4.9: Relationship between perception on the effects of rainfall variability and household heads' gender

Perceived Effects of Rainfall Variability	Male	Female	Total	χ^2	Df	P-value
Increased crop yields	39	79	118	1.416	1	.234
Reduced crop yields	67	51	118	.003	1	.955
Reduced water availability	50	68	118	7.723	1	.005
Increased weed attack	66	52	118	.013	1	.909
Delays in planting and harvesting	71	47	118	2.111	1	.146
Increased crop disease and pests	28	90	118	11.316	1	.001
Emergence of livestock diseases	66	52	118	.016	1	.900
Emergence and re-emergence of human diseases	30	89	118	12.399	1	.000

Source (Field Data, 2014)

The results shows a statistically significant difference between male and female household heads' perception on reduced water availability, increased crop disease/pests and emergence/re-emergence of human diseases as represented by chi-square values of 7.723, 11.316 and 12.399, respectively at 5% level and 1 degree of freedom. The results shows more females perceived rainfall variability as having effect on reduced water availability, increased crop disease/pests and emergence/re-emergence of human diseases as compared to their male counterparts. Specifically, about 58.0%, 76.2% and 75.0% of females considered rainfall variability as being responsible for reduced water availability, increased crop disease/pests and emergence/re-emergence of human diseases as compared to 42.0%, 23.8% and 25.0% male heads that were of the same opinion, respectively. This is particularly the case because women and girls are often the primary collectors, users and managers of water than males.

The results shows no significant gender difference in the perception of effects of rainfall variability on increased/reduced crop yields, increased weed attack, delays in planting and harvesting and emergence of livestock diseases. This implies that there may be a significant difference in the types of crops that different gender mainly concentrates with. Women are more likely to be involved in the production of food crops while men are more likely to be involved in the production of cash crops (FAO, 2010). Involvement by particular gender on certain farming activities is likely to affect their perception of effects of rainfall variability.

Table 4.10 shows the relationship between perception on the effects of rainfall variability and household head age.

Table 4.10: Relationship between perception of the effects of rainfall variability and household head age

	Age of the household head in years							
Perceived Effects	**18 - 30**	**31 - 40**	**41 - 50**	**51 - 60**	**>60**	χ^2	**df**	**P-value**
Increased crop yields	20	59	0	39	0	20	4	.571
Reduced crop yields	18	54	28	12	6	18	4	.028
Reduced water availability	21	59	9	24	5	21	4	.131
Increased weed attack	13	39	13	26	26	13	4	.000
Delays in planting and harvesting	15	56	23	19	5	15	4	.346
Increased crop disease and pests	6	67	28	17	0	6	4	.469
Emergence of livestock diseases	0	62	17	24	14	0	4	.001
Emergence and re-emergence of human diseases	0	93	25	0	0	0	4	.004

Source (Field Data, 2014)

The results indicated in Table 4.10 shows a significant relationship (P<0.05) between the perception on the effect of reduced crop yield and households' heads age with most households in the age of 31-40 years citing to have reduced yields as represented by 45.6%. There were fewer households in the age above 50 years who cited the effect of reduced crop yields. In the same way, there was a significant relationship between household perception on increased weed attack and households' heads age at 5% level. Majority of the farmers with the perception that rainfall variability contribute to increased weed attack were aged between 31-40 years as represented by 33.3% of the total respondents. This was closely followed by households aged between 51-60 years and 60 years and above each with 22.2% of households who held a perception that rainfall variability could be blamed for the increased cases of weed attacks. This study noted that majority of households with perception that the emergence of livestock diseases as well as emergence and re-emergence of human diseases has been contributed by rainfall variability were aged between 31-40 years as represented by 52.9% and 79.2% of the respondents, respectively. Table 4.11 shows the relationship between perception on the effects of rainfall variability and household head level of education.

Table 4.11: Relationship between perception on the effects of rainfall variability and household head level of education

	Level of education of the household head						
Perceived Effects	**No formal Education**	**Primary**	**Secondary**	**College**	**χ^2**	**df**	**P-value**
Reduced crop yields	0	0	98	20	18.622	3	.000
Increased crop yields crop yields	4	9	15	90	21.543	3	.000
Reduced water availability	0	12	35	71	11.646	3	.009
Increased weed attack	0	33	59	26	20.426	3	.000
Delays in planting and harvesting	4	11	23	80	13.865	3	.003
Increased crop disease and pests	17	17	17	67	14.252	3	.003
Emergence of livestock diseases	10	0	24	83	15.683	3	.001
Emergence and re-emergence of human diseases	0	25	10	84	2.952	3	.399

Source (Field Data, 2014)

Majority of the households who had a perception that rainfall variability has decreased crop yields and increased weed attack had secondary level of education as represented by 83.3% and 50.0% of the respondents, respectively. Most of the households who perceived that rainfall variability had resulted to reduced crop yields (75.9%), reduced water availability (60.0%), delays in planting and harvesting (67.7%), increased crop disease and pests (57.1%) and emergence of livestock diseases (70.6%) had college level of education (70.8%).

Table 4.12 summarizes the severity of drought, flooding, disease epidemic, water resource decrease, feed shortage, soil erosion and pest attack as perceived by respondents in the study area.

Table 4.12: Severity of the effect of rainfall variability in the area

Effects	Not affected	Low	Moderate	High	Very high	Total
Drought	12 (10.2%)	29 (24.6%)	59 (50.0%)	13 (11.0%)	5 (4.2%)	118 (100.0%)
Flooding	70 (59.3%)	23 (19.5%)	22 (18.6%)	3 (2.5%)	0 (0.0%)	118 (100.0%)
Disease epidemic	9 (7.6%)	48 (40.7%)	48 (40.7%)	10 (8.5%)	3 (2.5%)	118 (100.0%)
Water resource decrease	0 (0.0%)	29 (24.6%)	56 (47.5%)	22 (18.6%)	11 (9.3%)	118 (100.0%)
Feed shortage	9 (7.6%)	10 (8.5%)	45 (38.1%)	37 (31.4%)	17 (14.4%)	118 (100.0%)
Soil erosion	4 (3.4%)	52 (44.1%)	44 (37.3%)	18 (15.3%)	0 (0.0%)	118 (100.0%)
Pest attack	2 (1.7%)	29 (24.6%)	71 (60.2%)	14 (11.9%)	2 (1.7%)	118 (100.0%)

Source (Field Data, 2014)

Table 4.13: Ranking of the perceived effects

Effect of rainfall variability	Mean	Std. Deviation	Rank
Feed shortage	3.364	1.075	1st
Water resource decrease	3.127	0.892	2nd
Pest attack	2.873	0.699	3rd
Drought	2.746	0.935	4th
Soil erosion	2.672	0.755	5th
Disease epidemic	2.603	0.833	6th
Flooding	1.661	0.877	7th

Source (Field Data, 2014)

Feed shortage was noted to be the most severe effect on the farming practices in the study area as a result of rainfall variability (mean = 3.364 with a standard deviation of 1.075). This was closely followed by water resource decrease (mean = 3.127 with a standard deviation of 0.892). Some of the other severe effects of rainfall variability in the area were cited as pest attack (2.873), drought (2.746), soil erosion (2.672), disease epidemic (2.603) and flooding (1.661). These findings are consistent with Ng'eno & Bebe (2013) who in their study of perception of climate variability and change impact on dairy production in Nandi and Rongai Sub counties noted that drought, feed shortage, water resource and disease epidemic ranked highly. From households' point of view, drought is the cause of feed shortage. According to Thornton *et al,* (2006), climate change and variability is associated with changes in herbage growth, quality and dry matter yield which is in agreement with the findings of this study. Changes in rainfall and temperature regimes are also key parameters which modulate the emergence of various animal diseases and vectors often leading to reduced animal productivity (Baker & Viglizzo, 1998).

The FGDs too confirmed that dry spells cause shortage of pasture for livestock leading to reduced milk production, emaciated livestock thus fetching low market values. Increased pests and disease attack especially during heavy than normal rains and dry spells were also reported. The informants acknowledged the link between climate variability and the increased incidences of crop and livestock pests and diseases. However in the discussions, it was importantly noted that other than rainfall variability, crop and livestock production in the study area was greatly hampered by over fragmentation of land, decline in soil fertility caused by continuous cropping, soil erosion, and traditional livestock production systems.

These results are consistent with Bryan, Ringler, Okoba, Koo, Roncoli, Herrero & Silvestri (2011) who noted that households from 13 divisions within 7 districts (Garissa, Mbeere South, Gem, Njoro, Mukurwe-ini, Othaya and Siaya) in Kenya also identified feed shortage, drought, flood, erratic rainfall and hailstorms as the main climate-related shocks that affected their farming practices. The understanding of how farmers perceive climate risk is valuable to other stakeholders such as extension service, providers and climate information providers as it can assist in tailor-making their services to suit the farmers' needs and support them to better cope and adapt with climate variability (Moyo *et al*, 2012). Osbar *et al*, (2011) too indicates that seeking to understand the household perception of climate variability is important as it determines the process of how to provide relevant meteorological services.

4.5 Adaptation strategies and the relationship between the strategies and household characteristics

The third objective of this study sought to identify the farming practices/ adaptations adopted by households in Kisii Central Sub County to enhance resilience under the perceived rainfall variability. Under rain-fed agricultural systems, the seasonal rainfall variability means that farmers adopt a range of risk averse coping and livelihood strategies and this is evidenced by the highly variable production levels within different individual farmers' fields and among the farmers (Cooper, Dimes, Rao, Shapiro, Shiferaw & Twomlow, 2006).

In order to meet this objective, respondents were requested to state the different measures or innovations that they practiced in their farm to cope with changes in rainfall amounts. The households were asked to indicate whether they had adapted using any of the following methods: (i) cropping diversification (growing different varieties) (ii) early planting/ planting at onset of rains (iii) agro forestry (iv) rain water harvesting (v) use of modern technology e.g. greenhouses (vi) mixed farming (vii) using certified seed/hybrid (viii) destocking (adjusting the number and livestock management strategies) (ix) changing of animal breeds (x) livelihood diversification to nonfarm activities (switching from farming to non-farming activities) (xi) increased use of irrigation (xii) use of chemicals, pesticides or fertilizers (xiii) irrigation (xiv) use of shading/sheltering/tree planting/ mulching (xv) others. The main coping responses in relation to drought, flood, erratic rain, and hailstones are shown in Figure 4.8.

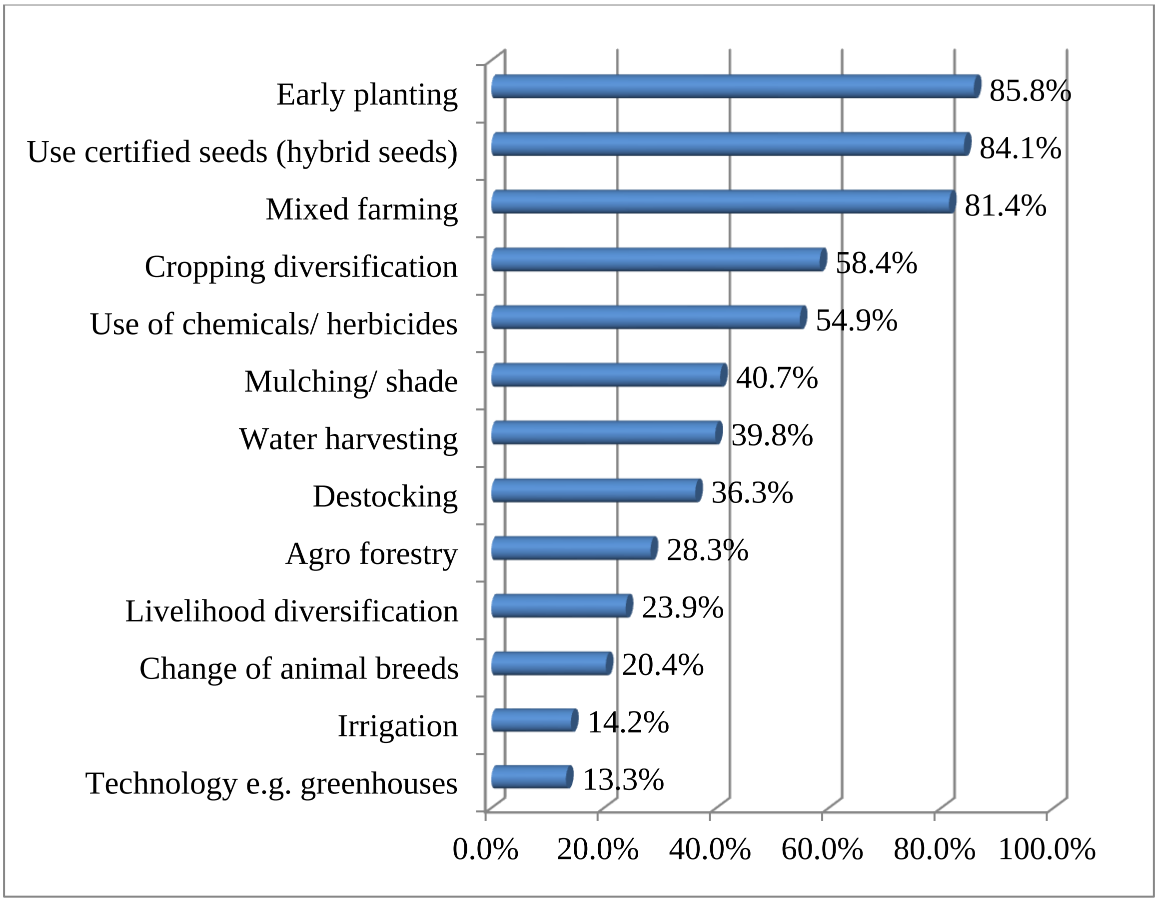

Figure 4.8: Adaptation strategies to rainfall variability

Source (Field Data, 2014)

The results in Figure 4.8 shows that the most key on-farm measure or innovation practiced as a response to rainfall variability is planting with early rains as consented by 85.8% of the total respondents. This was closely followed by use of certified seeds (hybrid seeds) (84.1%) and mixed farming (81.4%). This suggests that access to markets and possession of enough incomes are important for households facing climate shocks. This thus supports Bancy (2000), who reported that in order to counter the adverse effects of climate variability in maize production, it might be necessary to practice early planting and use hybrid seeds especially those early maturing ones. On the contrary Anderson and Hazzel (1990) argued that adoption of common high yielding varieties, uniform planting practices and common timing of field operations cause the yields of more crops to be more strongly influenced by weather patterns especially in developing countries and thus put farmers at even a greater risk.

Some of the other key coping strategies adopted by farmers were crop diversification (growing of more than one type of cash crop or food crop) and use of chemicals and herbicides as represented by 58.4% and 54.9% of the total respondents. Some farmers were further noted to use mulching/shade (40.7%), water harvesting (39.8%), destocking (36.3%), agro forestry (28.3%) and diversification into non-farm activities (23.9%) as coping mechanism to rainfall variability in the area. Some of the least popular on-farm measures or innovations practiced as a response to rainfall variability were change of animal breeds (20.4%), irrigation (14.2%) and adoption of technology such as greenhouses (13.3%). These findings are in agreement with Kabubo-Mariara & Karanja (2007), who found out that the adaptation strategies in Kenya mainly consisted of crop diversification, mixed cropping patterns and tree planting for providing fodder and shade/shelter for crops, water conservation measures and irrigation. Bryan *et al*, (2011) confirms that adaptation to climate change includes many possible responses, such as changes in crop management practices (e.g., choice of fields, planting dates, planting densities, crop varieties, etc.), livestock management practices (e.g., feeding and animal health practices, transhumance timing and destinations, etc.), land use and land management (e.g., fallowing, tree planting or protection, irrigation and water harvesting, soil and water conservation measures, tillage practices, soil fertility management, etc.), livelihood strategies (e.g., mix of crops or livestock produced, combination of agricultural and nonfarm activities, temporary or permanent migration, etc.). Hoang *et al*, (2014) argue that maintaining a variety of strategies is an important tool in allowing farming to survive in climate variations. This is because some of these approaches have been used for thousands of years to minimize risk and ensure at least some productivity during unfavorable years.

On the other hand strategies like irrigation and adoption of technology such as greenhouses have ranked lowly, 14.2% and 13.3% respectively. This may be attributed to the expensiveness associated with these strategies. Irrigation is generally considered a costly investment that cannot be implemented by individual farm households alone (Bryan *et al*, 2011). Bryan *et al*, (2011) further notes that irrigation requires both government and private sector support. The huge cost of erecting a greenhouse is also beyond most households reach and possibly most households lack information since this technology is relatively new in the study area. On the other hand Cooper *et al*, (2006) notes that most of the adaptation strategies have been of great importance and have evolved over many generations in the drier and more risk prone areas than many wetter areas and that farm households make subjective assessment of risks and vulnerability and make certain adjustments in their choice of technologies, and production and consumption decisions. Jayne, Yamano, Weber, Tschirley, Benfica, Chapato & Zulu (2003) equally found out that whilst most strategies have been of great importance and have evolved over many generations in the drier and more risk prone environments, they have perhaps only recently become of importance in many of the wetter and more assured environments. This perhaps is the reason why they are not ranking high in Kisii Central Sub County.

The relationship between various response strategies that have been implemented as a result of rainfall variability and characteristics of the heads of households is shown in Table 4.14, 4.15 and 4.16.

In particular, the differences between households' adoption of various adaptation strategies due to rainfall variability across the gender of the household heads is indicated in Table 4.14.

Table 4.14: Relationship between households' adaptation strategies due to rainfall variability and gender of the household heads

Response Strategies	Male	Female	$\chi 2$	P-value
Mixed farming	73	45	3.984	0.046
Crop diversification	68	50	0.000	0.989
Irrigation	66	52	0.012	0.912
Planting with early rains	69	49	0.432	0.511
Agro forestry	70	48	0.063	0.802
Mulching/ shade	46	72	10.74	0.001
Water harvesting	60	58	1.258	0.262
Technology e.g. greenhouses	102	16	6.013	0.014
Destocking	72	46	0.314	0.575
Change of animal breeds	67	51	0.012	0.913
Diversification into non-farm activities	70	48	0.044	0.834
Use certified seeds (hybrid seeds)	66	52	0.733	0.392
Use of chemicals/ herbicides	69	49	0.017	0.898

Source (Field Data, 2014)

There exist statistically significant relationship between the mixed farming, mulching/shade and technology adoption (e.g. greenhouses) response strategies with gender at 5% level (P-value of 0.046, 0.001 and 0.014 are <0.05). More males practice mixed farming (62.0%) and adopt modern technology that is geared towards provision of resilience against rainfall variability e.g. greenhouses (86.7%). On the contrary, the mulching/shading response strategy is more popular with females (60.9%) as compared to their male counterparts. This may be because women get involved in agricultural activities more than men (Odame, Hafkin, Wesseler & Boto, 2002). In farming, women participate in numerous agricultural tasks including mainly cleaning the field during land preparation, transporting inputs to the field, weeding, harvesting, transporting, threshing and storage of the production. Due to cost, time and labour required to diversify and adopt technology, it is perhaps more difficult for female headed households to diversify. Female headed households may be slow to respond due to challenges posed by customary household duties, financial constraints, social norms and constraints in acquisition of knowledge and skills (Asfaw & Admassie, 2004; Tenge & Hella, 2004). The difference between male and female farmers in the adoption of irrigation, planting with early rains, agro forestry, water harvesting, destocking, change of animal breeds, diversification into non-farm activities, use of certified seeds (hybrid seeds) and use of chemicals/ herbicides response strategies does not differ significantly at 5% level. These observations can perhaps be explained by Alumila, (2002) who confirms that there exists a broad range of contrasting diversification strategies employed between different types of households headed by either males or females. This is because there is region to region, village to village and household to household variation in the copying strategies that have evolved.

As far as the study area was concerned with respect to households' response strategies resulting from rainfall variability, this study noted that some strategies were associated with households whose heads were in certain age brackets as compared to others as shown in Table 4.15.

Table 4.15: Relationship between adaptation strategies and age of the household head

	Age of the household head						
Response Strategies	**18-30**	**31-40**	**41–50**	**51-60**	**>60yrs**	**χ2**	**P-value**
Mixed farming	21	59	21	15	3	4.868	0.301
Crop diversification	21	54	29	7	7	17.412	0.002
Irrigation	22	66	15	15	0	1.259	0.868
Planting with early rains	17	60	18	21	2	9.215	0.056
Agro forestry	11	41	33	26	7	8.786	0.067
Mulching/ shade	26	41	23	18	10	10.896	0.028
Water harvesting	26	58	11	18	5	4.839	0.304
Technology e.g. greenhouses	16	102	0	0	0	11.325	0.023
Destocking	6	66	12	23	12	15.447	0.004
Change of animal breeds	0	67	10	21	21	21.855	0.000
Diversification into non-farm activities	9	74	35	0	0	13.164	0.011
Use certified seeds (hybrid seeds)	11	66	21	15	5	25.288	0.000
Use of chemicals/ herbicides	6	63	32	13	4	21.706	0.000

Source (Field Data, 2014)

Table 4.14 shows that some of the response strategies that have significant relationship with households' head age at 5% level include crop diversification, mulching/shade, modern technology such as green houses, destocking, change of animal breeds, diversification into non-farm activities, use of certified seeds (hybrid seeds) and use of herbicides. Specifically, most of the farmers practicing crop diversification (growing of more than one type of food/cash crop), mulching/shading of crops and modern technology such as green houses were aged between 31-40 years as represented by 45.5%, 34.8%, 86.7%, 56.1%, 56.5%, 63.0%, 55.8% and 53.2% of the total respondents, respectively. The older the farmer, the more experienced he/she is in farming and the more exposure he/she has had to the past and present climatic conditions over longer periods of time. Mature farmers are able to access the characteristics of modern technology than younger farmers who might be concerned with quick profits rather than long term sustainability of their operations. Deressa *et al*, (2008) too found that age of a household represents experience in farming. Highly experienced households tend to have more knowledge of changes in climatic conditions and the relevant measures to be applied. However Gbetibouo (2009) and Adesina & Forson (1995) observe the contrary, that there is no consensus in the literature as to the exact effect of age in the adoption of farming technologies because the age effect is generally location or technology specific and hence, an empirical question.

Some response strategies practiced in the study area are however not particularly associated with household characteristics, in reference to households' heads age brackets. There is no statistically significant relationship (at 5% level) between practices such as mixed farming, irrigation, planting with early rains, agro forestry and water harvesting and households' heads age in the study area.

The practice of irrigation and use of chemicals/ herbicides were the two response strategies that were observed to have statistically significant relationship with the household level of education at 5% level as shown in Table 4.16.

Specifically, the irrigation practice was most associated with household heads with secondary (43.8%) and tertiary (56.3%) level of education while use of chemicals/ herbicides was mainly associated with household heads with tertiary level of education as represented by 72.6% of the respondents.

Majority of the response strategies (mixed farming, crop diversification, planting with early rains, agro forestry, mulching, water harvesting, technologies e.g. greenhouses, destocking, change of animal breeds, diversification into non-farm activities and use certified seeds) have no significant relationship with the household heads level of education at 5% level.

Table 4.16: Relationship between response strategies and level of education of the household head

	Age of the household head						
Response Strategies	**18-30**	**31-40**	**41–50**	**51-60**	**>60yrs**	**χ2**	**P-value**
Mixed farming	21	59	21	15	3	4.868	0.301
Crop diversification	21	54	29	7	7	17.412	0.002
Irrigation	22	66	15	15	0	1.259	0.868
Planting with early rains	17	60	18	21	2	9.215	0.056
Agro forestry	11	41	33	26	7	8.786	0.067
Mulching/ shade	26	41	23	18	10	10.896	0.028
Water harvesting	26	58	11	18	5	4.839	0.304
Technology e.g. greenhouses	16	102	0	0	0	11.325	0.023
Destocking	6	66	12	23	12	15.447	0.004
Change of animal breeds	0	67	10	21	21	21.855	0.000
Diversification into non-farm activities	9	74	35	0	0	13.164	0.011
Use certified seeds (hybrid seeds)	11	66	21	15	5	25.288	0.000
Use of chemicals/ herbicides	6	63	32	13	4	21.706	0.000

Source (Field Data, 2014)

Igoden *et al.,* (1990) and Lin (1991) observe a positive relationship between the education level of the household head and the adoption level of improved technologies and climate change adaptation. As such, farmers with higher levels of education are more likely to perceive climate change and adapt better. Related studies by Maddison (2006) and Nhemachena & Hassan (2007) indicate that farming experience, just like farmers' education level, increases the probability of uptake of adaptation measures to climate change.

Households were further asked about the types of livestock strategies used to deal with rainfall variability shocks. The main adaptation strategies in relation to livestock rearing in the study area are shown in Figure 4.7. Given that the main result of the rainfall variability shocks was a decline in livestock yield (or in some cases a loss of the entire livestock herd) it is not surprising that the main response in regard to livestock practices is mixed farming which is a two way reliance with both crop farming and livestock keeping. This is as indicated by 44.5% of the total respondents. The practice of zero grazing animal husbandry and poultry keeping was cited by about 21.9% and 20.3% of the households respectively. It can be noted that few farmers indicated to be involved in dairy goat keeping (7.0%) or to have destocked their herds (6.3%) as a coping mechanism to rainfall variability. This is as depicted in Figure 4.7:

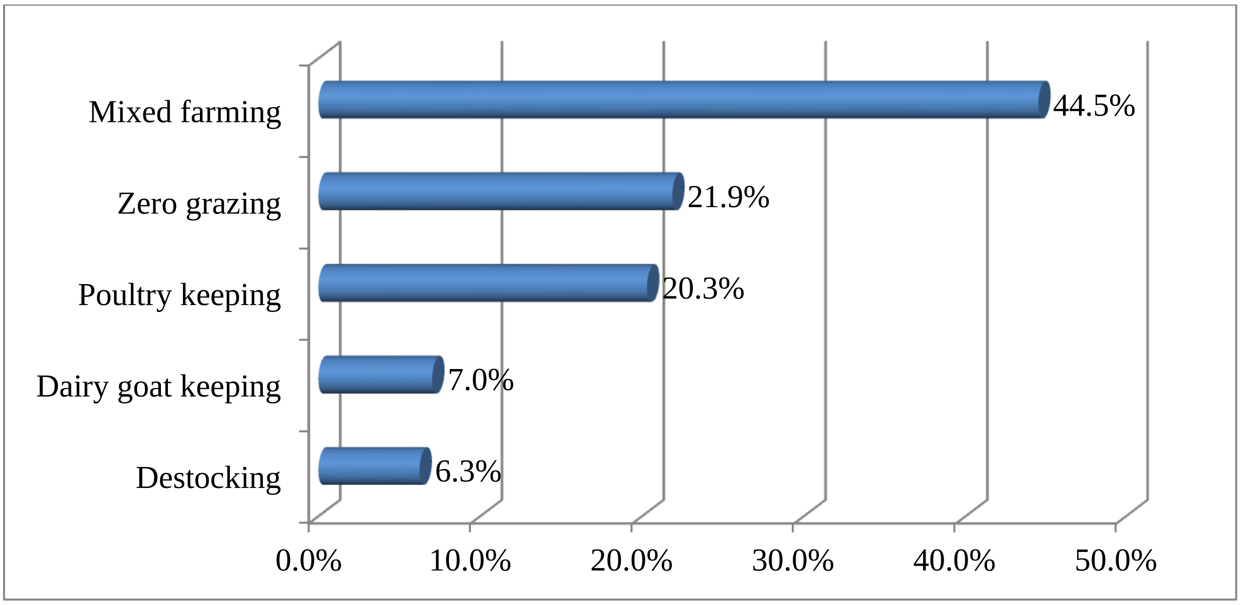

Figure 4.9: Types of livestock adaptation strategies used to deal with rainfall variability

Source (Field Data, 2014)

On the issue of the type of livestock kept, the households were asked to state whether the livestock they rear is influenced by rainfall variability. The results are as shown in Table 4.17:

Table 4.17: Whether rainfall variability influence the choice of livestock reared

Response	Frequency	Percent
Yes	50	42.4
No	50	42.4
Unsure	18	15.3
Total	**118**	**100.0**

Source (Field Data, 2014)

The results in table 4.17 shows that equal proportions of respondents (42.4%) indicated that the choice of livestock that they reared was influenced by rainfall variability just like those who refuted the idea. However, about 15.3% of the respondents were not sure whether their choice of livestock reared was influenced by rainfall variability.

This study noted that the most popular livestock kept in the study area was cattle (40.3%) and poultry (39.5%). This is as shown in Figure 4.8.

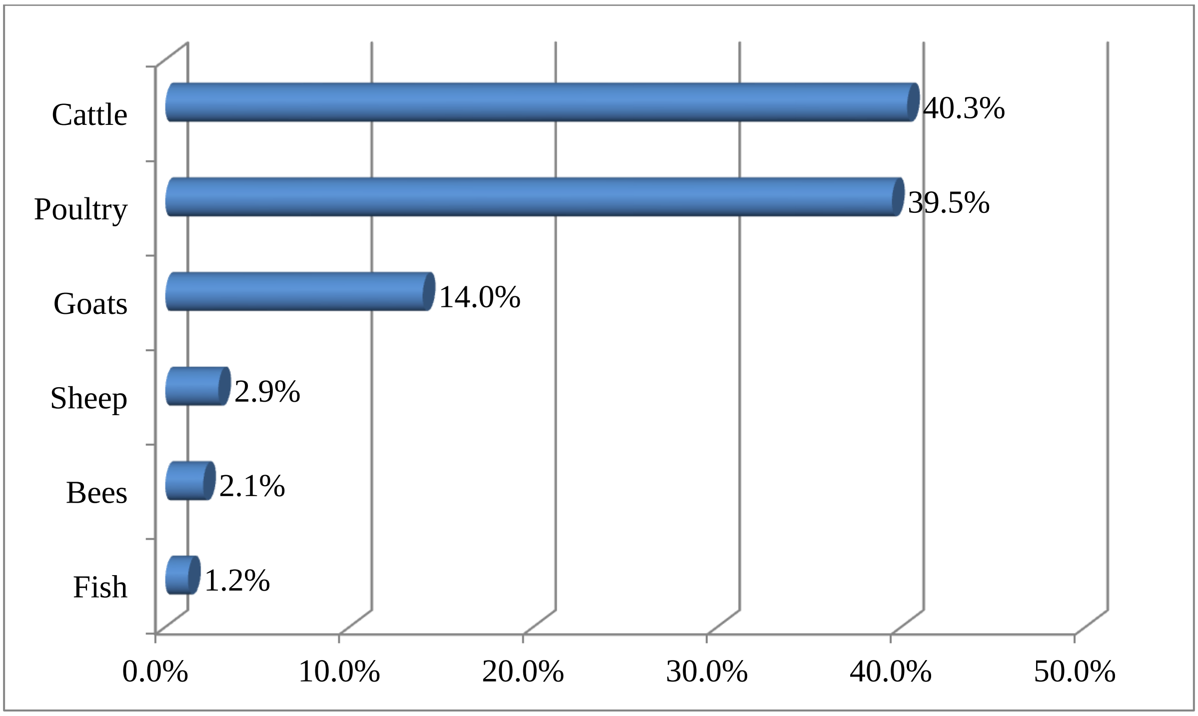

Figure 4.10: Type of animals kept as a result of rainfall variability change in the area

Source (Field Data, 2014)

About 14.0% of the respondents indicated to be rearing goats while 2.9%, 2.1% and 1.2% were keeping sheep, bees and fish respectively.

This study agrees with Gordon *et al*, (2010), who noted that farmers in regions that are prone to rainfall variability opt to diversify their livestock enterprises to include a mix of animals that are resistant to disease epidemics and death to livestock. Livestock keeping is less prone to climate variability as compared to crop farming.

As far as the choices of crops were concerned, majority of the respondents indicated that rainfall variability influenced the choice of crops grown in the study area. This is as indicated in Table 4.18.

Table 4.18: Whether the crops grown are influenced by the changes in rainfall amounts and distribution

Response	Frequency	Percent
Yes	96	81.4
No	9	7.6
Unsure	13	11.0
Total	**118**	**100.0**

Source (Field Data, 2014)

The results in Table 4.18 shows that majority of the respondents (81.4%) agreed that rainfall variability influenced the crops that they grew while about 11.0% of the respondent were not sure whether rainfall variability influenced the crops that they grew. However, about 7.6% of the respondents disagreed with the issue. The FGD discussions revealed that in the study area, several varieties of traditional crops (orphaned crops) such as *wimbi*, sweet potatoes, sorghum among others have been embraced due to their resistance against disease and insect attacks as well as tolerant to moisture stress. It was also noted that progressively, cultivars suited to the agro ecological zones in Kisii Central Sub County and in breeding for high yielding bananas has also been developed by KALRO and are available to farmers.

Studies have found out that the risk of plant diseases, pests and weed damage to agricultural crops has increased significantly with occurrence of new diseases, pests and weeds associated with direct consequence of climate changes (Jevtić, Lalić, Mihailović, Eitzinge, Alexandrov, Ventrella, Trnka, Anastasiou, Medany, Olejnik & Nikolaev, 2009).

This study sought to understand the relationship between household heads characteristics and the livestock practices adopted against rainfall variability. The results are shown in Table 4.19.

Table 4.19: Relationship between livestock practices and gender of the household head

	Gender of the household head		
Measures practiced	**Male**	**Female**	**Total**
Mixed farming	59.6%	40.4%	100.0%
Poultry keeping	50.0%	50.0%	100.0%
Destocking	100.0%	0.0%	100.0%
Zero grazing	50.0%	50.0%	100.0%
Dairy goat keeping	100.0%	0.0%	100.0%
Total	**59.4%**	**40.6%**	**100.0%**

Pearson's Chi-square value = 21.735, Degrees of freedom = 4, P-value = 0.000

Source (Field Data, 2014)

The results of chi-square analysis of the relationship between household head sex and the livestock farming practices adopted in response to rainfall variability shows a statistically significant relationship (chi-square value of 21.735 at 4 degrees of freedom). Specifically, mixed farming was more famous among male headed households (59.6%). Similarly, destocking and keeping of dairy goats was most popular among male headed households as represented by 100.0% of the respondents involved in the practice. Poultry keeping and zero grazing was equally popular among both male and female headed households. Destocking perhaps ranks highly in male headed households because the decision to sell or reduce stock numbers is mainly made by males in the African society. Women's' voices are often muted in family and community decision making (Quisumbing, 2003) and in addition, women are also mainly involved in managing home garden crops, poultry raising, feeding, watering and cleaning of livestock and milking (Teklewold, 2013).

The results of chi-square analysis for the relationship between household head age and farming practices adopted in response to rainfall variability shows a statistically significant relationship (chi-square value of 47.441 at 16 degrees of freedom). This is shown in Table 4.20.

Table 4.20: Relationship between livestock practices and age of the household head

	Age of the household head					
Measures practiced	**18 - 30**	**31 – 40**	**41 - 50**	**51 - 60**	**> 60 yrs**	**Total**
Mixed farming	25	52	23	15	4	118
Poultry keeping	59	0	0	59	0	118
Destocking	0	0	0	0	118	118
Zero grazing	0	59	0	59	0	118
Dairy goat keeping	0	118	0	0	0	118
Total	**24**	**48**	**19**	**21**	**7**	**118**

Pearson's Chi-square value = 47.441, Degrees of freedom = 16, P-value = 0.000

Source (Field Data, 2014)

Specifically, mixed farming was more popular among households with heads aged between 31-40 years (43.9%). Poultry keeping was more practiced among households with heads aged between 18-30 years and 51-60 years as represented by 50% of the households each. Destocking was most popular among households with heads aged above 60 years as represented by 100.0% of the respondents involved in the practice. Zero grazing was more practiced among households with heads aged 31-40 and 51-60 years as represented by 50% of the households each. All the dairy goat keeping households had their heads aged between 31-40 years. The FGDs confirmed that poultry and dairy goat keeping was gaining popularity among the youth in Kisii Central Sub County due to increased sensitization through mass media especially the vernacular radio stations; Egesa and Minto FM who host agricultural programs in their stations and other programs that exist in the region such 'one youth one hen campaign' targeting youth and women groups.

The results of chi-square analysis for the relationship between household head level of education and livestock farming practices adopted in response to rainfall variability shows a statistically significant relationship (chi-square value of 14.487 at 8 degrees of freedom). This is shown in Table 4.21.

Table 4.21: Relationship between livestock practices and education of the household head

	Level of education of the household head			
Measures practiced	**Primary level**	**Secondary level**	**College education**	**Total**
Mixed farming	10	23	85	118
Poultry keeping	0	0	118	118
Destocking	0	118	0	118
Zero grazing	0	59	59	118
Dairy goat keeping	0	118	0	118
Total	**8**	**27**	**82**	**118**

Pearson's Chi-square value = 14.487, Degrees of freedom = 8, P-value = 0.000

Source (Field Data, 2014)

Mixed farming and poultry keeping was more popular among households with heads having college education as the highest level achieved as represented by 71.9% and 100.0% of the households respectively. All destocking and dairy goat keeping was practiced by households with heads having secondary as the highest level of education attained. Zero grazing was equally practiced by households with heads having secondary and college as the highest level of education attained as represented by 50.0% each. This implies that higher level of education is crucial in livestock practices such as poultry keeping and zero grazing. This results are consistent Nalunkuuma (2013) that household heads that have more years of schooling are more likely to participate in zero grazing than those with lesser years and the fact that poultry farming requires high literacy standards and precision for correct administration of drugs, feeds, record keeping and taking of prompt management decisions (Adisa and Akinkunmi 2012).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study set out to assess the effects of rainfall variability on farming practices among households of Kisii Central Sub County, Kenya. The summary of findings, conclusions, implications and recommendations are presented in this chapter. Suggestions for further studies are also presented.

5.2 Summary

Based on the analysis of the research questions based on the study's objectives, the following findings were established:

As far as the characteristics of the respondents in this study was concerned, the results indicate that majority (56.8%) of the respondents were male. Most of the respondents had college education (63.6%), aged between 31 - 40 years (49.2%) and engaged in farming as the primary activity (49.2%). Majority of the households had lived in the study area for between 10 – 19 years as represented by 34.7% and were thus in a perfect position to understand the climatic issues in the area (rainfall variability).

Overwhelming majority of the respondents (94.1%) were in agreement that they perceived gross changes in rainfall patterns in the past ten years in the area as compared to 5.9% of the respondents who were of the contrary opinion. Changes in rainfall patterns in the past ten years were mainly noticed in form of raining late onset (22.0%), unpredictable/erratic rains (20.7%) and prolonged droughts (20.3%). Almost all the respondents (96.6%) had indeed experienced extreme weather events associated with rainfall in their past ten years stay in the study area. The most recent extreme events associated with rainfall variability in the last ten years were shorter than normal rains (38.8%) as well as drought and hailstones (38.2% and 29.6%, respectively).

Feed shortage was established to be the most severe effect perceived by households in the study area as a result of rainfall variability (mean = 3.364 with a standard deviation of 1.075). Other effects were water resource decrease, pest attack, drought, soil erosion, disease epidemic and flooding.

The most key adaptation practiced as a response to rainfall variability was planting with early rains as consented by 85.8% of the total respondents. Other measures were use of certified seeds (hybrid seeds) (84.1%) and mixed farming (81.4%). Some of the other key adaptation strategies adopted by farmers were crop diversification (growing of more than one type of cash crop or food crop in the same farm) and use of chemicals and herbicides as represented by 58.4% and 54.9% of the total respondents.

The study results shows more females perceived rainfall variability as having effect on reduced water availability, increased crop disease/pests and emergence/re-emergence of human diseases as compared to their male counterparts. The perception of reduced yields, increased weed attacks, emergence of livestock diseases as well as emergence and re-emergence of human diseases as a result of rainfall variability was most associated with farmers in the age of 31-40 years. Majority of the farmers who had a perception that rainfall variability has increased crop yields and increased weed attack had secondary level of education. Most of the farmers who argued that rainfall variability had resulted to reduced crop yields, reduced water availability, delays in planting and harvesting, increased crop disease and pests and emergence of livestock diseases had college level of education.

The main adaptation strategy in relation to livestock rearing in the study area involved the practice of mixed farming in which a two way reliance with both crop farming and livestock keeping was adopted. This is as indicated by 44.5% of the total respondents. The practice of zero grazing animal husbandry (21.9%) and poultry keeping (20.3%) were other major adaptation strategies cited. Most farmers also perceived changes in their livestock enterprises to be as a result of rainfall variability in the study area. The most popular livestock kept in the study area was cattle (40.3%) and poultry (39.5%). Majority of the respondents (81.4%) agreed that rainfall variability influenced the crops that they grew. Farmers in the study area had generally small parcels of land that was mainly used for both food crops and cash crops. The mean size of land that was under cash crop and food crop production was 1.168 and 1.204 acres respectively. The most common cash crops grown were tea (26.7%), coffee (18.2%) and sugarcane (16.6%) while the most popular food crops in the area were maize (31.5%) and beans (25.3%).

5.3 Conclusions

Gross changes in rainfall patterns have been noticed in the past ten years in the study area. Changes in rainfall patterns in the study area were mainly in form of late onset, unpredictable/erratic rains and prolonged droughts (dry spells). These incidences of climate change and variability present a number of socioeconomic and environmental challenges.

Feed shortage was noted to be the most severe effect on the farming practices as a result of rainfall variability since livestock farming was very important practice in the study area. Other effects were water resource decrease, pest attack, drought, soil erosion and disease epidemic. The understanding on how to deal with effects of rainfall variability to avoid hurting the household agricultural activities in the area is thus, key.

The most key on-farm adaptation to rainfall variability was planting with early rains, use of certified seeds (hybrid seeds) and mixed farming. Certified seeds have the ability of being bred to overcome some of the major climatic challenges that affect livestock and crop farming.

There existed a statistically significant relationship between the mixed farming, mulching/shade and technology adoption (e.g. greenhouses) adaptation strategies with gender. More male than female headed households practice mixed farming and adopt modern technology that is geared towards provision of resilience against rainfall variability e.g. greenhouses. On the contrary, the mulching/shading response strategy is more popular with females than male headed households. Most of the households practicing crop diversification (growing of more than one type of food/cash crop), mulching/shading of crops and modern technology such as green houses were middle aged (between 31-40 years). As far as households' heads education was concerned, this study noted that irrigation practice was most associated with household heads with secondary and tertiary level of education. Equally, the use of chemicals/ herbicides was also mainly associated with household heads with tertiary level of education.

The main adaptation in relation to livestock in the study area involved the practice of mixed farming, zero grazing animal husbandry and poultry keeping. There was a significant relationship between household heads characteristics and farming practices adopted as coping strategies for rainfall variability with respect to sex, age and level of education of the household heads. Specifically, mixed farming, destocking and keeping of dairy goats was more famous among male headed households. Mixed farming and dairy goat keeping was more popular among households with heads aged between 31-40 years. Poultry keeping was more practiced among households with young and old heads (between 18-30 years and 51-60 years). Destocking was most popular among households with heads aged above 60 years. As far as households' heads level of education was concerned, mixed farming and poultry keeping was more popular among households with heads having college education as the highest level attained. Destocking and dairy goat keeping was practiced by households with heads having secondary level of education.

5.4 Recommendations

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

The government (County and national) should realize the urgent need for measures that are geared towards reversing the negative impact of climate change and especially rainfall variability in the study area. The noted gross changes in rainfall patterns noticed in the past ten years have been proved to affect agricultural (crop and livestock) activities in the area and pose a big risk to future food security.

The County government should put in force, appropriate measures and policies that are aimed at reducing the farming problems in the study area that relate to feed shortage, water resource decrease, pest attack, drought, soil erosion and disease epidemic. These problems are widespread in nature and thus with ability to affect a cross-section of households in a negative way.

The government as well as development partners who have a stake in climate change and adaptations should endeavour to strengthen the adaptive capacity of vulnerable populations and of the agriculture sector as a whole in the study area. This requires a comprehensive assessment of the impacts of climate change and variability and the potential policy options that can facilitate adaptation. This can be done through an integrated approach that reinforces actions at both the County and national levels by helping households use their local knowledge in combination with introduced innovations to enhance local adaptations.

There is also need to support households through policies that help them get better access to hybrid seeds that are bred to match with the prevailing rainfall variability. This may be implemented through provision of subsidized planting seeds through the NCPB as well as strengthening the research organizations (KARLO (then KARI), KEFRI, ILRI, etc.) capacity to come up with appropriate planting seeds.

Climate change and variability issues should be mainstreamed into agricultural extension services. Extension officers should increase their contact with farmers by organising seminars for groups of farmers.

5.5 Areas of Further Research

The research presented in this study has examined the effect of rainfall variability on household farming practices in Kisii Central Sub County. However, more research needs to be done on the following areas:

i. A gendered analysis of the smallholder farmers' perception of the effects of rainfall variability on farming in the Kisii Central Sub – County.
ii. Evaluation of selected farming technologies and methods on smallholder farmers' adaptation to climate change in Kisii Central Sub – County.

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APPENDIX A: LETTER OF TRANSMITTAL.

Dear respondent.

<u>Ref: Request to Fill a Questionnaire.</u>

Please spare a few minutes of your busy schedule to respond to the items in this questionnaire. The purpose is to conduct research on ‘Effect of Rainfall Variability on Farming Practices and Adaptation among Households of Kisii Central Sub County, Kenya’. The findings of the study may provide valuable information for policy makers to allow them make right decisions on best livelihood options to adopt for particular regions. Once the study is over the results will be shared with you. Any sensitive information that you may reveal will be treated with utmost confidentiality and will not be divulged to a third party.

Yours faithfully,

Clifson Masese Otiso.

APPENDIX B: HOUSEHOLD QUESTIONNAIRE

The purpose of this study is to assess the effect of rainfall variability on farming practices and adaptation among households of Kisii Central Sub County, Kenya. You have been identified as a useful informant to assist us (Egerton University) to achieve this mission. Your participation is voluntary and you are assured that the information you provide will be treated with confidentiality and used for the sole purpose of research. Kindly respond to the queries below. If you need more writing space you can attach more paper.

Instructions

a. Please answer all the questions as fully as possible and to the best knowledge.
b. Tick the [_√__] appropriate box or indicate the letter that corresponds to the appropriate answer in space provided.

Respondent's Name (Optional)..

Ward...............................**Location**..................................**Village**..

Position in Household

[____]…………………………………………………………..

1=Household head 2=wife of house hold 3=daughter 4=son

5=other (specify)…………………………..

Q1. Please provide the following information about the **household head**

Sex 1=male 2=female	**Age** (yrs) 1= 18-30 2= 31-40 3= 41-50 4= 51-60 5= above 61	**Level of education** 1=No formal education 2=Primary level 3=Secondary level 4=College education 5=Others (specify)…….....................	**Years of stay in the area**	**Primary Activity** 1=Farmer 2=Businessman 3=Employed (specify)… …………………… 4=Others (specify)………………...
[____]	[____]	[____]	[____]	[____]

FARMING PRACTICES

Q2. a) Indicate the type of crop you cultivate in your farm

Production type	**Acreage**	**Principle crops grown in order of importance**			
		1^{st}	2^{nd}	3^{rd}	4^{th}
Cash Crops	[____] acres				
Food Crops	[____] acres				

b) Are the crops you cultivate in your farm influenced by the changes in rainfall amounts and distribution?

[____]…………………………………………………………..

1= Yes 2= No 3= Unsure

Q3. a) Indicate the livestock you rear in your farm (Choose all that apply)

……………………………………………………………………………………...

1= Cattle

2= Goats

3= Sheep

4= Poultry

5= Pigs

6= Fish

7= Bees

8= Others (specify)……………………………………………………………

b) Do rainfall variability influence the choice of livestock you rear?

[____]…………………………………………………………..

1= Yes 2= No 3= Unsure

c) Do rainfall variability influence your choice of livestock practices?

[____]…………………………………………………………..

1= Yes 2= No 3= Unsure

c) If the answer to b) above is **yes,** what measures do you practice in your farm? (Choose all that apply)…………………………………………………………..

1= Mixed farming

2= Poultry keeping

3= Destocking

4= Zero grazing

5= Dairy goat keeping

7= Others (Specify)…………………………………………………………………………

RAINFALL VARIABILITY

Q4.a) Have you noticed any changes in RAINFALL PATTERNS in past ten years in your area?

[____]…………………………………………………………..

1= Yes 2. No 3. Unsure

b) If the answer to a) above is **yes**, what change(s) have you noticed?

…………………………………………………………..

1= Less rain 2=More (heavier) rain 3= Erratic rains 4= longer droughts

5= floods 6= rains later 7= rains earlier 8= others (specify)……………………

c) Have you experienced any unusual weather event(s) or shocks associated with rainfall for example; drought, floods, shorter than normal rains, longer than normal rains, hailstones in the past ten years?

[____]…………………………………………………………..

1= Yes 2= No

d) If the answer to c) above is **yes**, give the most recent event(s)

[____]…………………………………………………………..

1= drought 2= floods 3=hailstones 4= shorter than normal rains

5= Longer than normal rains 6= others (specify)……………………………………

d) Do the changes in rainfall influence the choice of crops you cultivate or the animal you rear?

[____]…………………………………………………………..

1= Yes 2= No

EFFECTS OF RAINFALL VARIABILITY

Q5. a) What are the effects of the extremes/ weather events associated with rainfall in your area? (Tick all that apply).

[____] **Increased crop yields**

[____] **Reduced crop yields**

[____] **Reduced water availability**

[____] **Increased weed attack**

[____] **Delays in planting and harvesting**

[____] **Increased crop disease and pests**

[____] **Emergence of livestock diseases**

[____] **Emergence and re-emergence of human diseases**

[____]**Others**

(specify**)**………………………………………………………………………………

………………………………………………………………………………………………………

b) How severe are you affected by rainfall variability in your area?

[____]…………………………………………………………………..

1= Not affected 2= moderately affected 3= severely affected 4= don't know

b) How do you rate the severity of the following impacts that arise from the following events related to rainfall changes?

Rainfall Variability Events	***Not***	***Low***	***Moderate***	***High***	***Very High***
	1	2	3	4	5
Drought					
Flooding					
Disease epidemic					
Water resource decrease/ reduced stream volumes					
Feed/ fodder shortage					
Soil erosion					
Pest attack					
Others (specify)………					

Q6. What measures or innovations do you practice in your farm as a response to rainfall variability? (Tick all that apply)

[____] **Mixed farming**

[____] **Crop diversification/ cultivation of more than one type of cash or food crops**

[____] **Irrigation**

[____] **Planting with early rains**

[____] **Agro forestry**

[____] **Mulching/ shade**

[____] **Water harvesting**

[____] **Technology e.g. greenhouses**

[____] **Destocking**

[____] **Change of animal breeds**

[____] **Diversification into non-farm activities**

[____] **Use certified seeds (hybrid seeds)**

[____] **Use of chemicals/ herbicides**

[____]**Others**

(specify)……………………………………………………………………………

Q7. Other than rainfall variability, what other factors influence your farming practices?

[____] **Land fragmentation**

[____] **Extension services/ support programs**

[____] **Income levels/ Finance availability**

[____] **Soil fertility**

[____] **Technological influences**

[____] **Others** (specify)………………………………………………………

Thank you!

APPENDIX C: KEY INFORMANT QUESTIONNAIRE

Introduction

The purpose of this study is to assess the Effects of Rainfall Variability on Farming Practices and Adaptation Among Households of Kisii Central Sub County, Kenya. You have been identified as a useful informant to assist us (Egerton University) to achieve this mission. Your participation is voluntary and you are assured that the information you provide will be treated with confidentiality and used for the sole purpose of research. Kindly respond to the queries below. If you need more writing space you can attach more paper.

Category of the officer*: Tick as appropriate*

Agriculture……………….

NEMA…………………...

KARI…………………….

WRMA…………………..

Others……………………………………………..

A: General Information

i) Name (optional)……..……………………………………………………………

ii) Sex…………………………………Age…………………………………………

iii) Sub County/Ward/Area…………………………………………………………

iv) Profession…………………………………………………………………………

B: Interview Questions

1. Is there any form of climate variability or change in your area of operation? If yes please explain.
2. What do you think could be responsible for the kind of variability or change being observed in your area?
3. Has rainfall variability affected crop and livestock production in your sub county/ ward/ area? How has it affected it? What are the main crops cultivated in your area?
4. Other than rainfall variability, what other factors influence crop and livestock production in your area?
5. Are the farmers in your area aware of climate variability or change occurring it your area?
6. Have the farmers changed their farming practices in response to rainfall variability in your area? What are the responses?

7. Has there been training or sensitization of farmers on climate change and its impacts in your area of operation? How often has it been done?
8. What are your/ institution's effort to raise awareness on climate variability or change and the associated effects?
9. What are the major challenges in addressing climate variability or change issues?

Thank you for your contribution and invaluable time.

APPENDIX D: FGDs INTERVIEW SCHEDULE- CHECKLIST.

Introduction- Greetings, Introduction of the team and explanation of the purpose of the discussion

1. **Crop and livestock practices**

   Do you practice crop farming in your household? What crops do you cultivate? (Prompt to find the main cash crops and the main cash crops).

   Do you practice livestock rearing? What types of animals do you rear? (Prompt to find what the main kinds of livestock are)

2. **Indicators and effects of climate change**

   During your lifetime have you noticed any changes in climate? If so, what makes you think (why do you say) that the climate is changing?

   Do you think it's a temporal or permanent change?

   What do you think are the causes of the change?

   How does this change affect you and your community

   Your environment

   Your farm

   Your household

   Your community

3. **Response strategies**

   What can be done to address/ respond or adapt to such change impacts?

   How is it done?

   What tools/ resources/ information are needed to do that?

   What stands in the way of adapting to these changes?

   Can something be done to remove these challenges?

   What other factors are constraining i) crop and

   ii) Livestock production?

Thank you for your contribution and invaluable time.

APPENDIX E: RESEARCH AUTHORIZATION LETTER

NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471, 2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

24th September, 2014

NACOSTI/P/14/4106/3163

Clifson Masese Otiso
Egerton University
P.O. Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effect of rainfall variability on farming practices among households of Kisii Central District, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Kisii County** for a period ending **31st December, 2014.**

You are advised to report to **the County Commissioner and the County Director of Education, Kisii County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. S. K LANGAT, OGW
FOR: SECRETARY/CEO

Copy to:

The County Commissioner
The County Director of Education
Kisii County.

14-11-2014

COUNTY COMMISSIONER
KISII COUNTY

National Commission for Science, Technology and Innovation is ISO 9001: 2008 Certified

APPENDIX F: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MR. CLIFSON MASESE OTISO
of EGERTON UNIVERSITY, 0-40200
kisii,has been permitted to conduct
research in *Kisii County*

on the topic: *EFFECT OF RAINFALL VARIABILITY ON FARMING PRACTICES AMONG HOUSEHOLDS OF KISII CENTRAL DISRICT, KENYA*

for the period ending:
31st December,2014

Permit No : NACOSTI/P/14/4106/3163
Date Of Issue : 24th September,2014
Fee Recieved :Ksh 1,000

Applicant's Signature

Secretary
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 3285

CONDITIONS: see back page

APPENDIX G: MINISTRY OF EDUCATION RESEARCH AUTHORIZATION LETTER

REPUBLIC OF KENYA
MINISTRY OF EDUCATION SCIENCE AND TECHNOLOGY.

Telegram: "EDUCATION"
Telephone: 058-30695
When replying please quote
cdekisii@gmail.com

COUNTY DIRECTOR OF EDUCATION
KISII COUNTY
P.O. BOX 4499 - 40200
KISII.

Ref: CDE/KSI/RECH/1/18 — 14TH November, 2014

STATE DEPARTMENT OF EDUCATION

Clifson Masese Otiso
Egerton University
P.O Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION.

Following your Research Authorization vide your letter Ref.NACOSTI /P/14/4106/3163, to carry out research in Kisii County, this letter refers.

I am pleased to inform you that you have been granted authority to carry out your research in the County on "**effect of rainfall variability on farming practices among households of Kisii Central District, Kisii County**," for a period ending **31st December, 2014.**

Wish you a successful research.

COUNTY DIRECTOR OF EDUCATION
KISII COUNTY
P. O. Box 4499 - 40200, KISII
Date..........................
Sign..........................

RICHARD L. CHEPKAWAI
COUNTY DIRECTOR OF EDUCATION
KISII COUNTY.

APPENDIX H: TOTAL MONTHLY RAINFALL (MM) FOR THE YEARS 1995-2014

YEARS	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTALS
1995	663.7	101	262.2	163.4	223	117.7	154.9	66.7	186.9	105.8	267.8	93.7	2406.8
1996	130	218.4	154.1	220.5	274.8	174.4	128.7	153.7	267.3	184.1	215.9	126.1	2248
1997	110.6	59	111	302.2	232.7	98.5	101.8	176.8	31.1	157	245.8	365.8	1992.3
1998	106.7	80.8	115.4	233.2	228.2	204.3	107.2	146.4	186.4	199.6	107.2	81	1796.4
1999	93.5	58.1	29.6	280.3	244.5	155.9	118.2	176.9	173.4	329.9	151.2	121.6	1933.1
2000	31.5	80.8	109.5	254.1	351.4	178.7	137	136.9	219.2	134.4	272.2	170.2	2075.9
2001	210	149	151	239	423	145	50.3	76	323	262	205	62.2	2295.5
2002	213.4	89.9	255.5	203	226.1	133.3	108.4	154.4	59.7	234.8	265.3	145.8	2089.6
2003	115.5	77.4	179.6	232	319.7	267.7	107.3	257.2	165	199.6	154.6	112.6	2188.2
2004	118.6	150.5	86.5	304.8	214.3	113.8	102.8	192.9	353.9	99.8	162.7	186.2	2086.8
2005	74.6	79.2	178.8	211.3	286.9	153.8	76.5	203.5	170.4	65.9	112	51.6	1664.5
2006	90.1	185.6	232.4	348.8	314	141.1	86.1	102.4	140.4	97.5	255.4	208.4	2202.2
2007	188.6	179.5	151.1	172.3	246.7	191.4	139.3	70.7	158.9	125.4	97.5	96.6	1818
2008	30.8	59.5	304.1	291.1	118.5	136	220.6	191.7	168.9	241	154.5	82.1	1998.8
2009	120.8	54.7	252.2	242	311.1	188.1	70	213	145.3	94.1	133.4	310	2134.7
2010	108.6	106.5	217.7	244.6	375.5	252.3	80.3	178.1	256.7	256.9	109.6	229.6	2416.4
2011	101.1	44.7	141.7	228.4	235.1	94.4	99.1	266.4	266.4	209.2	312.6	22.1	2021.2
2012	6.4	70.4	143.8	377.6	238	254.8	89	172	227.3	198	322.3	220.1	2319.7
2013	68.4	60.8	291.2	399.6	224.9	105.2	104.3	143.6	262.8	151.9	218.1	125.9	2156.7
2014	63.4	63.1	179.6	139.2	183.6	70.6	169.9	396.9	240.6	205.6	163.4	112.8	1988.7
Average	132.315	98.445	177.35	254.37	263.6	158.85	112.585	173.81	200.18	177.625	196.325	146.22	2091.675

SOURCE: METEOROLOGICAL DEPARTMENT, P.O. BOX 30- KISII