

**ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES
AMONG SMALL SCALE FARMERS OF KITUTU AND NYARIBARI
CHACHE IN KISII COUNTY, KENYA**

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(N85/28217/2013)

A Thesis Submitted in Fulfillment of the Requirements for the Degree of Doctor of
Philosophy in the School of Environmental Studies of Kenyatta University

November, 2017

DECLARATION

Declaration by the candidate

This thesis is my original research work and has not been presented for a degree in any other University or any other award. Appropriate credit has been given where reference has been made to the work of others.

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DEDICATION

Dedicated to my late father Justus Wamalwa Sikemu, whose passion for Education was unprecedented and inspiring, and my mother Esther Nabangala Wechuli with whom am indebted forever. This work is also dedicated to the vulnerable and socially excluded who deserve utmost attention in the face of uncertainty and risks attributed to climate change.

ACKNOWLEDGEMENTS

My first and profound gratitude goes to my able supervisors Dr. Daniel Gathuru Manguriu and Dr. Benson Kamau Mburu for their exemplary guidance, invaluable nuggets of counsel, encouragement and unprecedented support during this work without which I would not have had the confidence to complete. I am also forever indebted to the entire intellectual community at Kenyatta University, who contributed to my intellectual growth at all stages of this journey, and particularly for listening to me and adding their voice in this work.

I also wish to express my humble appreciation to my colleagues in Kenya Agricultural and Livestock Research organization (KALRO), Kakamega, and County and Sub county officers of Agriculture, Livestock, Fisheries and Forestry in Kisii County, who helped me during data collection and entry. I also wish to extend my heartfelt appreciation to Swedish International Development Agency (SIDA) for supporting the implementation of Agriculture Support Development Programme where the idea of this work was born.

My deep and warm gratitude goes to my intimate friend and partner in life, Everlyne Wafula, whose faith in me and reliable support made it possible for me to dream again in the midst of very pressing family financial engagements. To my children Samuel, Elizabeth, Eleazer and Abigael, I wish to thank you for your understanding and loyal support during the entire period of the study.

Finally, I wish to thank the almighty God to whom all honor and glory belongs “Oh God! You have been my strength and help”.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALIN	Arid Lands Information Networks
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
ASDSP	Agriculture Sector Development Support Programme
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CCAFS	Climate Change, Agriculture and Food Security
CAADP	Comprehensive African Agricultural Development Programme
CSA	Climate Smart Agriculture
ENSO	EL Nino Southern Oscillation
EWIS	Early Warning and Information Systems
FAO	Food and Agriculture Organization
GoK	Government of Kenya
GDP	Gross Domestic Product
GCMs	Global Climate Models
GEF	Global Environmental Facility
GHGs	Greenhouse Gases
ICPAC	IGAD Climate Prediction and Application Centre
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
KALRO	Kenya Agriculture and Livestock Research Organization
KAPP	Kenya Agricultural Productivity Project
KCG	Kisii County Government
KENAFF	Kenya National Farmers Federation
KMD	Kenya Meteorological Department
MENR	Ministry of Environment and Natural Resources
MICCA	Mitigation of Climate Change in Agriculture
MLND	Maize Lethal Necrosis Disease
MOALFD	Ministry of Agriculture, Livestock and Fisheries Development
NAAIAP	National Accelerated Agriculture Inputs Access Programme

NALEP	National Agriculture and Livestock Extension Programme
NAPA	National Adaptation Programme of Action
NCCRS	National Climate Change Response Strategy
NCCAP	National Climate Change Action Plan
NGO	Non-Governmental Organization
NEMA	National Environmental Management Authority
PSP	Participatory Scenario Planning
REDD+	Reducing Emissions from Deforestation and Forest Degradation
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WCED	World Commission on Environment and Development
WFP	World Food Programme
WMO	World Meteorological Organization
WRI	World Resources Institute

ABSTRACT

Climate variability and change has caused instability in production and decline in productivity exacerbating food insecurity particularly in Latin America, Africa including Kenya and some parts of Asia. The magnitude and frequency of extreme climatic events is projected to increase. The effects of these climatic changes will become even more pronounced among small scale farmers whose farming activities are weather dependent and vulnerable to climate change, and already affected by environmental degradation and socio-economic risks. Effective adaptation to climate change among small scale farmers is therefore of critical importance, and is dependent on adoption of climate smart practices. However, studies have shown low adoption of climate smart farming practices among small scale farmers world over, in Kenya and Kisii county. This study therefore examined factors influencing adoption of climate smart practices among farmers of Kitutu and Nyaribari Chache in Kisii County, evaluated their existing knowledge, attitude and practice of these practices, assessed their perception of climate change, examined the extent of climate information dissemination, and the resultant impact on uptake of these practices. The research adopted a survey research design, where both quantitative and qualitative research strategies were used. Data was gathered through Focus Group Discussions, questionnaires, key informant interviews, observations and desk review. Both simple random and purposive sampling were used to sample 420 small scale farmers and technical officers of the agriculture sector respectively. Data was analysed using both quantitative and qualitative techniques. To test the statistical significance of the findings and relationships between the variables, chi-square test was used. The study revealed low (23.3%) access to weather and climate information, but growing (63.1%) awareness of climate change problem as evidenced by increase in temperature (48.1%), change in rainfall patterns (24.3%), emerging new strains of diseases and pests (40.7%), and decline in production (47%) for over 3 decades. The study further showed an emerging need (74%) for adoption of climate smart practices. The findings also revealed high awareness (66%) and positive attitude (84.5%) of farmers towards climate smart practices, but exhibited low knowledge (15%) and adoption (59.2% - 1.9%) of these practices. The low adoption was shown to be as a result of low diversification of income sources (86%), lack of awareness of available policy provisions (75%), lack of knowledge (85%), financial limitations (64.3%), low access to weather and climate information (76.7%), inadequate extension services (47.5%), dysfunctional farmer groups and weak policy framework. Besides the influence of perceived characteristics of climate smart practices, adoption of climate smart practices was shown to be enhanced by higher income level ($P=0.028$), educational level ($P=0.028$), size of the farm ($P=0.0$), farming experience ($P=0.002$), knowledge of the practices ($P=0.0$), weather and climate information ($P=0.0$) based on chi-square test results, which were within the significant level ($p < 0.05$). The study concluded that, while there was an emerging appreciation of climate change problem and need for adoption of climate smart practices, their adoption was mainly constrained by weak legal and policy framework, financial setbacks, limited climate information and knowledge of climate smart practices. The study therefore recommends up scaling of climate and weather information sharing, promotion of skill and knowledge of climate smart practices, development of sound policy and legal framework, and mobilization of funds

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agriculture sector is vital in eradication of extreme poverty and hunger, and supports livelihoods of close to 1.5 billion people worldwide living in smallholder households in rural areas (World Bank, 2008). Despite its vital importance, the sector is highly sensitive and susceptible to climate change and variability (Perret, 2006; Fischer *et al.*, 2005; Van de Steeg *et al.*, 2009; Schlenker & Lobell, 2010), and small scale farmers are disproportionately affected, as a result of poverty, high dependency on natural resources and inadequate capability to adopt new livelihood strategies (Osborne & Viner, 2006).

Intergovernmental Panel on Climate Change (IPCC, 2007b) affirmed climate change occurrence and has projected further change and upsurge in the mean climate characteristics. This is likely to cause more severe effects on agriculture that has already registered instability in production, decreases in crop yield and livestock productivity. This will subsequently enhance hunger among millions of people worldwide, particularly in Latin America, Small Island States, Africa and some parts of Asia. This precarious situation is as a result of low adaptive capacity attributed to poor resource base, weak institutions and limited technology (IPCC, 2007a). Estimates of the impacts of climate change on agriculture suggest that in future, both productivity and production stability will decline in areas experiencing food insecurity (FAO, 2010).

The agricultural sector supports local livelihoods and contributes enormously to national Gross Domestic Product (GDP) in most countries in Africa (Mendelsohn *et al.*, 2000a). The contribution of agriculture to GDP varies in different countries but studies indicate an average contribution of 21% (Mendelsohn *et al.*, 2000b). Notwithstanding the crucial role Agriculture plays in Africa, the sector suffers from inadequate adoption of high yielding technologies, climate largely dominated with droughts, floods and effects of climate change (Mendelsohn *et al.*, 2000b).

These events have led to starvation and extensive impacts on socio-economic development. A third of people living in Africa are settled in areas faced with drought and 220 million experience drought every year (IPCC, 2014; Collier *et al.*, 2008). With vagaries of weather and extreme events set to increase and intensify as a result of climate change (IPCC, 2007a), reductions in yield in some African countries could be as much as 50% by 2020, and net crop returns could drop by 90% by 2100 (Boko *et al.*, 2007). This will pose serious risks to food security and to the realization of key developmental objectives.

Agriculture in East and Central Africa contributes about 40% of the region's GDP and is the main livelihood source for approximately 80% of the population in the region (IFPRI, 2004). However, high variability of rainfall both within and between seasons across the region has caused uncertainty and large fluctuations in farmers' yield and income. This has been compounded largely with semi to arid conditions, degrading soils and high poverty (Fischer *et al.*, 2005; IPCC, 2007a). The region undergoes protracted and extremely adverse droughts that cover expansive areas once every decade and more regular localized events (Christensen *et al.*, 2007).

In Kenya, agriculture contributes about 24% of GDP and supports livelihoods for approximately 80% of the small scale farmers in the rural areas (IFPRI, 2004). However, significant decline in crop yield and livestock production has been reported (Christensen *et al.*, 2007). This is mainly due to water and heat stress attributed to droughts, increase in temperature, erratic and unpredictable rainfall in high agricultural potential areas, and high variability of rainfall in arid and semi-arid areas due to climate change (Fischer *et al.*, 2005; IPCC, 2007; Christensen *et al.*, 2007). These extreme events and other climate characteristics such as rainfall and temperature are projected to increase further based on model prediction (Christensen *et al.*, 2007). This is likely to exacerbate existing food insecurity, poverty and hamper realization of development goals.

Though uncertainty prevails over the precise nature and extent of these changes, most climate change projections for Kenya, indicate an increase in temperatures by about

2.5⁰C to 3.0⁰C accompanied by modest and seasonally variable increases in precipitation of 5 to 10 % by mid-century (IPCC, 2007b; IPCC, 2014). This scenario is likely to have significant effects on agriculture particularly small scale farmers. According to UNEP/GoK (2000), a single drought event in a 12-year period will reduce GDP by 7% and enhance poverty by 14%.

In Kisii County, climate change problem has been characterized by temperature change, changing rainfall patterns, and new strains of pests and diseases. According to Kenya Meteorological Services, (2012) and ASDP, (2014) the area has been experiencing prolonged dry spells from the usual period of January - February to April, shortening of the long rainfall season from the previous March- July to April-June and rise in temperature by 2⁰C for the last 3 decades. Consequently, most farmers had difficulties in planning their farming activities with resultant crop failure, decline in crop yield and food security, and high poverty levels above the national average (47%) among most rural households (Ogechi & Hunja, 2014).

While farmers strive to adapt through innovation, studies by Rao *et al.*, (2011) and Pettengell, (2010) indicated their limited capability to effectively respond to these rapid and overwhelming changes beyond their normal experience. In response to these unpredictable changes in the agriculture sector and particularly among small scale farmers, several approaches have been suggested among them being “Climate Smart Agriculture”. This is agriculture that enhances productivity in a sustainable way, improves resilience, mitigates greenhouse gases, and boosts realization of national food security and development objectives (FAO, 2010; FAO, 2013).

This approach involves practices such as adoption of climate tolerant varieties, risk insurance and use of climate information in farming. These practices are mainly aimed at both sustainability and agricultural intensification, considered key for ensuring enhanced productivity and food security.

1.2 Statement of the Problem

Climate change and variability has resulted into decline and instability in production worsening the existing food insecurity and poverty in developing countries. The effects of these climatic changes will become even more pronounced among small scale farmers, whose farming activities are weather dependent and vulnerable to climate change, and already adversely affected by environmental degradation and socio-economic risks (World Bank, 2008; Rao *et al.*, 2011; Thornton *et al.*, 2009; Van de Steeg *et al.*, 2009; Schlenker *et al.*, 2010). To ensure resilience, adoption of climate smart practices among small scale farmers is required. In spite of the vital role played by climate smart practices in not only enhancing resilience, but also increasing productivity, reducing greenhouse gas emissions, and addressing environmental degradation, their adoption by small scale farmers has been low globally (FAO, 2010; FAO, 2013; Fanen *et al.*, 2014). This is due to several lapses and challenges that have not been explored (Dance & Sarpong, 2011; Roncoli *et al.*, 2009; Adger *et al.*, 2007). Most studies tend to focus on the impact of climate change on agriculture and adaptation measures (Mburu, 2013; Rao *et al.*, 2011; Schlenker *et al.*, 2010; Van de Steeg *et al.*, 2009; Sivakumar *et al.*, 2005), but few have examined the factors that affect the adoption of adaptation methods (Deressa *et al.*, 2009).

Over years, improved technologies including climate smart practices have been developed and disseminated in Kenya, by Kenya Agricultural and Livestock Research Organization (KALRO) and through donor supported programs and projects (MOALFD, 2010). In spite of the implementation of these programs, adoption of climate smart practices has remained low, particularly among small scale farmers (Ogada *et al.*, 2014; Mugwe *et al.*, 2009). Similarly, in response to effects of vagaries of weather attributed to climate change in Kisii County, climate smart practices have been disseminated for several decades. In spite of these efforts, adoption of climate smart practices has also remained low among small scale farmers (ASDSP, 2014). This study therefore sought to identify factors that hinder adoption of climate smart practices among small scale farmers of Kisii county with specific focus to Kitutu and Nyaribari Chache sub counties.

1.3 Objectives of the Study

1.3.1 General Objective

To examine the factors influencing adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County in Kenya.

1.3.2 Specific Objectives

- a) To analyze perception of climate change risks, their effects on farming and influence on adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County
- b) To determine the existing knowledge, attitude and practice of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County.
- c) To examine socio economic factors influencing adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County.
- d) To examine the extent of climate and weather information dissemination and its influence on adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County.

1.4 Research Questions

To achieve its objectives, the study was guided by the following research questions;

- a) How is the perception of climatic change risks and their impacts on farming among small scale farmers influencing adoption of climate smart practices of Kitutu and Nyaribari Chache in Kisii County?
- b) How is the existing knowledge and attitude towards climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County, influencing their adoption?
- c) Which socio-economic factors are influencing adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County?
- d) To what extent has climate information been disseminated and influenced

adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County?

1.5 Hypotheses

In this study, the following hypotheses were tested:

- a) The perception of climate change and its associated risks among small scale farmers of Kitutu and Nyaribari Chache in Kisii County has significant influence on the adoption of climate smart practices.
- b) The level of knowledge of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County has significant influence on their adoption.
- c) Socioeconomic factors have significant influence on the adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County.
- d) Climate change information has significant influence on the adoption of climate smart practices.

1.6 Significance of the Study

By establishing the factors that influence adoption of climate smart practices, the study is of significance in several ways. The findings of this study will facilitate design of necessary interventions that will enhance knowledge and practice of climate smart practices among small scale farmers in areas with similar ecological and socioeconomic conditions with the study area in Kenya. This will subsequently lead to enhanced resilience to climate change, increased food security, poverty alleviation among small scale farmers, economic growth and mitigation of climate change.

The outcome of this study will also contribute to the body of literature on the efforts towards adaptation to adverse effects of climate change in agriculture sector and provide invaluable information necessary for ongoing policy development with regard to mainstreaming climate smart practices in the Agriculture sector in Kenya. This study further provides invaluable information for researchers in developing improved systems

to ensure that their experimental systems are appropriate for farmers' needs, abilities, and circumstances. Finally, this study will help farmers to make informed climate smart practices adoption decisions that require considerable resources, skills, and time to implement and manage.

1.7 Conceptual Framework

Adoption of technologies and adaptation to climate change in this study is informed by various perspectives and paradigms upon which many studies of adoption and adaptation have been based. They include innovation diffusion framework (Rogers, 2003), adopter perception perspective (Prag & Posthumus, 2012; Reimer *et al.*, 2012), and smallholder farmer adaptive capacity framework (Jones *et al.*, 2010) (Figure 1.1).

The frameworks appreciate the dynamic processes and ways in which individual capabilities relate with informal and formal institutions to determine adaptation capacity and hence adoption of technological innovations (Frank & Penrose, 2012; Brooks & Kelly, 2005; Deressa *et al.*, 2009; Dulal *et al.*, 2010).

The smallholder farmer adaptive capacity framework (Jones *et al.*, 2010; Djurfeldt *et al.*, 2011), takes into consideration the determinants of adaptive capacity. Which refers to the capability for a system to respond, recover and cope with uncertainty or hazard (IPCC, 2007b). The framework identifies five attributes of adaptive capacity “Asset base, Institutions, Knowledge and information, Innovation, Flexible forward-looking decision-making and governance” (Jones *et al.*, 2010).

Innovation diffusion framework is considered one of the most appropriate, comprehensive and tested work that has been recommended and applied in several adoption of technology studies (Hillbur, 1998; Medlin, 2001). The theory identifies information dissemination as the main determinant influencing adoption decisions, and explains how innovation is taken up in a population, characteristics that cause the innovation to spread, various mental stages that individuals undergo before they adopt an innovation and categorizes individuals depending on their attitudes towards innovation.

While adopter perception perspective is based on the premise that the perception about the problem (climate change) and attributes of innovations (climate smart practices) by individuals poses significant influence to adoption of technologies (Reimer *et al.*, 2012; Prag & Posthumus, 2012).

The link between various aspects in the conceptual framework is highly intricate, than can be adequately represented in a simple diagram below.

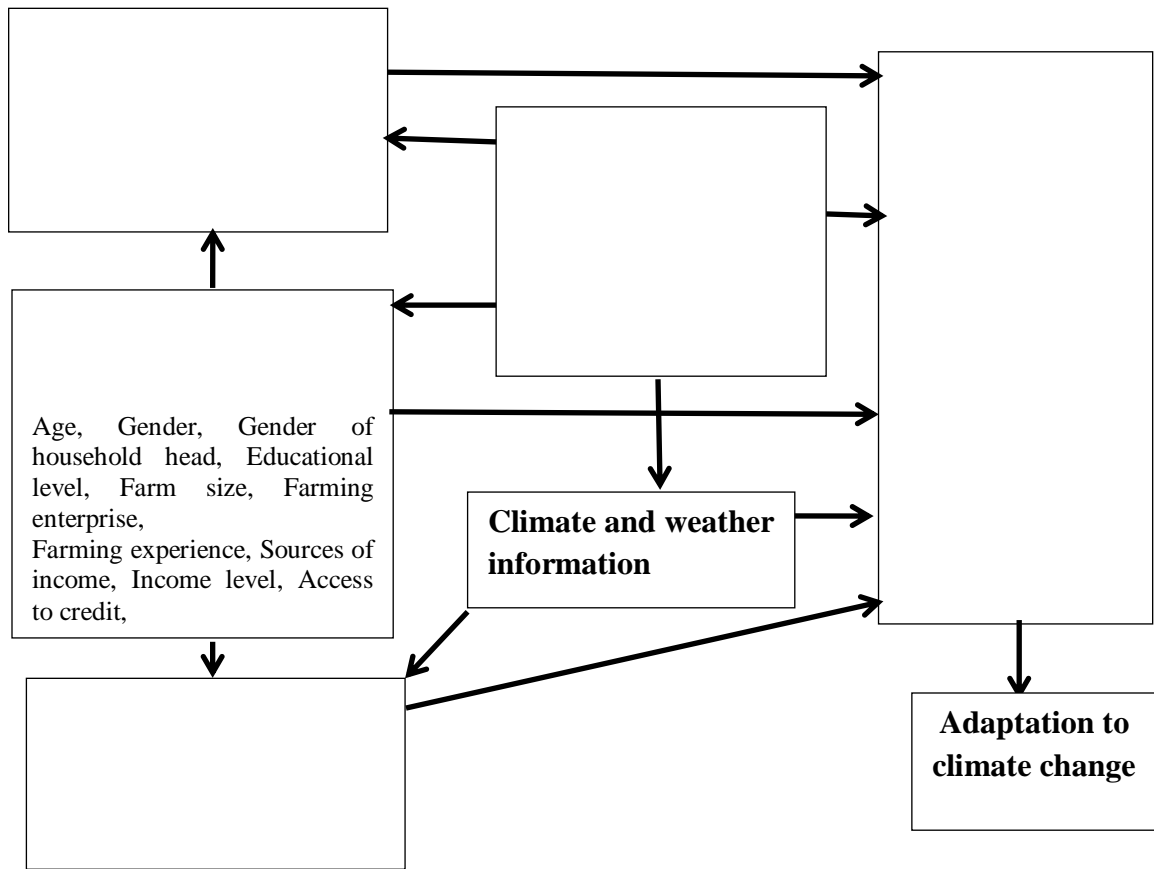


Figure 1:1 Conceptual Framework; Adapted from Jones *et al.* (2010); Reimer *et al.* (2012) and Prag & Posthumus (2012)

Adoption of climate smart practices by the small-scale farmer was positioned at the tail end of the framework and inextricably linked to all the other attributes (Figure 1.1), to highlight fundamental importance of small scale farmers in guaranteeing effective and lasting adaptation. The institutions and policies consist of state, market, NGOs, farmer groups, cooperative societies, linkages-networks and partnerships and policies,

regulations and practices, which influences the access and adoption of new practices through funding, supporting innovation, facilitating access to market and appropriate knowledge and information (Agrawal, 2008).

Access to appropriate knowledge about climate smart practices and climate and weather information by small scale farmers is crucial in sustaining and enhancing productivity besides making critical decisions about how to change in the light of environmental variation (Jones *et al.*, 2010). While communities strive to adapt to changes in the climate, the rate at which the climate is now changing globally is beyond their experience and hence the need for scientific climate information to effectively achieve adaptive capacity (Roan *et al.*, 2011).

Even with knowledge about climate change problem and climate smart practices among small scale farmers, change in behavior and attitude towards adoption of climate smart practices can take a long time depending on the social and economic factors i.e. size of farm, farmer demographics, market prices, operating costs, attitudes, values, beliefs, views and opinions of neighbors (Hallam *et al.*, 2012). These factors can also influence adoption of climate smart practices depending on how they shape the knowledge levels of farmers concerning the practices and perception of the climate change problem and the innovations.

Based on the above conceptual framework, this study sought to establish the relationship and the influence, the explanatory variables (independent variables) have on adoption of climate smart practices (dependent variable) (Table 1.1).

Table 1.1: Independent & Dependent Variables of the Study

Independent variables	Dependent variable
Socio-economic characteristics Age and Educational level Gender and gender of household head Farm size Farming enterprise and experience Sources of income/Income level Access to credit Membership to farmers organizations	Adoption of climate smart practices
Knowledge of climate smart practices	Adoption of climate smart practices
Perception of climate change and its risks	Adoption of climate smart practices
Dissemination of climate information	Adoption of climate smart practices

1.8 Definition of Terms and Concepts

Climate Smart Agriculture An approach towards food security and socioeconomic development based on three pillars: enhancement of productivity and earnings, improvement of resilience of livelihoods and ecosystems and mitigating and removal of greenhouse emissions from the atmosphere (FAO, 2010; FAO, 2013).

Resilience The ability of small scale farmers to recover from shocks resulting from climate variability and change due to knowledge and skills of farming operations based on climate information and smart technologies (IPCC, 2007b).

Small Scale Farmers “The bulk of Sub-Saharan Africa population who depend little on either state or market for daily existence; who are held back by a number of economic, political and institutional factors at local, regional, national and international levels; who experience a prolonged and multidimensional crisis such as high degree of subsistence farming, low productivity, low and uncertain incomes, high risk of exposure to market failures and climatic adversaries, and increase to multiple source of off-farming income” (Djurfeldt *et al.*, 2011).

Climate Change	Change in the mean characteristics of climate over a long period of time (IPCC, 2007b).
Climate Variability	“Variations in the mean state and other statistics such as standard deviations and statistics of extremes of the climate on all temporal and spatial scales beyond that of individual weather events” (IPCC, 2007b).
Climatic shocks	Unpredictable and erratic weather, and drought or floods that suddenly affect agriculture and livelihoods.
Climate Change Impacts	The effects or results of climate change on agriculture or livelihoods (IPCC, 2007b).
Vulnerability	Inability to withstand shocks by farmers whenever they occur (IPCC, 2007b).
Mitigation	Measures undertaken to reduce or remove (carbon sequestration) greenhouse gas emissions from the atmosphere (IPCC, 2007).
Climate Information	Refers to agricultural advices on weather and climate that play crucial roles to increase agricultural production. It refers to observations, data and analysis of past, present and future forecasts of average characteristics of weather in particular area. The climate information also includes the likely hazards, opportunities and impacts of different climatic probabilities. It’s generated through peoples’ own observations and by meteorological services (Roncoli <i>et al.</i> , 2009; WMO, 2009).
Climate Smart Practices	Practices adopted in farming systems under climate smart agriculture that enhances sustainable agricultural production while responding to climate change challenges (FAO, 2010; FAO, 2013).

Adaptation	A process of undertaking necessary measures in order to cope with uncertainty or risks associated with unpredictable erratic weather and extreme weather events such as drought and floods on agriculture. It as well means taking necessary measures in order to take advantage of opportunities that arises from these weather phenomena (IPCC, 2007b).
Perception	Is a dynamic process of interpreting the external world guided by sense and experience and generally refers to how people select, organize and interpret information (Wossink & Boonsaeng, 2003)
Attitude	A settled way of thinking or feeling (viewpoint, perspective) about something (Arbuckle <i>et al.</i> , 2013).
Productivity	Is the ability of a production system to produce more economically and efficiently. It's a measure of efficiency in an agricultural production system which employs land, labour, capital and other related resources (FAO, 2010).
Production	Is the act of creating output, goods or services which have values and contributes to the utility of individuals (FAO, 2010).
Knowledge	In this study, it refers to having understanding on how the technology is applied (Rogers, 2003).
Awareness	Learning about the existence of an innovation or a technology (Rogers, 2003).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a synopsis on climate variability and climate change, and its effects on small scale farmers, adaptation strategies to climate change in agriculture sector, with explicit attention on climate smart practices and factors influencing adoption of climate smart practices. The section also covers literature review of knowledge, attitude and practice of climate smart practices, perception of climate change, and climate information dissemination and their impact on adoption of climate smart practices. This part concludes with gaps to be filled by the study.

2.2 Climate Change and Climate Variability

Though there were concerns many decades back over the possibility of global warming, work to establish the certainty of global warming in relation to greenhouse gases was undertaken by scientists under Intergovernmental Panel on Climate Change (IPCC) after its formation in 1988 (IPCC, 2007b). Their findings affirmed the warming of the climate system, with global average temperature increase of 0.74% (IPCC, 2007b). In tandem with global warming, Africa has been warming at the rate of 0.05% per decade for the last 100 years (Hulme *et al.*, 2001).

This rate is projected to rise further based on model projections. The climate model simulation for Africa, indicate an average temperature rise of about 3°C to 4°C, which is approximately 1.5 times the world average response under a range of possible emissions scenarios (Christensen *et al.*, 2007). Its projected drier subtropical regions may become warmer than the moister tropics with much of Mediterranean Africa, northern Sahara and southern Africa expected to register decline in rainfall (Collier *et al.*, 2008).

Nearly all models concur that it will become more warm, the extent of warming is unpredictable (Hulme *et al.*, 2001). Rainfall on the other hand has been shown to be highly inconsistent spatially and temporally (IPCC, 2007b). Enormous uncertainty with

regard to the scale of rainfall changes simulated by Global Circulation Models (GCMs) in the region exists. The challenge involves ascertaining the nature of the climate change effect on African rainfall pattern against a backdrop of huge natural unpredictability compounded by the use of climate models that may not be perfect (Sivakumar *et al.*, 2005).

East Africa is experiencing increasing mean rainfall and there are a small number of areas where average rainfall is likely to decline (Thornton *et al.*, 2009). There is still some doubt about this development, however, Funk *et al.* (2008) argues that climate models have most likely underrated the impacts of warming in the Indian Ocean and may be overrating rainfall in the East African region. Hulme *et al.* (2001) indicated why there is much less confidence about the ambiguity in depiction of climate variability in the tropical areas in nearly all the GCMs via mechanisms such as EL Nino-Southern Oscillation (ENSO), and interactions between the land cover and atmosphere. Such interactions have been suggested to be important in determining climate Variability in Africa (Hulme *et al.*, 2001).

Kenya exhibits wide-ranging climatic conditions due to maritime and terrestrial influence. While average temperature changes with altitude, the more significant climatic differences is with regard to rainfall (Thornton *et al.*, 2009). In terms of rainfall, Kenya experiences bimodal seasonal pattern, with long rainfall occurring between March to June, and short rains taking place from September to November/December. Rainfall is correlated to topography with highest elevation regions in the central highlands and some parts of rift valley receiving rainfall amount of 3200mm per year. While low areas and over two thirds of the country receive below 500mm of rainfall every year particularly in the northern parts of the country. As a result of climate change, rainfall has become erratic in arid and semi-arid areas, and uncertain in high rainfall areas (Osbaahr & Viner, 2006).

Kenya also experiences a cycle of droughts and floods in every decade based on long term historical climate data, with floods contributing 60% of all disasters in Kenya

(Obati, 2005). Floods occur mainly in Lake Victoria basin, lower Tana river basin, coastal areas and semi-arid and arid regions despite low rainfall (WRI, 2007). The trend of the floods and droughts shows an increase in frequency and magnitude (UNEP/GoK, 2000). Kenya is also undergoing short term impacts from floods and droughts. Present effects on socio economic growth and livelihoods from these events in Kenya may be projected into even more worse scenarios with the future adverse effects of anthropogenic climate change.

2.3 Effects of Climate Variability and Change on Small Scale Farmers

Agricultural production in developing countries and particularly among small scale farmers relying mainly on rainfall has declined resulting into enhanced food insecurity and poverty (Mendelsohn *et al.*, 2000a; Boko *et al.*, 2007; Mburu *et al.*, 2014). With erratic and unpredictable weather patterns, and frequency and intensity of extreme climatic events set to increase as a result of climate change (IPCC, 2012), further decline in crop yields will occur in most tropical and sub-tropical regions (IPCC, 2007b). This will compound the already existing food insecurity and the prevalence of hunger in developing countries, and reinforce the existing vulnerabilities of small scale farmers (Osbaahr & Viner, 2006).

Results from various studies (Mendelsohn *et al.*, 2000a; Mendelsohn *et al.*, 2000b), on impacts of climate change on agriculture in Africa, drawn from several climate models and IPCC Special Report Emissions Scenarios (SRES) show that some areas of Sahara region will emerge as the most vulnerable by 2100, with expected decline of 2% and 7% of GDP, while Western and Central Africa, Northern and Southern Africa may experience a decline in agricultural production by 2% to 4% and 0.4% to 1.3% respectively.

Reports (Fischer *et al.*, 2002; Boko *et al.*, 2007), also indicate that climate change will cause a wide-ranging decline in most of the crops such as sorghum, maize, millet and groundnuts in several countries such as Sudan, Ethiopia, Eritrea, Zambia, Ghana and Gambia. Yields from crops that rely on rainfall could drop by 50% by 2020 and dwindle

net revenues from crops by 90% by 2100 in some countries, worsening food insecurity and putting millions of persons at risk of starvation , with Africa expected to account for the majority by 2080s particularly small scale farmers.

In Kenya, high spatial and temporal variability of climate coupled with change in seasonal patterns has, posed significant and multiple risks such as crop and livestock losses (Thornton *et al.*, 2009). Studies on adverse effects of climate change and variability on farming in Sub-Saharan Africa and in Kenya indicate significant mean changes in crop yields (Schlenker *et al.*, 2010; Mburu, 2013). These have disproportionately affected small scale farmers particularly in Kenya, because of existing vulnerabilities (Fischer *et al.*, 2005; IPCC, 2007; Thornton *et al.*, 2009; Mburu, 2013). For instance, La Nina droughts of 1999 in Kenya contributed to starvation of approximately five million people mainly small scale farmers (Ngecu *et al.*, 1999).

A recent study by Mburu *et al.* (2014), on the effects of climate variability and change on the food security in Yatta District in Kenya, affirmed the severe and adverse effects in terms of access, availability and sufficiency of food among small scale farmers. The interactions of several factors such as temporal and spatial variability of climate, change in seasonal patterns, degraded soil and uncertain future climate scenario will pose further drop in production and consequently lead to enhanced food insecurity, retardation in economic growth and increased poverty among close to 80% of small scale farmers who depend on agriculture for their livelihood in Kenya (Thornton *et al.*, 2009).

2.4 Adaptation to Climate Variability and Change in Agriculture

IPCC defines climate change adaptation as “adjustment in human and natural systems in response to actual or expected climatic variation, with a view to moderating harm or exploiting beneficial opportunities” (IPCC, 2007b). Adaptation can either be reactive or anticipatory. Adaptation may also be of different interventions ranging from development activities, that seek to deal with the causes of vulnerability, to those which target specifically the impacts and hazards of climate change (Meridian Institute, 2011; McCray, 2007).

Adaptation in agriculture has increasingly gained attention with its application taking different dimensions such as transformation of whole farming systems, modifications of existing systems and adoption of practices such as soil and water conservation, agroforestry (Ifejika, 2010; Meridian Institute, 2011). While small scale farmers have been using their extensive knowledge in dealing with extreme weather events, the extraordinary and sustained magnitude of variability linked to climate change is beyond capacity of local coping mechanisms (Pettengell, 2010).

Though climate change has been around for several decades, it wasn't until 1987, as a result of the Brundtland report, titled "our common future" that this phenomenon received serious global attention (WCED, 1987). This report informed the establishment of Intergovernmental Panel on Climate Change jointly by World Meteorological Organization and United Nations Environmental programme in 1989. In the light of the same report, United Nations also convened an international conference on Environment and development at Rio de Janeiro that culminated into the formation of United Nations Framework Convention on Climate Change (UNFCCC), conventions on biological diversity, desertification and agenda 21 (Kubiszewski *et al.*, 2012).

Under UNFCCC, developing countries are expected to develop adaptation strategies, while developed countries are expected to offer necessary financial and technological support (UNFCCC, 2007). The developed countries are under obligation to provide this support based on "common and differentiated responsibilities principle". This is because "the contribution of countries to climate change and their capacity to prevent and cope with its consequences varies enormously". In this case developing countries are less endowed, less capable of coping and more vulnerable to climate change (UNFCCC, 2007).

Currently there are four adaptation funds under UNFCCC and Kyoto protocol. These funds include Least Developing Countries Fund, Special Climate Change Fund, GEF trust fund (channeled through GEF) and Adaptation Fund yet to be actualized under Kyoto protocol. Adaptation funds also exist under Kyoto protocol under Clean Development

Mechanisms and Multilateral Environmental Agreements whose areas of work contribute to synergy with adaptation. In spite of availability of these funds, the process of access is lengthy and complex, besides their insufficiency (UNFCCC, 2007).

So far the effort towards combating climate change in Kenya remains low (Mutinda *et al.*, 2010). Analysis of the country's state of preparedness to climate change effects revealed weak and inadequate policy and legal framework with most policies leaning towards environmental management (Mutinda *et al.*, 2010). The only significant development towards climate change is reflected in the development of National Climate Change Response Strategy (NCCRS) and National Climate Change Action Plan (NCCAP) 2013- 2017 (MENR, 2010). Currently there are efforts towards development of fairly strong policy provisions on combating climate change; however, they are still at drafting stage. Budget support and mainstreaming of climate change in all sectors remains elusive (MENR, 2013). In Kenya's Agriculture sector, the process of mainstreaming climate change is at its initial stages as recently evidenced by national adaptation meeting for agriculture (MOALFD, 2014).

2.5 Climate Smart Practices

Efforts towards addressing climate change effects in agriculture and particularly among small scale farmers, have often been seeking for innovation and improved access to technological practices (Howden *et al.*, 2007). And as such there have been efforts towards best practices for adapting to the effects of climate change and variability (Beddington *et al.*, 2011). One of the new approaches recommended being adoption of Climate Smart Agriculture (CSA) (FAO, 2010; WMO, 2001; WMO, 2007; WMO, 2009).

Climate Smart Agriculture (CSA) is a concept that was coined by FAO and widely endorsed by International institutions such as International Fund for Agricultural Development (IFAD), World Bank, United Nations Environment Programme (UNEP), World Food Programme (WFP), Consultative Group for International Agricultural Research/Climate Change Agriculture Food Security (CGIAR/CCAFS and Comprehensive African Agricultural Development Programme (CAADP) (FAO, 2010;

FAO, 2013). It's aimed at sustainable intensification, sound and efficient management of natural resources, and offers an opportunity for climate change funding while seeking to strengthen the livelihoods of small scale farmers through improved access to services, knowledge, genetic & financial resources, markets etc. (ibid).

The approach is based on the acronym SMART, where S stands for specific, M for measurable, A for achievable, R for reliable and T for timely (McCarthy *et al.*, 2012). The climate smart approach aims at enhancing productivity and returns, improving adaptation of livelihoods and ecosystems and reducing greenhouse gas emissions (FAO, 2010). In the light of the climate smart concept, agriculture is therefore considered SMART if it meets the above indicated objectives.

The approach includes well proven technologies that already exist and other innovative practices such as; conservation agriculture; agroforestry; water harvesting and efficient use; use of varieties and breeds that can perform better under various climatic stresses; use of safety nets, risk insurance and timely climate information by farmers (FAO, 2010; FAO, 2013). These technologies have been implemented in several countries in Africa, Asia, and Latin America and Pacific with positive results (Branca *et al.*, 2011; Branca *et al.*, 2012). However, its widespread adoption remains a challenge.

Review of several studies (Rockstrom *et al.*, 2009; Branca *et al.*, 2011; Branca *et al.*, 2012), on select practices such as use of cover crops, rotation of crops, intercropping with legumes, water harvesting, irrigation, integrated nutrient management, contour farming, terracing, agroforestry, minimum tillage and crop residue management showed stability in production and significant increase in yield of crops both in the short and long run in humid and dry areas. The increase in yield is attributed to enhanced soil fertility, enhanced infiltration of water and water retention capacity, controlled soil erosion and improved soil structure. These practices as opposed to conventional practices require use of low inputs and enhance soil carbon sequestration, a process that involves removal and storage of carbon from the atmosphere by soils (Branca *et al.*, 2012).

Improved pasture and grazing management enhances the quality of forage, which in turn increases yield of livestock besides ensuring resilience to erratic weather patterns and effects of extreme weather events particularly in dry areas (Kohler *et al.*, 2014; Kuria *et al.*, 2015). Study carried out by Fanen *et al.* (2014) on the role of climate smart practices in combating climate change; desertification and improving livelihoods in Northern Nigeria indicated positive significance. However, there is need for appropriate institutions, political goodwill, adequate financial and human resources, besides availing information and incentives to enhance their adoption.

2.6 Adoption of Climate Smart Practices among Small Scale Farmers

Adoption of scientific and technological innovations in the agricultural sector has received considerable attention given their contribution to improved productivity and incomes (Rockstrom *et al.*, 2009; Branca *et al.*, 2011; Branca *et al.*, 2012), particularly in the developing countries, where agriculture play a pivotal role in terms of eradicating poverty, hunger and supporting livelihoods of the majority small scale farmers (World Bank, 2008). As such numerous agricultural technologies have been developed besides the vast literature generated. In spite of these efforts, adoption of new technologies at farm level remains a challenging and a dynamic issue. This is affirmed by several studies conducted in countries in Africa and Asia, such as Ethiopia, Nigeria and Nepal in India (Deressa *et al.*, 2009; Dulal *et al.*, 2010; Fanen *et al.*, 2014).

In Kenya, various programs have been undertaken towards promoting adoption of climate smart practices. In spite of the implementation of these programs involving efficient, sustainable and productivity enhancing technologies, their adoption has remained low particularly among small scale farmers. This has been confirmed by various studies across the country (Ogada *et al.*, 2014; Mugwe *et al.*, 2009).

The low adoption has been shown to depend on varying factors in different places and across agro ecological zones in Kenya (Ogada *et al.*, 2014). Survey done in Embu and Taita by Mutsotso *et al.* (2011) in Kenya showed that farmer's adoption of biodiversity conservation was constrained by the absence of the technologies in local agro shops. Another study by Mugwe *et al.* (2009), which examined uptake of soil fertility

management practices among small holders in central highlands of Kenya, indicated resource endowment as one of the significant factors influencing the decision either to adopt or reject the new innovations. Other work done by Ogada *et al.* (2014) mainly focusing on adoption of fertilizers and improved maize varieties in Kiambu, Embu and Coastal lowlands noted low adoption as a result of climatic conditions, high cost of inputs and labour, limited access to extension services, unavailability of inputs in agro shops, gender and low financial endowments.

2.7 Factors Influencing Adoption of Climate Smart Practices among Small Scale

Farmers

The adoption of technologies has been shown to depend upon a myriad of factors including household and farm characteristics. These characteristics include age, gender, level of education, and head of household, asset endowment, farm size and farming experience. Other factors that influence decision with regard to adoption comprise perception of the problem, characteristics of technologies, institutions and the influence of the market (Jones *et al.*, 2010; Rogers, 2003; Frank & Penrose, 2012).

Assets and wealth endowment such as income, savings and access to credit, and insurance is considered to have significant influence on adoption of technologies by small scale farmers. This is because they act as a ‘safety net’ in time of crisis, enabling farmers to innovate, and take risks, which support long-term sustainable adaptation (Jones *et al.*, 2010). Similarly, technology adoption in some cases requires heavy capital investment, which in most cases is out of reach to majority rural farmers. This implies that farmers with higher resource endowments are more likely to adopt climate smart practices compared to the less endowed farmers (Deressa *et al.*, 2009).

Similarly, effective engagement in the market by farmers is also considered as key factor that determines farmers ability to adopt technological practices. Jones *et al.* (2010) asserts that existence and engagement of markets by small scale farmers enhances their livelihood strategies. Other factors that have been shown to influence adoption of new practices include market imperfections (Deressa *et al.*, 2009; Ogada *et al.*, 2014; Jones *et*

al., 2010). Surveys have also shown that where the tools for implementation are readily available and accessible in the local marketplace, adoption of technologies becomes easier (Ogada *et al.*, 2014; Agrawal, 2008).

Institutions also play a critical role in adoption of agricultural practices (Djurfeldt *et al.*, 2011). Jones *et al.* (2010) affirms that effective adoption of climate smart practices requires involvement of institutions at all levels. For instance, local collective and civil society institutions play a significant role in terms of asset building, access to information, resource mobilization, capacity and skills development, creating linkages necessary for adoption of adaptive strategies (Agrawal, 2008). The policy context that supports payments for environmental services, funds research and promotes dissemination of information and advice also greatly influences the adoption of new practices (Jones *et al.*, 2010).

2.8 Knowledge, Attitude and Practice of Climate Smart Practices

2.8.1 Knowledge of Climate Smart Practices

Knowledge is organized information or data, and is considered crucial in the process of adoption of innovations (Azman *et al.*, 2013). Rogers (2003) asserts the importance of knowledge in influencing the decisions and actions of farmers in the course of adopting technologies or practices and goes further to characterize and categorize knowledge into three: knowledge on awareness, how to adopt and underlying principles of adoption. Awareness knowledge refers to learning about the existence of an innovation or a technology, while how-to - knowledge refers to having understanding on how the technology is applied, and principle knowledge denotes to the ability to understand the guiding rules of application of the technology (Rogers, 2003).

Adoption has been shown by Weir *et al.* (2000) to depend significantly on the farmers level of knowledge derived from their educational level, training, advice and information they receive. Surveys (Jones *et al.*, 2010; Deressa *et al.*, 2009; Dulal *et al.*, 2010), shows that better educated and informed farmers are always at the forefront in terms adoption of

new technologies. In spite of the critical role that knowledge plays in the decision and adoption of innovations, studies (Dzanku *et al.*, 2011; Roncolli *et al.*, 2009), have shown that small scale farmers are often isolated from information. Even though knowledge is considered a necessary condition for adoption it's not sufficient in itself (Jones *et al.*, 2010). For instance, farmers may have knowledge about climate smart practices, but may be constrained to adopt if they consider them not profitable and not consistent to their needs, priorities, beliefs and attitudes (Rogers, 2003).

2.8.2 Perceived Attributes of Climate Smart Practices

Attitude is considered an important indicator of human behavior and willingness to accept ideas (Arbuckle *et al.*, 2013). It has also been observed by Nyeko *et al.* (2002) that understanding the perceptions and attitude of farmers shed light on why individuals adopt technologies beyond profit. This is an important consideration for researchers in developing technologies that match the aspirations of the farmers (*ibid*).

Rogers (2003) contends that perception of individuals with regard to the attributes of innovations such as their relative advantage, compatibility with existing values, simplicity and ease of use, its ability to be experimented on a limited basis, and visibility of results, significantly builds the confidence of adopters. Hence reducing the perceived risks and uncertainties in their mind, subsequently influencing their attitude and adoption. It has also been noted by (FAO, 2010; FAO, 2013) that perceived attributes of technologies such as the costs and benefits of technologies greatly influences their adoption among farmers. Characteristics of a technology, such as simplicity, visibility of results, usefulness towards meeting an existing need and low capital investment also promotes its eventual adoption (Frank & Penrose, 2012).

2.9 Perception of Climate Change and Its Impact on Adoption of Agricultural Practices by Small Scale Farmers

The goal of perception therefore is to take information from the world and make sense of it. Wossink & Boonsaeng (2003) observed that the perception of farmers and their knowledge is critical in the development and research approaches. They indicated that

several policies fail because they are not applicable to farmers' perceptions and needs. Consequently, understanding the perception of individuals sheds light on their needs and aspirations vital for designing and developing relevant interventions.

Prager & Posthumus (2010), indicated that perceptions of adopters significantly influence adoption decisions. The adopter perception paradigm postulates that the process of adoption starts with the adopter's "perception of the problem and technology proposed" (Reimer *et al.*, 2012). Smithers & Smit (2009) also contends that perceptions about the environment influences adoption of strategies for adaptation to climate change. Weber (2010) further affirms that decisions and actions with regard to development and adoption of adaptation strategies to climate change are informed by perception of the climate risk among other factors.

It has also been noted by Posthumus *et al.* (2010) that perceptions depend on the context and are specific to the location due to diversity in factors such as education, culture, age, gender, institutional factors and resource endowments. Study by Nyanga *et al.* (2011) among small scale farmers in Zambia examining the relationship between perception of climate change and conservation agriculture as an adaptation strategy, established that most small-scale farmers attribute climate change to supernatural forces and did not consider conservation agriculture as an adaptation strategy. While a similar study in Kenya in the semi-arid areas indicated significant link between perception of climate change and adaptation strategies (Kalungu *et al.*, 2013).

Several research findings (Kalungu *et al.*, 2013; Wossink *et al.*, 2003; Posthumus *et al.*, 2010), have confirmed the importance of farmers' perception in adoption of agricultural practices. In spite of the critical role perception plays in the development and adoption of strategies, scarcity of information on small scale farmer's perception of climate change risks and its influence on the adoption of adaptation strategies is evident (Kalungu *et al.*, 2013). Kalungu *et al.* (2013) contends that there is dearth of knowledge about perceptions of rural farming households on the impacts of climate change on agricultural practices. Consequently, actors involved in adaptation to climate change and adoption of adaptation

strategies including climate smart practices have often not taken into consideration the perception of small scale farmers of climate change and its effects.

Similarly, awareness of climate change and its associated risks in developing countries has been rated as poor in comparison with developed countries, with Africa rating as the least of all (Pelham, 2009). A study by Mutinda *et al.* (2010) indicated low awareness of climate change and its effects at community level, with farmers having difficulties distinguishing between impacts arising from climate change and those as a result of environmental degradation. Several other studies (Deressa *et al.*, 2009; Dulal *et al.*, 2010), have shown that where positive perception of climate change characteristics exists in terms of noted change in precipitation, temperature and increased incidence of extreme events, it has played a crucial role towards small scale farmers' adoption of adaptation strategies either directly or indirectly. A Study has also shown, high adaptation in semi-arid areas, where climate change effects are more pronounced than high rainfall areas (Kalungu *et al.*, 2013).

2.10 Climate Information and Dissemination

2.10.1 Climate Information

Climate change is continuous and unpredictable, and therefore requires flexible decision making and planning that helps in dealing with uncertainties and risks presented by short and long term changes of climate change. This is a key element of adaptive capacity that depends on climate forecasts and information. Consequently, integration of climate information services has gained widespread recognition in agricultural activities (WMO, 2012; Christoplos, 2009). This information is useful in making decisions, diversifying livelihoods, managing risks and mitigating adverse effects of climate change. The information forms a fundamental basis upon, which agricultural decisions are made e.g., what crops and variety to grow? When to grow? When to harvest? When to stock or destock? When to apply fertilizer and pesticide?.

For many years, farmers have innovatively adapted with success to the changes in climate through intense observation, practice and experimentation (Carswell & Jones, 2004).

However, considering the complex process involved in gaining insight about the trends of an erratic phenomenon such as rainfall, uncertainty has been expressed on the capability of farmers to clearly understand the climate scenarios from their traditional and local observations (WMO, 2012), hence the need for scientific climate information.

Gathering of quality climatic data requires adequate operational national systematic observational network and access to regional and global climate data. According to UNFCCC climate information and forecasting services is useful in monitoring climate, enhances the understanding of the dynamics in the climate system, provide input in climate models and thus plan for adaptation options (UNFCCC, 2007).

In order to reduce vulnerability, enhance adaptive capacity to constantly changing climate, small scale farmers and other actors require access and adoption of quality climate forecasts and their likely effects for coming seasons and years. This enables them to undertake flexible planning, identify a range of response options, and make decisions for now and the future (WMO, 2012). Climate information should be accompanied by services that communicate, train and help users understand how to interpret and act on the information. According to World Bank (2008), appropriate climate information enhances small holder farmer's ability to mitigate the adverse effects of climate change.

It is also argued that to avoid disastrous consequences, important considerations in agricultural activities should be aligned to the changing climate (CGIAR, 2009). This is because, timely updated information of weather and climate scenarios helps farmers to change their agricultural activities in line with seasonal weather changes (WMO, 2012). Apparently access to appropriate technical assistance on climate information to small scale farmers reduces costs of adapting to climate change (World Bank, 2008).

In spite of the vital role climate information plays in enhancing resilience to climate change and variability, and managing risks, Dzanku *et al.* (2011) and Roncolli *et al.* (2009) indicate isolation of small scale farmers from available knowledge and information systems. This position is supported by Mburu, (2013) who indicates low

awareness in terms of climate information and lack of specific policies on climate change adaptation with regard to small scale farmers in Kenya. In Kenya, integration of climate information in agriculture has been undertaken in various areas by CARE Kenya and in all 47 counties by Agriculture Sector Development Support Programme (ASDSP) through an innovative and all-inclusive process referred to as Participatory Scenario Planning; however, little is known about access and use of this information by small scale farmers.

2.10.2 Dissemination of Climate Information

Innovation decision theory postulates that dissemination of information plays a significant role in adoption decisions of individuals (Rogers, 2003). In spite of the vital role climate information plays in adoption of appropriate practices, Harvey *et al.*(2009) articulated the limited sharing of information among climate change practitioners in Africa. Chamboko *et al.*(2008) further indicated existence of limitation in terms of information delivery mechanisms such as reliability, timing, infrastructural development and even language.

Cherotich *et al.* (2012) during their study on access to climate change information and support services by the vulnerable groups in semi-arid Kenya for adaptive capacity development, found lack of capacity on the part of extension agents in terms of interpreting weather data. This hampered effective dissemination of climate information. Cherotich *et al.* (2012) further asserted that there is lack of readily available good quality climatic and agronomic data and time series of climate information to farmers & planners in most developing countries including Kenya.

Murgor (2014) in his study on Farmers Access to Climate and Weather Information and its Impact on Maize and Wheat Production in Uasin Gishu County, found out that climate & weather information is not readily coordinated, shared or disseminated in a timely way in the county. Murgor (2014) also alluded to a major challenge of adaptability, format and timing challenges of climate information. He further indicated that climate information is not downscaled and repackaged in formats that farmers

access, understand and can use. This is further compounded by lack of skill in dissemination attributed to limited knowledge with regard to the principles of extension education on the part of change agents (Mwangi, 1998).

Cherotich *et al.* (2012) argued that choice of dissemination channels have significant influence on access and use of climate information. According to innovation decision theory there are mainly two channels of dissemination. These are, mass media which is considered most effective in dissemination of knowledge and interpersonal channels considered important in influencing individuals attitude towards innovation (Rogers, 2003). Studies (Marx, *et al.*, 2007; Roncoli *et al.*, 2009), have shown that facilitated group interaction appears to be the most effective method to communicate seasonal forecast information in a way that farmers can use. It's therefore recommended that climate information dissemination should ideally be a routine part of agricultural extension services where they are functional (*ibid*). This is in agreement with innovation decision theory which considers interpersonal communication channel as a more effective channel (Rogers, 2003).

In Kenya, the Meteorological Department (KMD) spreads weather forecasts using dissemination pathways such as mass media, print media and the internet, while Arid Lands Information Networks (ALIN) uses Information and Communication Technologies (Nguo & Lusaka, 2005).

2.11 Knowledge Gaps

Several studies (Brooks *et al.*, 2005; Deressa *et al.*, 2009; Dulal *et al.*, 2010; Mburu, 2013) have been undertaken to measure the impact of climate change on Kenyan agriculture, and suggested adaptation measures. However, most of them failed to indicate the factors affecting the choice of the suggested adaptation methods. This presents an important limitation since farmers' responses to climate change or their choice of adaptation methods is dictated by a host of factors.

There are also a number of studies (Brooks *et al.*, 2005; Deressa *et al.*, 2009; Dulal *et al.*, 2010) that have examined factors that determine farmers adoption of strategies for adapting to climate change. However, literatures review, indicate mixed results and variation in factors that influence adoption with regard to different technologies in different places.

There are also a number of studies (Brooks *et al.*, 2005; Deressa *et al.*, 2009; Dulal *et al.*, 2010) that have been undertaken to determine factors influencing adoption of adaptation strategies. But most of them focus on arid and semi-arid areas considered more vulnerable and pay little attention to high rainfall areas like Kisii County. There is therefore paucity of information with regard to the factors influencing choice of adaptation measures in areas that are considered humid.

Rogers (2003) affirms the importance of knowledge about technologies and attitude as important prerequisites that determine the decisions and actions of farmers in the course of adopting technologies or practices. In occasions where adoption of technologies has failed, several studies (Howley *et al.*, 2012; Dzanku *et al.*, 2011; Jones *et al.*, 2010; Roncolli *et al.*, 2009), have indicated limited knowledge as one of the factors responsible, but failed to show the specific knowledge gaps and why.

Similarly, the adopter perception paradigm postulates that the process of adoption starts with the perception of the problem and technology under consideration (Reimer *et al.*, 2012; Prag & Posthumus, 2012). There is dearth of information on smallholders perception of climate change and its effects considered a key element influencing adoption of adaptation strategies, particularly in areas considered high rainfall areas (Smither & Smit, 2009; Kalungu *et al.*, 2013). At the same time perception is location specific.

Availing timely and appropriate climate information has been considered critical in helping farmers prepare and adapt to uncertainties and risk through adoption of appropriate practices. In addition, innovation diffusion paradigm postulates that

information dissemination is the main determinant that influences adoption of technologies; however, few studies (Murgor, 2014; Cherotich *et al.*, 2012) have explored the extent of dissemination and access of weather and climate information among small scale farmers including the study area. There is therefore need to assess the extent of outreach of this information and its influence on adoption of climate smart practices, and dissemination pathways in order to determine appropriate measures for strengthening access and use of climate information for enhanced adoption of climate smart practices.

Currently, there are suggestions in the Ministry of Agriculture to develop appropriate legal and policy framework, strengthen capacity, generate and disseminate information and knowledge. There are also efforts in the ministry towards determining information needs of stakeholders and development of targeted communication products to support the implementation of climate smart technologies. There are also plans to finalize an agriculture based insurance policy, align climate smart technologies to tap into existing and emerging funding mechanisms and integrate climate smart technologies application in the ongoing climate change policy development (MOALFD, 2014). The success of these initiatives requires considerable research that this study was intended to contribute to.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the study area, study design, study population, sampling method, sample size, data collection methods, data collected and data analysis.

3.2 Study Area

3.2.1 Location

The study area was the former Kisii Central District, currently divided into 3 sub counties namely Kitutu Chache North (Marani, Kegogi, Ngenyi), Kitutu Chache South (Nyakoe, Kitutu Chache and Kisii Municipality) and Nyaribari Chache (Nyaribari Kiogoro, Nyaribari Keumbu and Nyaribari Central) (Figure 3.1). The area is further divided into 15 wards covering a total area of 361km², with a population of 336,149 persons and average farm size of 0.5ha (GoK, 2009). The study area has a hilly topography and is endowed with several permanent rivers flowing from East to West into Lake Victoria.

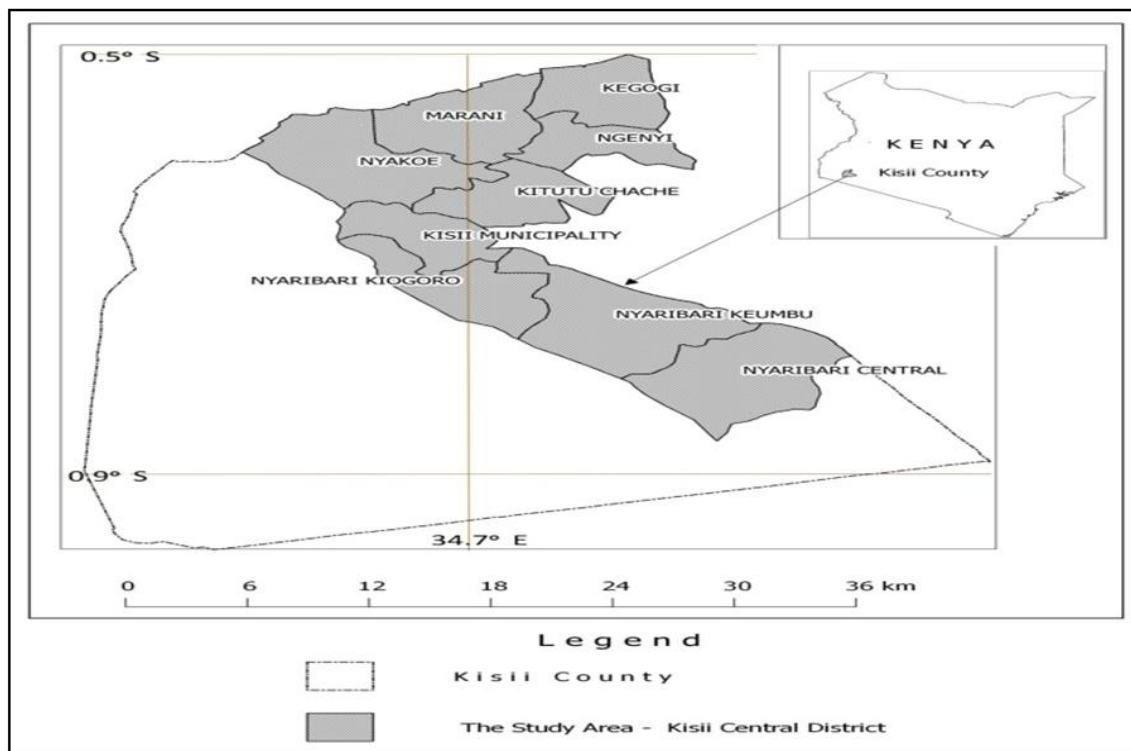


Figure 3.1: Map of Study Area

3.2.2 Soils and Vegetation

Soils are 75% red volcanic loam (nitosols) and therefore generally good and fertile for agriculture. The remaining area is comprised of clay, red loams, sandy soils, black cotton soils (verisols) and organic peat soils (phanosols) (Jaetzold *et al.*, 2009). Natural vegetation is very partial with 90% of the total area under cultivation (Ogechi & Hunja, 2014).

3.2.3 Ecological Zones

This area falls into three agro ecological zones: Lower Highland Zone (LHI) (Keumbu and Kilgore), Upper Midland Zone (UMI) (Kiogoro and Marani) and Lower Midland Zone (LMI) (Nyakoe and Township) Table 3.1.

Table 3.1: Agro Ecological Zones of Kitutu and Nyaribari Chache in Kisii County

Agro Ecological Zone	Altitude	Annual Mean Temperature °C	Annual Average Rainfall (mm)
LH1	2000-2210	18-16.2	1400-2100
UM1	1500-1620	20.5-19.9	1600-1800
LM1	1450-1550	21.7-21	1300-1600

Source: Jaetzold *et al.* (2009).

3.2.4 Climate

The region has a highland equatorial climate resulting into two rainy seasons. The long rains occur between February and June, while short rains are experienced between September and early December in all areas. The area receives an average annual rainfall of 1500mm. Dry spell is generally experienced in January and July. The maximum temperatures in the area usually range between 21°C–30°C, while the minimum temperatures range between 15°C–20°C (Jaetzold *et al.*, 2009).

3.2.5 Agriculture

Agriculture is mainly small scale and non-mechanized, and is the mainstay of the area, employing a workforce of over 80%. Agriculture is also a source of livelihood for

majority of the rural dwellers and raw materials for agro-based industries that are under development (GoK, 2009). In spite of the critical role agriculture plays, high population density coupled with high demand for food has exerted a lot of pressure on land resources. This has subsequently led to declining farm sizes and continuous cultivation without fallow periods resulting into deterioration of soil fertility and depression of productivity.

While acknowledging land degradation, study by Ogechi & Hunja (2014) on land use/cover changes and main drivers of agricultural land degradation in Keumbu (Nyaribari Chache Sub County), revealed expansion of cropland, human settlement with consequent reduction in forest and grassland, exacerbation of soil erosion, decline in crop yield and rise in food insecurity.

The declining productivity has been aggravated further by unpredictable weather changes attributed to climate change. In spite of the challenges the area is considered suitable for growing of crops like tea, coffee, maize, beans, bananas, fish farming and livestock rearing. The area was selected for the study because of the decreasing yield of crops as a result of poor agronomic practices, unpredictable weather changes, and low soil fertility due to over use of same land parcels over a long time.

3.3 Study Design

The research adopted a survey design involving both quantitative and qualitative research strategies. These research strategies facilitated triangulation and dovetailing of the findings and helped to offset the weaknesses of either of the two approaches (Bryman, 2008).

3.4 Target Population

The study population consisted of 336,149 farmers of Kitutu and Nyaribari Chache sub counties in Kisii County.

3.5 Sample Size and Sampling Procedure

The sample size for the study was arrived at by use of a formulae by Krejcie & Morgan (1970). The formula entails determining the sample size(s), from a given fixed population (P) with the sample size within plus or minus 0.05 of the population proportion at 95 percent level of confidence. The 95% confidence level is preferred because its narrower, with lower variability and when coupled with a higher sample size it enhances precision (Bryman, 2008).

This formula is shown as follows:

$$S = X^2 NP (1-P) / d^2 (N-1) + X^2 P(1-P)$$

Equation 3.1: Krejcie & Morgan (1970)

Where: X^2 = Chi-Square table value for 1 degree of freedom at the preferred confidence level (in this case 3.84), N = the population size (336 149), P = the population proportion (assumed to be 0.5), d – the degree of precision stated as a proportion (0.05). use of the formula gave 384 as the minimum sample size for the study.

However, the study adopted a sample size of 420 participants who were randomly selected from each of the 15 wards in the study area as indicated in Table 3.2. The sample size was larger to accommodate non-responses. Both probability and non-probability sampling techniques (simple random and purposive sampling) were used in this study. Simple random sampling technique was used in determining individuals for administration of questionnaires. The population was divided into sampling units represented by wards. Proportional sample sizes for wards was arrived at using the following formula

$$ni = n/N * 420$$

Where ni is Sample size for the ward, n is the total number of farmers in the ward and N is the total number of farmers in the study area. The respondents were randomly sampled from lists of farmers, who had been assigned numbers. They were drawn from all the 15 wards in the three sub counties as indicated in Table 3.2.

Table 3.2: Distribution of Respondents in 15 Wards of Kitutu and Nyaribari Chache In Kisii County

Sub County	Ward	No of Farmers	Frequency	Percentage
Kitutu	Sensi	24 010	30	7.1
Chache	Kegogi	16 007	20	4.76
North	Monyerero	26 412	33	7.85
	Marani	14 406	18	4.28
Kitutu	Nyakoe	27 212	34	8.09
Chache	Nyatieko	20 809	26	6.2
South	Bogeka	21 610	27	6.4
	Bogusero	22 410	28	6.67
	Kitutu central	28 012	35	8.3
Nyaribari	Keumbu	25 611	32	7.6
Chache	Kiogoro	17 608	22	5.2
	Kisii central	30 414	38	9.0
	Ibeno	24 811	31	7.4
	Bobaracho	20 009	25	6.15
	Birongo	16808	21	5
	Total	336 149	420	100

The number of respondents per ward ranged between 18 to 38 depending on the proportion of the population. Purposive sampling was on the other hand, used in identifying key informants and Focus Group Discussions (FGDs) participants. In this study key informant interviewees were individuals who had competence and knowledge in the area of Agriculture and climate change by virtue of their academic qualifications and or many years of work, drawn from public and private agencies (Table 3.3). They were identified with the help of County Directors of Agriculture and Livestock. While focus group participants, were mainly service providers (extension officers) and farmers who had working and farming experience in the area of study. They were also identified based on records of farmers and staff in the Agriculture and Livestock offices at the sub county level.

3.6 Data Collection Methods

Before the actual data collection, pretesting of tools to determine their reliability and validity using a randomly selected sample of 30 farmers and technical officers of agriculture was conducted in June, 2015. The farmers and technical officers were drawn from all the three sub counties of the study area. The study tools were considered reliable if the respondents answered the questions in the same way each time they were asked. The study tools were deemed valid, if they measured accurately the concepts; they were intended to measure (Bryman, 2008). The farmers and technical officers were taken through the questionnaire, key informant interview and focus group discussion tools and then asked to offer any suggestions and criticism regarding the clarity and appropriateness of each of the tools. After which, all of the recommendations and comments were taken into consideration and appropriate changes made (Bryman, 2008).

Data collection commenced with administration of individual questionnaires to small scale farmers who had been randomly selected for the study, after which key informant interviews were carried out with technical officers of in the agriculture sector. Collection of data was undertaken by supervisors who consisted of 3 subcounty agricultural officers and 4 research assistants from each ward, who were trained and served with questionnaires. The research assistants consisted of ward agricultural extension workers.

In bid to establish factors influencing adoption of climate smart practices, quantitative data on socioeconomic characteristics of respondents and climate smart technologies practiced was collected using questionnaires. The socioeconomic characteristics included age, gender, gender of household head and educational level. Others included farm size, farming enterprise, farming experience, sources of income, income level, and access to credit, membership and benefits drawn from farmer organizations.

The climate smart practices which were examined in the study included practices that had been promoted under National Agriculture and Livestock Extension programme (NALEP) and Kenya Agriculture and Livestock Research Organization (KALRO). They included practices that were also being promoted under Agriculture Sector Development

Support Programme (ASDSP) and considered climate smart by FAO (FAO, 2010; FAO 2013);

- a) Drought, disease, pest and flood tolerant and early maturing varieties and use of greenhouse technology
- b) Mixed cropping, integrated crop and livestock systems, Intercropping and crop rotation, improved fallowing, rain water harvesting and irrigation
- c) Soil and water conservation and agroforestry
- d) Biogas production, farm yard composting and use of organic manure and farm specific nutrient management and precise fertilizer application
- e) Making of hay and silage, pasture management e.g. controlled grazing, improved forage varieties and feed management to reduce methane emissions
- f) Use of agro weather advisories and index based agricultural insurance

To determine the knowledge, attitude and practice of climate smart practices among farmers, collection of data was centred on various aspects. These aspects included awareness, level of knowledge and farmers perceived characteristics of climate smart practices such as benefits, profitability, cost, risks and uncertainties. Practice of climate smart practices dwelled on the proportion of farmers who had tried, eventually adopted or abandoned them and reasons for their decisions. Finally, the study looked at the influence of knowledge of specific climate smart practices and on their adoption.

To establish the perception of the farmers with regard to climate change and its influence on adoption of climate smart practices, the study sought to determine whether farmers recognized the problem of climate change and its effects on farming, and whether this had indeed translated into shift to climate smart practices. In assessing the extent of dissemination of climate information and its influence on adoption of climate smart practices, the study looked at the proportion of respondents that were aware and knowledgeable in the use of climate information. The study further sought to establish the relationship between access to climate information among small scale farmers in the study area and adoption of climate smart practices.

3.6.1 Questionnaires

The questionnaires were administered to 420 farmers selected randomly for the study. The questionnaire items were aligned to the four themes of the study. The questionnaires captured data on demographic and socioeconomic profile of respondents, their perception about climate change, its effects on farming and corresponding responses, knowledge, attitude and adoption of climate smart practices among the respondents, factors perceived to influence adoption and the institutional and policy context of adoption of climate smart practices. The questionnaires also captured the extent of dissemination of climate information and its impact on adoption of climate smart practices.

3.6.2 Focus Group Discussions

Four mixed sex Focus Group Discussions (FGDs) were undertaken, two with extension service providers from the agriculture sector, and the other two with farmers. These discussions, involved small groups of eight to twelve people who were led through open discussion guided by a trained leader (skilled moderator). During the discussions, the leaders explained to the participants the purpose of the discussions. After which the discussions were structured around a checklist of carefully predetermined questions under the four themes of the study (Appendix 3). Apart from ensuring full participation of every participant, further probing was undertaken to ensure sufficient information was generated. The proceedings of the discussions were noted on flip charts and note books.

3.6.3 Key Informant Interviews

Key informant interviews were conducted with a broad array of actors drawn from public and private agencies with specific mandate in agriculture or climate change adaptation (Table 3.3). The key informant interviews were aimed at providing an in depth understanding of climate change and its impacts in the study area, adoption of climate smart practices, policies and institutional arrangement at the county level dealing with climate change challenges. These interviews were also aimed at determining the technical and institutional capacity to respond to changing climate and its effects. During the study, thirty key informants were interviewed.

Table 3.3: Key Informant Interviewees of Kitutu and Nyaribari Chache in Kisii County

Type of organization	Respondents
Government departments	Chief officer (Agriculture, Livestock and Fisheries) County Directors of Agriculture and Livestock County Director of Fisheries County Executive officer of Environment County Director of Environment Sub county heads of Agriculture, Livestock and Fisheries Ecosystem Conservator of Forestry County Director of National Environmental Management Authority(NEMA)
NGOs and CBOs	One Acre Fund, Kenya National Farmers Federation(KENAFF), Juhudi Kilimo
Farmer Organizations	Otamba Youth Group, Kenyori Women Group & Nyaura Widows group

3.6.4 Observations

Observations were made to confirm and gain primary knowledge of climate smart technologies practiced in the study area. The observations were captured in field notebooks and in the form of pictures, and notes.

3.6.5 Desk Study

To identify institutional and policy weaknesses with regard to adoption of climate smart practices in the study area, a desk study was undertaken. The desk review included analysis of existing policies, strategies and regulations in the agriculture, water, environment and land both at National and County levels.

3.7 Type of Data Collected

Both primary and secondary data were collected to realize the objectives of the study. The data was encapsulated in four themes as indicated below.

- a) Factors influencing adoption of climate smart practices among small scale farmers.
- b) Existing knowledge, attitude and practice of climate smart practices among small scale farmers.

- c) Perception of climate change, its effects on farming and its impact on adoption of climate smart practices among small scale farmers.
- d) Extent of climate and weather information dissemination and its influence on adoption of climate smart practices among small scale farmers.

3.8 Data Analysis

Data was analysed by use of both qualitative and quantitative approaches. The quantitative data mainly questionnaire items were coded and analysed using SPSS version 16.0, where the generated results were presented in form of tables, charts and figures. Qualitative data from key informant interviews, FGD notes and desk review of policies was analysed by establishing the categories and themes, relationships/patterns and conclusions drawn in line with the study objectives (Gray, 2004).

To test the statistical significance of the findings of this study, important in determining the factors influencing adoption of climate smart practices, relationship between independent variables i.e. demographic and socio economic characteristics, knowledge level of climate smart practices, perception of climate change and its risks and extent of dissemination of climate information and dependent variable (adoption of climate smart practices) , was analyzed using chi- square contingency (χ^2) statistical test (Table1.1; Table 3.4). This is because it allows the establishment of confidence that there is a relationship between two variables in the population. (χ^2) value was interpreted in relation to its associated level of statistical significance, which in this case was $p < 0.05$ (Bryman, 2008). *P* value greater than 0.05 denoted lack of association or relationship between the variables in the population.

Table 3.4 Data Analysis Matrix

Objective	Data Sets	Data Source	Analysis Method	Statistical Test
1	Demographic, Socioeconomic and Farm Characteristics	Questionnaires, Key Informant Interviews, Focus Group Discussions, Desk reviews	SPSS	Chi-square
2	Knowledge, Attitude and Practice of Climate Smart Practices	Questionnaires, Key Informant Interviews, Focus Group Discussions, Field Observations	SPSS, Qualitative	Chi-square
3	Perception, Climate Change and Its Effects, Adoption of Climate Smart Practices	Questionnaires, Key Informant Interviews, Focus Group Discussions, Field Observations	SPSS, Qualitative	Chi-square
4	Climate and Weather Information Dissemination, Adoption of climate smart practices	Questionnaires, Key Informant Interviews, Focus Group Discussions, Field Observations	SPSS, Qualitative	Chi-square

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, results are presented and discussed in five sections; socioeconomic and farm characteristics of respondents (4.2), perception of climate change risks and its influence on adoption of climate smart practices (4.3), knowledge, attitude and practice of climate smart practices (4.4), factors influencing adoption of climate smart practices (4.5), and extent of climate information dissemination and its impact on adoption of climate smart practices among small scale farmers (4.6).

4.2 Socio Economic and Farm Characteristics of Respondents

4.2.1 Age Distribution of Respondents

The respondent's age ranged between 18 years to over 50 years. The number of both male and female respondents generally increased with increase in age bracket. This implied age is positively correlated with farming engagement. Only 7.85% (n=33) of the respondents were between the age of 18-30 years (Table 4.1).

Table 4.1: Age and Gender Distribution of Respondents of Kitutu and Nyaribari Chache in Kisii County

Age (yrs)	Gender				Total	
	Male		Female			
	Frequency (n)	Percentage %	Frequency (n)	Percentage %	Frequency (n)	Percentage %
18-30	15	3.57	18	4.28	33	7.85
31-40	58	13.8	57	13.57	115	27.38
41-50	75	17.85	59	14.04	134	31.9
>50	94	22.38	44	10.47	138	32.85
Total	242	57.6	178	42.4	420	100

*Average age of the Farmers (47 Years)

From the results, it was observed that majority of the farmers were beyond the age of 30 years. The average age of the farmers in the study area was 47 years, however other findings reveal average age differences among different agro enterprises. For instance, average age of coffee farmers in Kisii was found to be 57 years, while that of fish farmers stood at 43 years (KCG, 2014). Very few (7.85%) young people in Kitutu and Nyaribari Chache sub counties were engaged in farming, despite the high unemployment rate. According to a survey conducted by ASDSP (2014), the low involvement of youths in farming was due to lack of land, capital and low interest in farming. These results were in congruence with the findings of Murage *et al.* (2013), who found out that there were more elderly farmers in Kenya, compared to Tanzania and Ethiopia. Similar findings were established by Wemali (2014) in Mumias sugar belt Zone, and Mirona, (2005) in the entire Kisii County. This affirmed UNDP (2011) position that Kenya's farming population is aging because agriculture remains unattractive to youths.

4.2.2 Gender Distribution of Respondents

Out of the total 420 respondents, 242 were males (58%), while 178 were females (42%), (Table 4.1). This shows that both males and females were involved in farming activities. The involvement of both sexes was because farming remains the main source of livelihood among 80% of the rural dwellers in the study area (GoK, 2009). From the study, it was also explicit, there were more registered male farmers compared to females. These findings agree with Okuthe *et al.* (2013), which revealed the existing bias in extension services offered to men compared to women.

4.2.3 Gender of Household Head

Majority (86%, n=361) households were male headed, while only (14%) were female headed (Figure 4.1). This indicated decision making in most of the households in Nyaribari and Kitutu Chache sub counties were determined by men. This agreed with ASDSP, (2014) house hold survey results in the entire Kisii County that revealed that most of the households were male headed (64%), while female headed and youth headed households constituted 11% and 26% respectively.

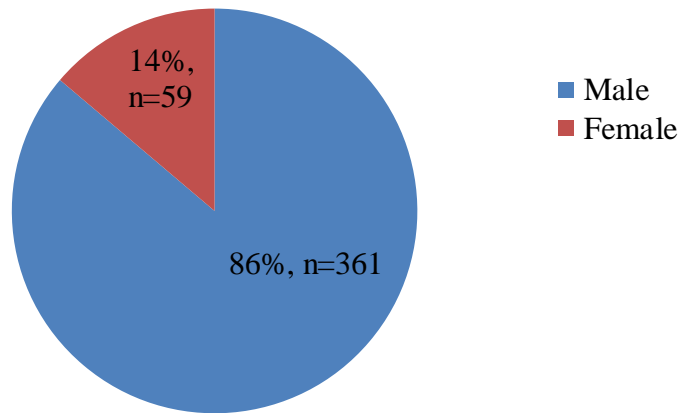


Figure 4.1: Gender of Households heads in Kitutu and Nyaribari Chache of Kisii County

4.2.4 Education Level of Respondents

Most (87.37%, n=367) respondents had attained both primary and secondary level of education. Very few (10.65%, n=44) had attained middle level college and university education. Only (2.14%, n=9) lacked formal education (Table 4.2). This showed that most of the farmers in the study area had sufficient capacity to understand and apply farming principles, and therefore capable of adopting climate smart practices.

More women (20.71%, n=87) had primary level of education as compared to men (19.5%, n=82) (Table 4.2), conversely, more men had attained secondary education and above compared to women. This was probably due to higher dropout rate among girls and women at primary level due to social cultural challenges. These results were consistent with government statistics, which exhibited high literacy rate (86.5%) in the study area. The proportion of the population in Kisii County with primary education was estimated at 64.5%, while the proportion of the population with secondary education was estimated at 17.3% (GoK, 2009).

Table 4.2: Educational Level of Respondents of Kitutu and Nyaribari Chache in Kisii County

Educational level	Gender				Total	
	Male		Female		Frequency (n)	Percentage %
	Frequency (n)	Percentage %	Frequency (n)	Percentage %		
Primary	82	19.5	87	20.71	169	40.23
Secondary	128	30.47	70	16.67	198	47.14
College	24	5.71	12	2.85	36	8.57
University	5	1.29	3	0.71	8	1.90
No formal education	3	0.71	6	1.42	9	2.14
Total	242	57.61	178	42.38	420	100

4.2.5 Farm Sizes of Respondents

Majority (76.4%, n=321) of respondents owned 2 acres and less of land, with only 23.6 % (n=99) owning beyond 2 acres (Figure 4.2). The average mean land holding size in the study area was 2 acres.

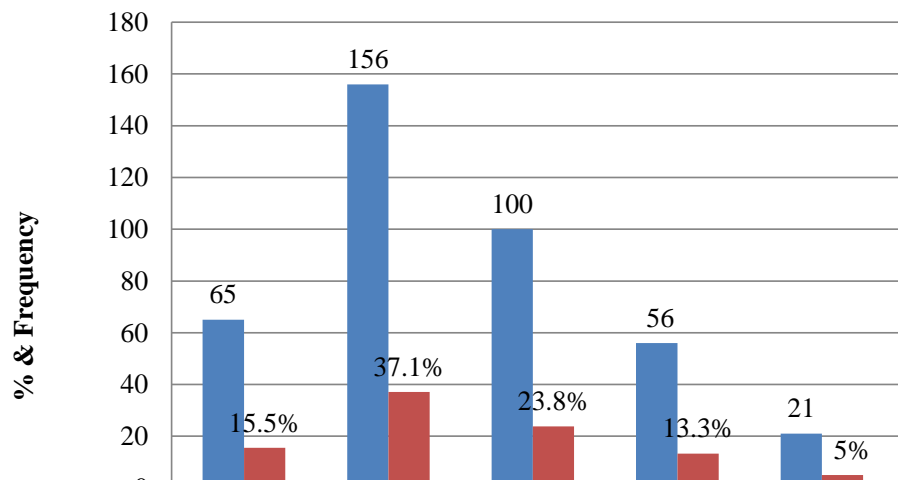


Figure 4.2: Farm Sizes of Respondents of Kitutu and Nyaribari Chache in Kisii County

This study affirmed the continued fragmentation of land into smaller units as a result of high population density that has hindered agricultural mechanization. These results concurred with the Kisii County Government Integrated Development Plan which placed the mean land holding size of Kisii County at the range of between 0.5 to 4.5 acres (KCG, 2014).

4.2.6 Farming Enterprises of Respondents

Most of the farmers (97%, n=407) in the county were involved in crop farming (Figure 4.3). Very few (3%, n=13), were engaged entirely in livestock rearing in spite of the conducive climatic conditions. This could be attributed to scarcity and small sizes of land. These findings revealed high dependency on crop farming in this area, a scenario which predisposed them to high vulnerability to climate change and weather shocks. Farmers should therefore be encouraged to consider diversifying from crops only to livestock enterprises and off farm income generating activities for enhanced resilience to climate change effects.

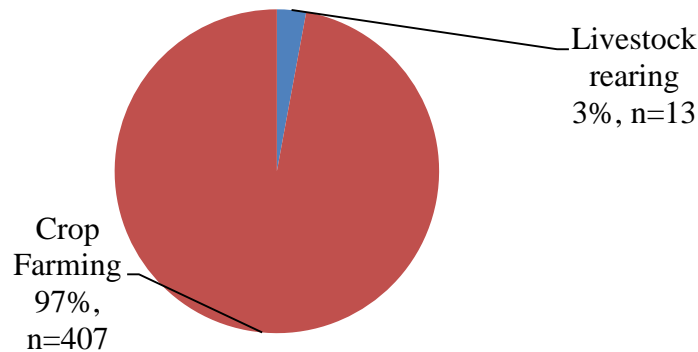


Figure 4.3: Farm Enterprises of Respondents of Kitutu and Nyaribari Chache in Kisii County

4.2.7 Farming Experience

All respondents (100%, n=420) had some level of experience in farming, ranging from 1 to over 10 years. Majority (51.9%, n=218) of respondents had experience of over 10 years (Table 4.3). A very small (2.87%) proportion of respondents had one-year experience. This could be young people who had just made their entry into farming.

Table 4.3: Farming Experience of Respondents of Kitutu and Nyaribari Chache in Kisii County

Farming Experience (Years)	Gender				Total	
	Male		Female		Frequency (n)	Percentage %
	Frequency (n)	Percentage %	Frequency (n)	Percentage %		
1	9	2.16	3	0.7	12	2.87
2-5	44	10.47	39	9.2	83	19.76
6-10	62	14.76	45	10.71	107	25.47
>10	127	30.24	91	21.67	218	51.9
Total	242	57.61	178	42.38	420	100

In terms of gender men (57.61%) were more experienced compared to women (42%) (Table 4.3). This was probably due to limited access of women to productive resources such as land and credit. These results are similar to those of Okuthe *et al.* (2013) who found that over 50% of the farmers in Ndhwa division of Homabay County, had experience of over 3 years in farming. This clearly depicted that most farmers in the study area had sufficient knowledge and skill with regard to farming. According to Iheanacho (2000) and Okuthe *et al.* (2013) farming experience influences knowledge in terms of farm management and tends to enhance farmers understanding of environmental and socio-economic factors that affect farming.

4.2.8 Crops Grown in Kitutu and Nyaribari Chache areas in Kisii County

The crops grown in the area were mainly Fruits (Avocadoes, Bananas, Paw Paws), Cereals (Maize *zea mays*), Pulses (beans), Cash crops (Tea, sugarcane, Coffee), Vegetables (Kales *brassica sp.* Onions, and other vegetables). This diversity indicated the high potential and suitability of the agro ecological conditions in the study area, for supporting growing of several crops. Thus viable for application of climate smart

practices such as intercropping, mixed cropping and crop rotation. These findings corroborate those of Jaetzold *et al.* (2009).

4.2.9 Main Sources of Income of Respondents

Majority of respondents (86%, n=361) derived their income from farming activities, with only (14%, n=59) relying on other sources (Table 4.4). The findings indicated clearly that most people in the area rely on agriculture or farming for their livelihood. This was consistent with national and county findings, which showed that farming supported over 80% of the rural people in terms of livelihood and food security beside its substantial contribution to wider economic development goals (KCG, 2014; GoK, 2009).

Table 4.4: Sources of Income of Respondents of Kitutu and Nyaribari Chache in Kisii County

Sources of income	Gender				Total	
	Male		Female			
	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Farm income	312	74.28	49	11.66	361	86
Non-farm income	50	11.90	9	2.14	59	14
Total	362	86.2	58	13.80	420	100

This also showed little diversification of livelihoods hence high vulnerability to climate change, and other risks. In terms of gender disaggregation, men dominated in both farm income (74.28%, n=312) and non-farm income (11.90%, n=50), compared to women 11.66% (n=49) and 2.14% (n=9) respectively (Table 4.4). This could be due to social cultural barriers that hinder women from participating and benefiting from cash crop farming.

4.2.10 Income Levels of Respondents

Majority (48.1 %, n=202) of respondents had monthly income of less than kshs 5000/=. This indicated that most respondents barely survived and therefore unable to save and invest in any other meaningful economic activity. This also applied to the case of those who indicated earning of between kshs 5001/= 15000/= (41.9%, n=176). Very few (5.2%, n=22), earned above kshs. 25 000/= (Table 4.5), which was considered above the international poverty threshold (\$1.9 per day per person) given an average household size of 5 persons in the study area. Income level was considered for the study, because it acts as a proxy measure of material wellbeing and capacity to absorb new innovations and climate change shocks (Deressa *et al.*, 2009). The results of this study, indicated majority of the farmers were poor (earning less than kshs.15 000/month) and unable to make significant investment in their farming activities including adoption of climate smart practices. In order to enhance adoption of climate smart practices, necessary policy and institutional measures should be undertaken to create additional income opportunities. These findings were in agreement with Djurfeldt *et al.*(2011), who argued that small scale farmers hardly rely on either government or market institutions for their existence and are characterized with mere subsistence farming, meager output per unit area, small and unpredictable incomes and high vulnerability to socioeconomic and climatic risks.

Table 4.5: Monthly Income of Respondents of Kitutu and Nyaribari Chache in Kisii County

Monthly Income	Gender					
	Male		Female		Total	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %	Frequency	Percentage %
≤5000	87	20.71	115	27.38	202	48.1
5001-15000	128	30.47	48	11.42	176	41.9
15001-25000	14	3.3	6	1.4	20	4.8
25001-35000	10	2.3	6	1.4	16	3.8
>35000	3	0.7	3	0.7	6	1.4
	242	57.48	178	42.52	420	100.0

Disaggregation by gender revealed more females (27.38%, n=115), were likely to earn the lowest income of kshs 5000/= or less as opposed to men (30.47%, n=128) (Table 4.5). This point to high vulnerability among women compared to men in this area. This was attributed to the relegation of women to subsistence farming considered their domain, compared to men who concentrated on commercial agricultural enterprises. There is therefore need to enhance women participation in profitable farming enterprises to improve their socioeconomic status necessary in boosting their adoption of climate smart practices and resilience to climate change risks.

4.2.11 Respondents Access to Credit

Majority (90%, n=378) of farmers in the study area had no access to credit. Only 10% (n=42) of the respondents indicated they had applied and used credit in their farming activities (Figure 4.4). This was due to lack of awareness of existing credit facilities, high interest rates or lack of collateral due to limited land sizes and title deed ownership. This was articulated during focus group discussions. In the entire Kisii County, only 40% of the population was in possession of title deeds (KCG, 2014). Credit is considered vital in supplementing the meager resources that farmers have, to meet the costly financial requirements in their farming activities (Jones *et al.*, 2013). With limited access to credit, farmers were constrained in terms of investing in farming activities including adopting of innovations, such as climate smart practices. Similar results were found during ASDSP household survey in the entire Kisii County. According to the household survey, only 16% of the household's accessed credit, out of which male constituted 11%, while female formed 5% (ASDSP, 2014).

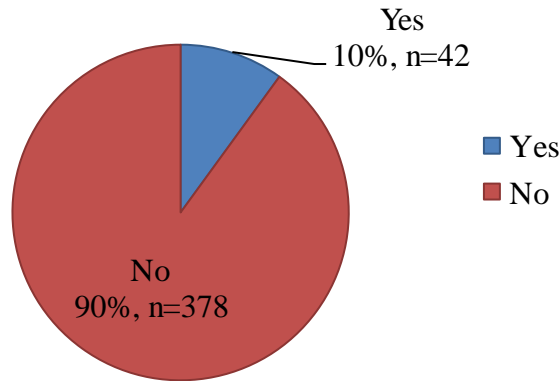


Figure 4.4: Access to Credit among Respondents of Kitutu and Nyaribari Chache in Kisii County

4.2.12 Respondents Membership in Farmer Organizations

Majority of respondents (86.7%, n=364) belonged to farmer organizations in this area (Figure 4.5). This demonstrated high awareness and good understanding of the benefits of farmer groups. The findings were in agreement with Kristin (2004) who found out that most farmers belonged to some type of farmer group in Meru Central District (Meru County). With enhanced performance of these groups; farmers were likely to reap many benefits associated with them, including adoption of climate smart practices. However, the study noted that membership in groups was often motivated by the need for financial assistance, to the extent that its unavailability resulted into waning of membership in most groups.

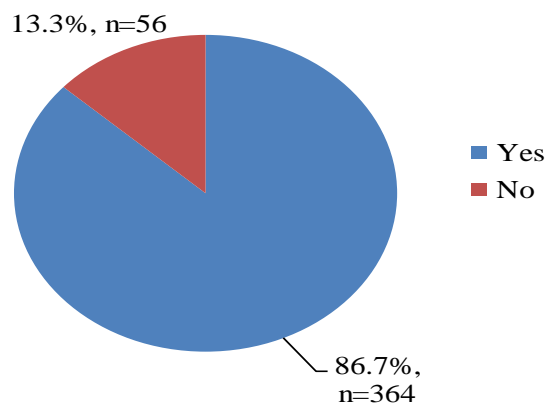


Figure 4.5: Membership in Farmer Groups

4.2.13 Benefits Farmers Derive from Organizations

All the respondents (100%, n=420) indicated as having benefited from their participation in farmer organizations in one way or another (Figure 4.6). However, majority (55.0%, n=249) were of the view that membership in these organizations had enhanced their access to extension services. Others 23.3% (n=98) and 18% (n=77) alluded to the fact that farmer organizations had facilitated their access to credit and new methods of farming respectively.

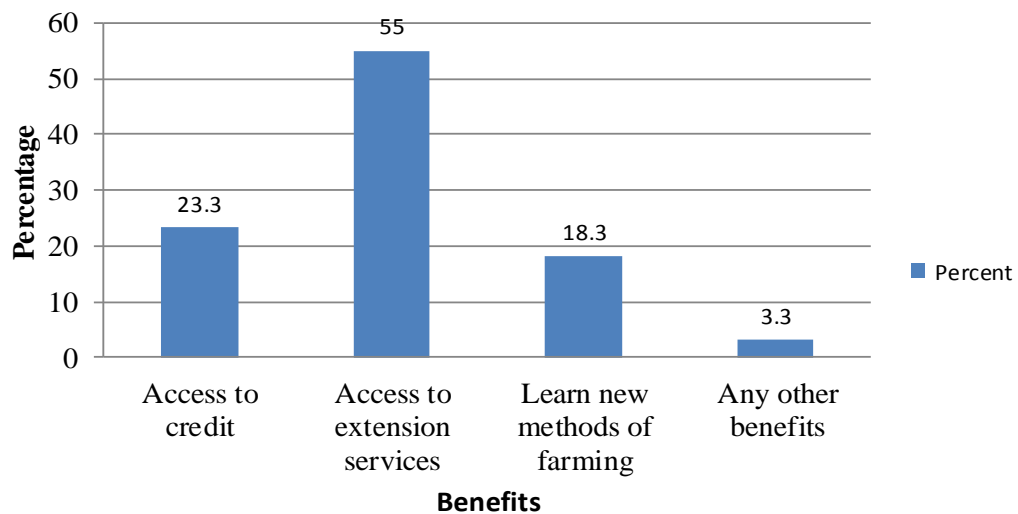


Figure 4.6: Benefits derived from Farmer Organizations in Kitutu and Nyaribari Chache of Kisii County

This clearly showed that farmers benefited mainly in terms of enhanced access to extension services. This was consistent with Jones *et al.* (2013) who found out to a great extent how farmer organizations enjoyed extension services owing to the cost effectiveness of providing the services to groups instead of individuals. However, these findings indicated poor performance of these farmer groups in terms of other benefits inextricably linked to them. Farmer organizations have been shown to benefit farmers in many other ways. According to World Bank (2008), collective action among farmers has a long history and is widely acknowledged and recognized as a way that enhances farmers ability to access and participate competitively in markets.

Cooperative action by farmers has also been shown to enhance increased access of farmers to financial services such as credit and insurance and direct financial capital from the organizations themselves. Farmer organizations have further been found to offer training, extension services and technical assistance to its members. Similarly, donors, development agencies and government agencies often prefer offering support to farmer organizations as opposed to individuals (Jones *et al.*, 2013).

Farmer organization is also enables farmers to overcome barriers attributed to social norms and hierarchies that hinder farmers from accessing services and resources including information. Collective action particularly among farmers also enhance their linkage to other actors and players resulting into a social network, where learning and capacity building takes place. It involves among other things sharing of information and exposure to new technologies (Jones *et al.*, 2013).

Adoption of innovations is also argued to begin with the process of diffusion that is facilitated by interactive social network, which has been found to improve proper and timely information flow regarding profitability of new technologies particularly farmer to farmer interaction (Centola, 2010; Suer & Ziliberman, 2010). Based on this perception, promotion of focal farmers in the social network has been undertaken as a way of enhancing diffusion and adoption of technologies (Jones *et al.*, 2013). It was expected that members in farmer organizations accessed certain benefits which influenced the adoption of climate smart technologies. However, this study noted that the high membership in the farmer organizations had not benefitted farmers fully due to poor management, financial misappropriation and high focus on donor support. This was indicated by key informants and during the focus group discussions with the small scale farmers.

4.3 Perception of Climate Change Effects on Farming and its Influence on adoption of Climate Smart Practices

The first objective of this study was to assess perception of climate change risks on farming among small scale farmers of Kitutu and Nyaribari Chache in Kisii County and its influence on adoption of climate smart practices.

4.3.1 Perceived Climate Change

Almost all respondents (97.4%, n=409) were in agreement that climate change was a reality. Similarly, majority (63.1%, n=265) felt strongly that climate change was evident in the study area (Figure 4.7). This showed clearly the growing awareness of climate change challenge among farmers in the study area.

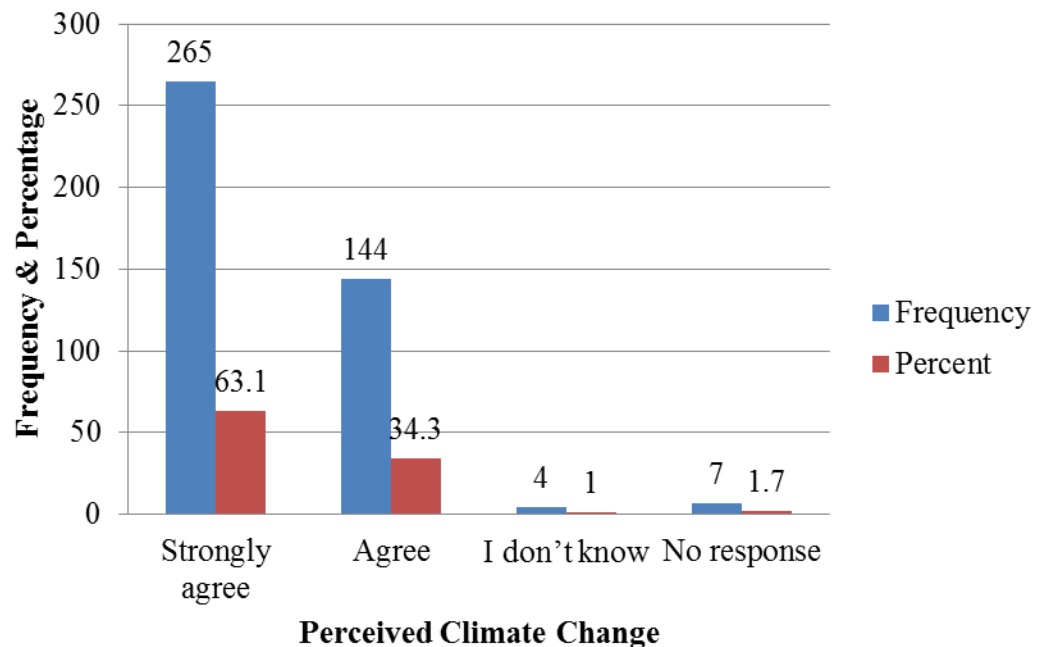


Figure 4.7: Perceived Climate Change in Kitutu and Nyaribari Chache of Kisii County

These findings were in agreement with several studies that had shown increasing awareness of farmers with regard to climate variability and change in Kenya and other parts of East and Central Africa in both drier areas and humid areas (Oremo, 2013; Legesse *et al.*, 2012; Mburu, 2013; Kalungu *et al.*, 2013; Nyanga *et al.*, 2011). Interviews with key informants, particularly service providers in the agriculture sector

indicated growing realization of climate change predicament.

In spite of the emerging appreciation of climate change concern, there were still other farmers, who still held the belief that the area was humid with adequate rainfall from both long rain and short rain seasons according to FGDs. There is therefore need for further sensitization to affirm and deepen their grasp of the climate change problem in the study area. Similarly, in spite of the glaring observation, analysis of County Government documents clearly demonstrated that most County Government officials were still oblivious of and not concerned about climate change (KCG, 2014). This was evidenced by lack of clear policy guidelines on climate change adaptation in agriculture. This implies that there is need for enhanced efforts towards creation of awareness on the causes and risks associated with climate change among the policy makers at the County level.

4.3.2 Observed Climate Change Attributes over the Last 30 Years (1980-2010)

Majority (48%) indicated increase in temperature, change in rainfall patterns (24.3%) and increase in rainfall 17.4%) as the main climate change variables that had been observed for the last 30 years (Table 4.6).

Table 4.6: Observed Climate Change Attributes over the Last 30 Years (1980-2010) in Kitutu and Nyaribari Chache of Kisii County

Observed climate change attributes	Frequency (n)	Percentage %
Increase in temperature	202	48.1
Decrease in temperature	5	1.2
Increased wind	2	0.5
Increase in rainfall	73	17.4
Decrease in rainfall	24	5.7
Change in rainfall patterns	102	24.3
No Observation	12	2.9
Total	420	100.0

These results showed clearly that the main climate attributes that had changed in this area were temperature and rainfall, and rainfall patterns. These observations were in agreement with predicted changes by IPCC scientists (IPCC, 2007). These findings were also similar to what had been observed in Uasin Gishu County and sub-humid regions of KARI Kabete in Kikuyu and KARI Muguga in Limuru, where most of the farmers indicated change in rainfall patterns and increase in temperature (Kalungu *et al.*, 2013; Murgor, 2014).

Key informants and focus group discussion participants also acknowledged climate change occurrence. This was evidenced by change in rainfall patterns, rise in maximum temperature to about 32⁰C from previous 26⁰C, prolonged dry spells from the usual period of January - February to April, shortening of the long rainfall season from the previous March- July to April-June, change in humidity level and emergence of new pests and diseases for over a period of 3 decades.

They also indicated increased occurrence of floods, mudslides and change in rainfall in terms of distribution but not in the amounts. An ASDSP survey, similarly found out that most of the households (81%) had noticed changes in the environment in terms of poor rainfall distribution, increased frequency, intensity and prolonged drought, degraded soils, drying up of wells and rivers, and incidence of diseases and pests (ASDSP, 2014). These findings were also confirmed by analysis of climatic data from Kenya Meteorological services station in Kisii County (Figure 4. 8 & 4.9). According to Figure 4.8, there was a steady rise in maximum temperature and slight rise in the mean temperature over the period of 30 years between 1980 to 2010 in Kisii County. While Figure 4.9, revealed a very small change in rainfall within the same period in the study area. These changes in both rainfall pattern and temperature accounts for significant adverse effects to production among farmers.

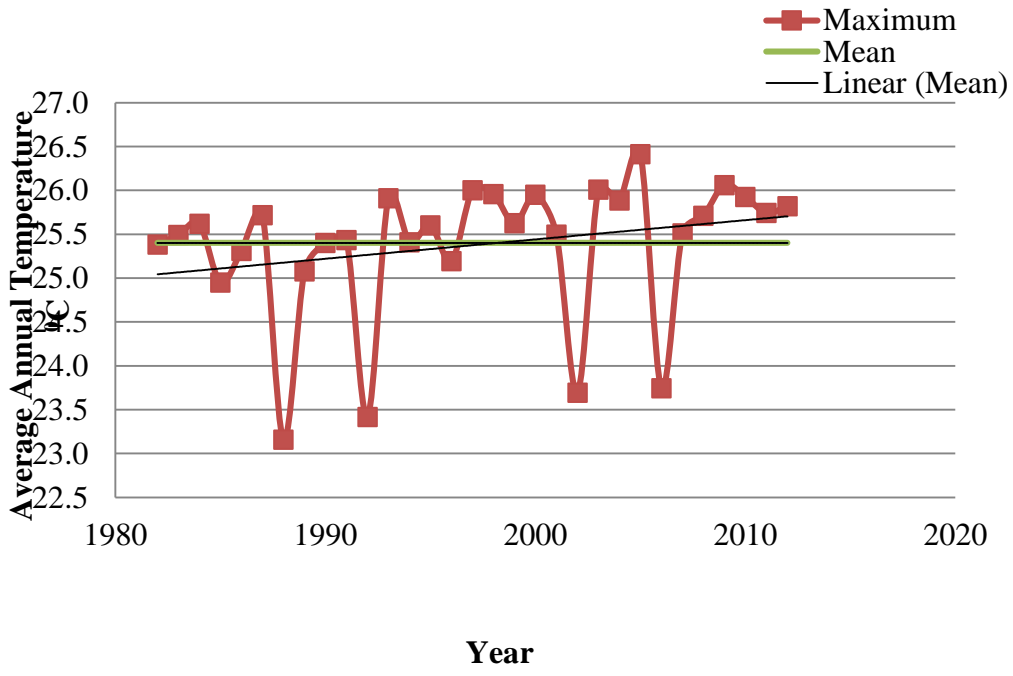


Figure 4.8: Average Annual Temperature for Kisii County

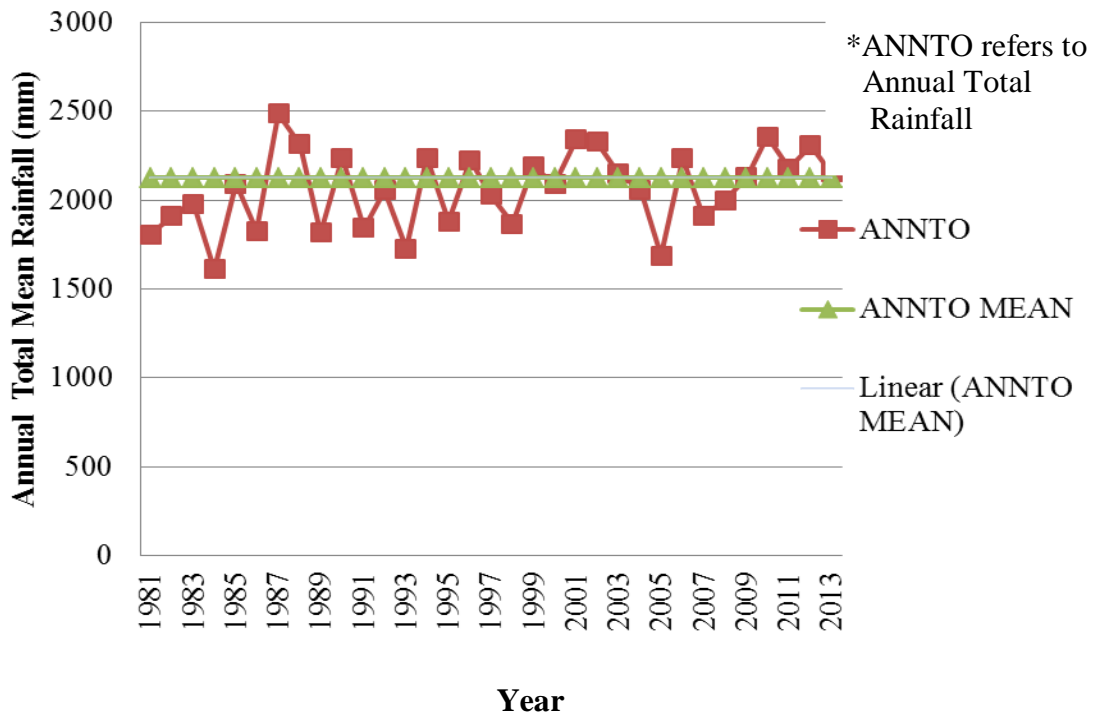


Figure 4.9: Annual Mean Rainfall for Kisii County

4.3.3 Perceived and Actual effects of Climate Change on Farming

Activities

Farmers cited different effects both in general and with regard to different aspects of climate change such as temperature, rainfall, change in rainfall patterns, droughts and floods (Figure 4.10).

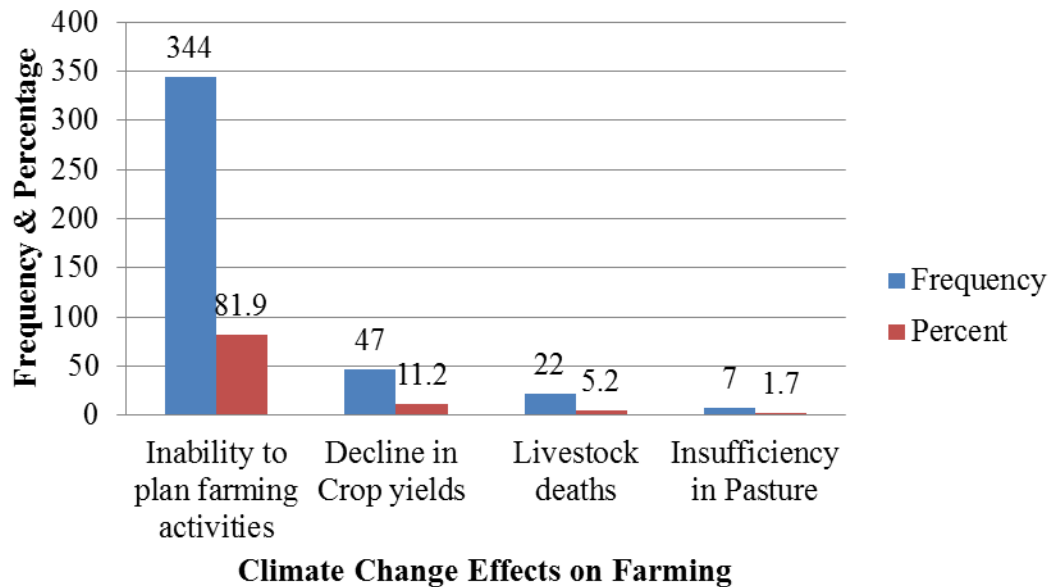


Figure 4.10: Effects of Climate Change on Farming Activities

In terms of general effects of climate change, most (81.9%, n=344) of the respondents indicated inability to plan their farming activities and decline in crop yields (11.2%, n=47) as the main effects of climate change (Figure 4.10). Other effects of climate change cited included livestock deaths (1.2%); destruction of crops and insufficiency of pastures (1.7%). This showed that farmers were mostly being affected by shift in seasonal and erratic weather patterns, as shown by difficulties they were experiencing in planning. The findings also implied some element of flooding and drought occurrence in Kitutu and Nyaribari Chache as evidenced by destruction of crops, livestock deaths and insufficiency of pastures though to a small extent.

This study further affirms the findings at Yatta in Kenya, in Africa and other parts of the world, which showed decline in agricultural production and enhanced food insecurity as a result of climate change (Mendelsohn *et al.*, 2000a; Boko *et al.*, 2007; Mburu *et al.*,

2014: Oromo, 2013). Key informants similarly indicated negative effects of climate change such as increased food insecurity, as a result of decline in food production. Other effects mentioned by key informants included increased leaching of nutrients and soil erosion as a result of surface runoff, and emergence of diseases such as Maize Lethal Necrosis Disease (MLND), Mites on Eucalyptus, and Tuta absoluta pest on tomatoes.

With regard to effects of increase in temperature on farming, emergence of new strains of pests and diseases (40.7%, n=171), decline in crop yield (24%, n=101) and wilting of crops (5.2%, n=22) were the main effects which were cited. At the same time a significant number (30%, n=126) of respondents showed unawareness with regard to the likely effects of temperature on farming activities (Table 4.7).

Table 4.7: Effects of Increased Temperature on Farming in Kitutu and Nyaribari Chache of Kisii County

Effects of increased temperature on farming	Frequency (n)	Percentage %
Emergence of new strains of pests and diseases	171	40.7
Decline in crop yield	101	24.0
Wilting of crops	22	5.2
I don't know	126	30
Total	420	100.0

These results are consistent with IPCC report, which suggests that while temperate regions are likely to benefit in terms of crop yield as a result of increase in temperature, the tropical regions and semi-arid areas are likely to experience negative impacts such as decline in crop yield even with moderate rise in temperature of 1-2⁰C. The report indicates possibility of all regions in the world experiencing negative impacts as a result of further upsurge in temperature by the end of 21st Century (IPCC, 2007b).

In terms of effects of increase in rainfall and floods on farming, results showed that majority (58%, n=242) of the farmers were not aware. Apparently flooding may not be

common and hence low appreciation of its negative effects among the majority of farmers. The effects, which were known to them as a result of increase in rainfall were soil erosion (22%, n=94) (Figure 4.11), probably due to the fact that the area is hilly and prone to soil erosion (Plates (4.1; 4.2).

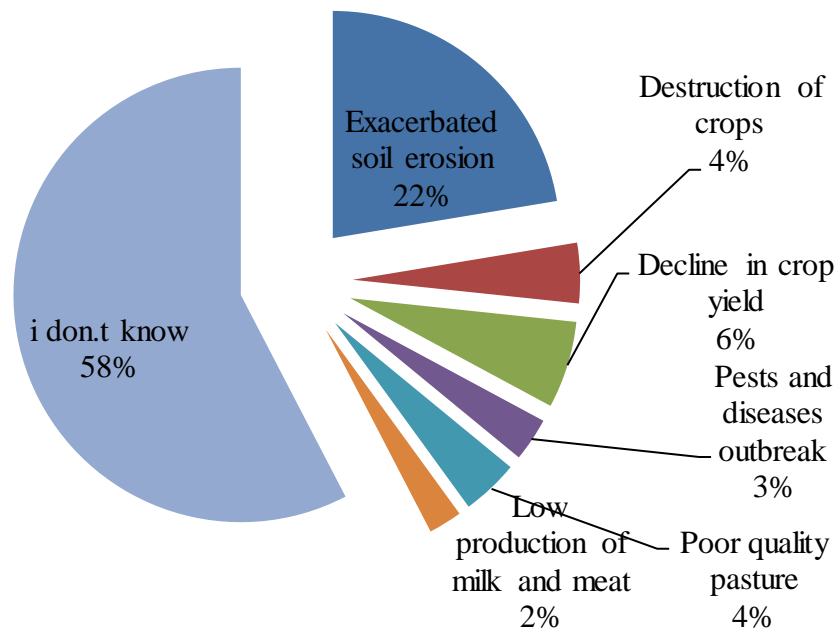


Figure 4.11: Effects of Increase in Rainfall and Floods in Kitutu and Nyaribari Chache of Kisii County

Other effects were noted, however, to a very limited extent. Decline in crop yield, destruction of crops, poor quality pasture as result of nutrient leaching and pests and diseases scored very low respectively (6%, n=26), (4%, n=18), (4%, n=18), (3%, n=13) (Figure 4.11). These findings on the overall showed low effects of enhanced rainfall that is normally accompanied by flooding in other areas. This is because of the hilly nature of the topography of the study area.



Plate 4.1: Maize Damaged by EL Nino Rains at Misesi in Kisii County during October–December, 2015



Plate 4.2: Massive Sheet of Soil Erosion during El Nino rainfall at Misesi in Kisii County during October - December, 2015

Compared to other climate change variables, the impact of irregular rainfall patterns was highly pronounced in the area. Almost all (99.8%, n=419) of the respondents underscored the negative effects of erratic rainfall patterns on farming. Majority (70.5%, n=296)

identified decline in crop yield as the most serious effect, followed by inability to plan farming activities (23.8%, n=100) and instability in production (5.5%, n=23) (Table 4.8).

Table 4.8: Effects of Erratic Rainfall Patterns on Farming in Kitutu and Nyaribari Chache of Kisii County

Effects of erratic rainfall patterns	Frequency (n)	Percentage %
Decline in crop yield	296	70.5
Inability to plan farming activities	100	23.8
Instability in production	23	5.5
No response	1	0.2
Total	420	100.0

These results were in agreement with Huho *et al.* (2012), who affirmed changing rainfall patterns in Laikipia County with overall decline in growing period of crops and yield. Similar results were also obtained by Arukulem *et al.* (2015) at Senetwo Location in West Pokot County, who indicated reduced growing period, erratic planting dates, and overall decline in yield as a result of changing rainfall pattern. This showed the need to provide timely weather information to farmers to help them plan and mitigate the effects of erratic rainfall patterns.

These results resonated well with Maize production statistics from the Department of Agriculture (Table 4.9). Production of maize showed decline from 75, 232 metric tons in 1996 to 53 330 metric tons in 2006 in spite of increase in production area. It should however, be noted that the decline in production is not entirely as a result of climate change, but also attributed to other reasons such as decline in soil fertility as a result of continuous cultivation and poor farming practices. This clearly showed drop in productivity per unit area of land. This if not addressed will lead to enhance food insecurity and compromise the development goals of the study area.

Table 4.9: Maize Area, Production and Yield Trends in Kitutu and Nyaribari Chache in Kisii County

Year	Area	Production (Metric (tons))	Yield (tons/ha)
1996	19, 800	75, 232	3.8
1997	14, 545	45, 821	3.2
1998	13, 600	40, 054	2.9
1999	-	-	-
2000	14, 250	44, 986	3.2
2001	15, 400	52, 673	3.4
2002	22, 200	54, 005	2.4
2003	23, 200	67, 956	2.9
2004	23,050	68, 465	3.0
2005	21, 835	52, 565	2.4
2006	23, 700	53, 330	2.3

Source: Kisii County Agricultural office

With regard to effects of drought, majority (58.8, n=247) of the respondents apparently were unaware of the drought phenomenon in the study area because it was not a common feature. However, few farmers noted crop failure (27.1%, n=114) as the effect of drought (Table 4.10).

Table 4.10: Impacts of Increased Frequency and Intensity of Droughts in Kitutu and Nyaribari Chache of Kisii County

Impacts of droughts	Frequency (n)	Percentage %
Crop failure	114	27.1
Livestock deaths	59	14.0
Not aware	247	58.8
Total	420	100.0

This finding indicates majority of the farmers were unaware of the likely impacts of drought; however, few of them were gaining appreciation of the adverse effects of

drought that was emerging under climate change scenario in the area, between the rainfall seasons. These results support the findings of a study by Porter & Semenov, (2005) on crop responses to climatic variation, who indicated anticipated increases in production losses under increased frequency and intensity of extreme events.

4.3.4 Farmers Degree of Perception and Concern about Climate Change effects on Farming

In agreement with the above findings, majority (97.3%, n=409) of farmers agreed that climate change had negatively affected their farming activities (Table 4.11). Similarly, (54%, n=227) strongly felt climate change had serious implications on farming enterprises (Table 4.11).

Table 4.11 Farmers Degree of Perception about Climate Change Effects on Farming in Kitutu and Nyaribari Chache of Kisii County

Farmers degree of perception	Frequency (n)	Percentage %
Strongly agree	227	54.0
Agree	182	43.3
I don't know	11	2.7
Total	420	100.0

On the other hand, Figure (4.12) shows that most (92%, n=385) of farmers were concerned about climate change effects. Key informants attested to the concerns farmers had with regard to climate change that had been demonstrated by frequent visits of farmers seeking for information on adaptation to the changing conditions. These findings were in agreement with a study by Arbuckle *et al.* (2013) among Iowa farmers in the United States of America, who showed concern about climate change effects and pursuit of adaptation strategies to climate change. The high concern about climate change effects among farmers in the study area, therefore pointed to their serious need for adaptation hence adoption of climate smart practices.

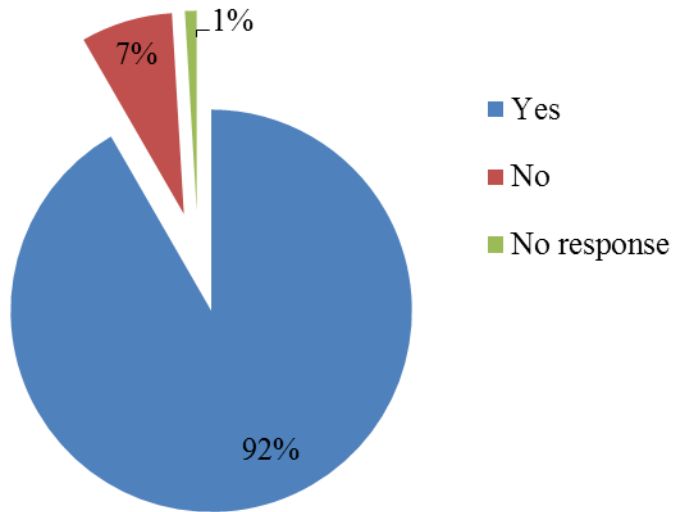


Figure 4.12: Concern about the Climate Change effects in Kitutu and Nyaribari Chache of Kisii County

4.3.5 Adaptation to Climate Change effects

Most (74%, n=311) of the respondents acknowledged efforts towards mitigation of climate change effects (Figure 4.13). This revealed considerable emphasis on adaptation to climate change effects in the study area among the majority farmers.

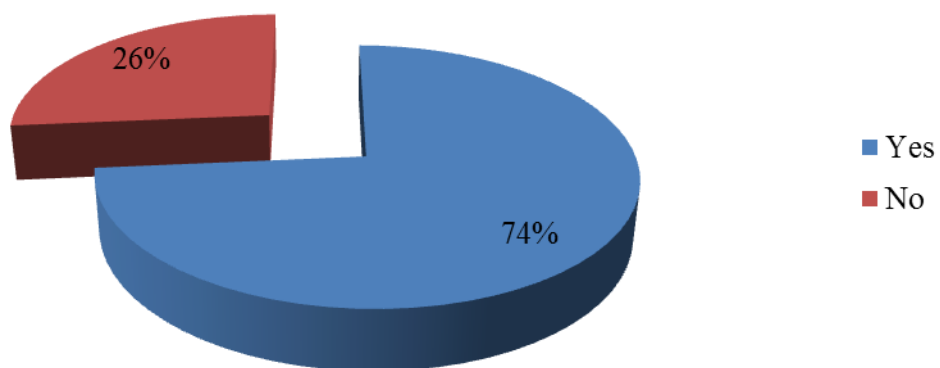


Figure 4.13: Climate Change Response among Farmers of Kitutu and Nyaribari Chache in Kisii County

However, majority (72.5%, n=305) could only indicate adaptation to climate change

through adoption of appropriate crop and livestock varieties. Very few farmers thought of diversification to other non-farming activities (1%), increased water conservation (3%), varying planting date (9%) and insuring of crops and livestock (1%) as adaptation measures to climate change (Figure 4.14).

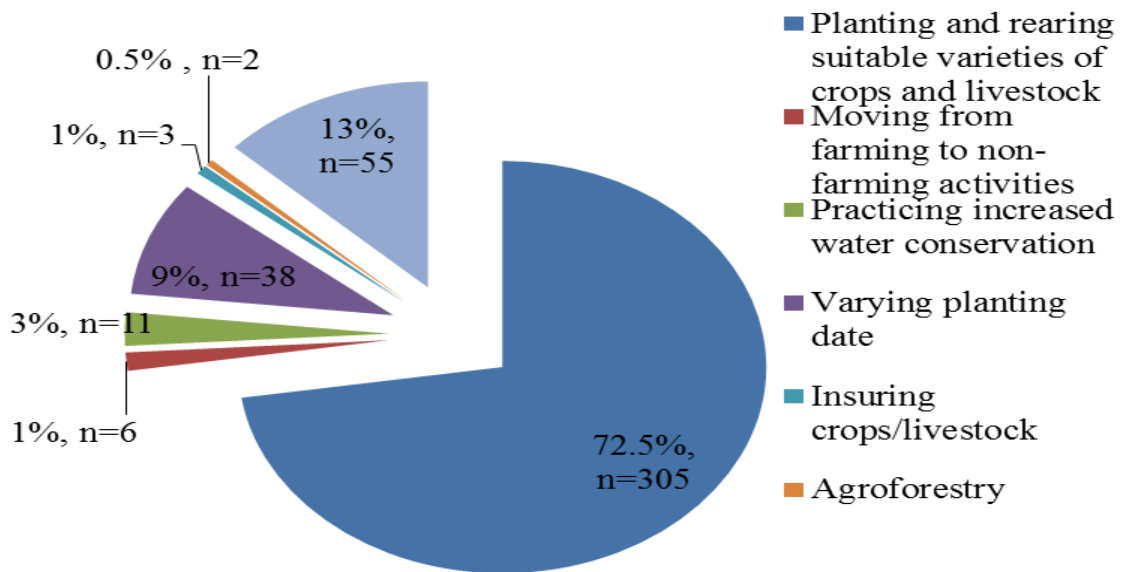


Figure 4.14: Adaptation Measures to Prevailing Climate Change Phenomenon in Kitutu and Nyaribari Chache of Kisii County

These results showed farmers high consideration of planting and rearing suitable varieties as key measure of adaptation to climate change. However, they demonstrated limited understanding of many other adaptation options such as agroforestry, insurance, water conservation etc. The results were also in congruence with several studies (Deressa *et al.*, 2009; Legesse *et al.* 2012) in Ethiopia, which showed adoption of suitable varieties as one of the key response strategies to climate change effects. This is also in agreement with IPCC (2007a) which considers adoption of appropriate varieties of crops and livestock feeds such as finger millets, sorghum, groundnuts and wonder grass as a key element in combating the threat of climate change to food security. Key informant interviews with technical officers of Agriculture, also affirmed shift towards climate smart practices such as greenhouse and water harvesting technologies in response to perceived climate change among farmers.

4.3.6 Relationship between Change in Rainfall Patterns and Adoption of Climate Smart Practices

Based on the Chi square tests results, change in rainfall patterns had strong influence on adoption of all climate smart practices (Table 4.12). The more the erratic the rainfall pattern the more farmers adopted climate smart practices. Hence the hypothesis posited indicating the significant influence of perception of climate change and its associated risks among small scale farmers of Kitutu and Nyaribari Chache in Kisii County on the adoption of climate smart practices was accepted.

Table 4.12: Relationship between Change in Rainfall Patterns and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practices	Chi square test results		
	χ^2	Df	P
Improved fallowing	21.572	6	0.001
Agroforestry	20.905	6	0.02
Crop rotation	17.924	3	0.00
Rainwater harvesting	10.441	3	0.015
Planting cover crops	10.279	3	0.016
Mulching	11.873	3	0.008
Farm yard composting	13.742	3	0.003
Hay making	23.110	3	0.00
Pasture rehabilitation and management	11.162	3	0.011
Use of organic manure	11.433	3	0.010
Agro weather advisories	10.507	3	0.015
Index based agricultural insurance	11.981	3	0.007

These findings were in agreement with several other studies (Oloo, 2013; Mburu *et al.*, 2015; Bryan *et al.*, 2011; Stefanovic, 2015) in both humid and semi-arid areas of Bungoma, Yatta, Garissa, Mbeere, Njoro, Othaya, Siaya and Laikipia in Kenya, which showed adoption of diverse climate smart practices in response to climate change effects among farmers. According to Oloo (2013) farmers were adapting to climate change by adopting mulching and soil fertility improvement strategies in Bungoma. In Yatta a study by Mburu *et al.* (2015) showed farmers embraced drought tolerant crops, charcoal burning and rainwater harvesting. A study by Bryan *et al.* (2011) indicated change in crop varieties, change of planting dates, planting of trees, decrease in number of livestock

and soil and water conservation in response to climate change effects in Garissa, Mbeere, Njoro, Othaya, Gem and Siaya.

4.4 Farmers Knowledge, Attitude and Practice of Climate Smart Practices

The second objective of this study was to determine the existing knowledge, attitude and practice of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County. Adoption of agricultural innovations has been shown to depend on farmer's knowledge and attitude (Roger, 2003). It was therefore hypothesized that knowledge of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache areas in Kisii County had significant influence on their adoption.

4.4.1 Awareness of Climate Smart Practices

Majority (66%, n=278) of respondents were found to be acquainted with climate smart practices (Figure 4.15). These findings signified high awareness of climate smart practices among farmers in the study area. The high awareness was due to promotion of these practices through National Agriculture and Livestock Extension Programme and Agriculture Sector Development Support Programme. The high awareness of the climate smart practices among the farmers is a significant step towards eventual adoption of these practices.

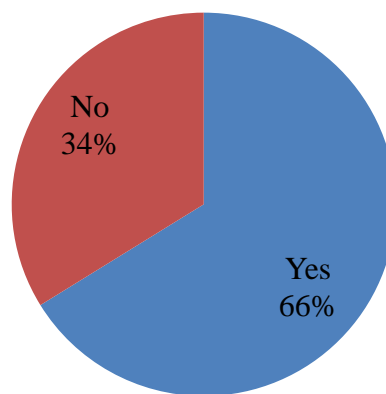


Figure 4.15: Awareness of Climate Smart Practices in Kitutu and Nyaribari Chache areas of Kisii County

These results were consistent with findings obtained during a baseline survey of ASDSP, where majority of the farmers in the entire Kisii County were found to be conversant with climate smart practices such as minimum tillage (61%), crop rotation (76%), intercropping (79%), mulching (62%), cover cropping (54%), terracing (58%) and planting in pits (51%) (ASDSP, 2014). However, these findings were different from the observations made in Northern Nigeria, where most farmers and extension officers from the Ministry of Agriculture, apparently were unaware of the climate smart practices as a result of limited access to information (Fanen *et al.*, 2014).

4.4.2 Communication Channels used for Awareness Creation

The most pronounced methods used to enhance awareness on climate smart practices included farmer field days (43.1%), neighbors (21.4%) and extension services (16%) (Table 4.13). Farmer field days and extension services were mainly undertaken by technical officers, who should therefore be supported to promote enhanced awareness creation concerning climate smart practices. Other ways farmers received the information although to small extent included farmer groups (0.7%) (Table 4.13).

Table 4.13: Communication Channels used for Awareness Creation in Kitutu and Nyaribari Chache of Kisii County on Climate smart practices

Communication channels	Frequency (n)	Percentage %
Farmers 'field days	120	43.1
On farm trials	30	11.0
Extension services	45	16.0
Media	22	7.9
Neighbor	59	21.4
Farmer groups	2	0.7
Total	278	100.0

These findings were different from the study undertaken in a semi-arid areas of Kenya by Cherotich *et al.* (2012), who found out that majority of people in semi-arid areas received

climate change information and support services through the media and indigenous sources. This was probably due to low extension services outreach attributed to low staffing levels common in hardship areas.

4.4.3 Awareness of Existing Provisions in the Agriculture Sector Policies that Support Innovation and Adoption of Climate Smart Practices

Responses showed a disconnect between available policies and the farmers i.e. farm forestry rules, Agriculture Sector Development Strategy 2010-2020, Forestry Act 2005 Only (25%, n=103) of the respondents indicated awareness and understanding of the policy provisions linked to adoption of climate smart practices such as farm forestry rules (Figure 4.16).

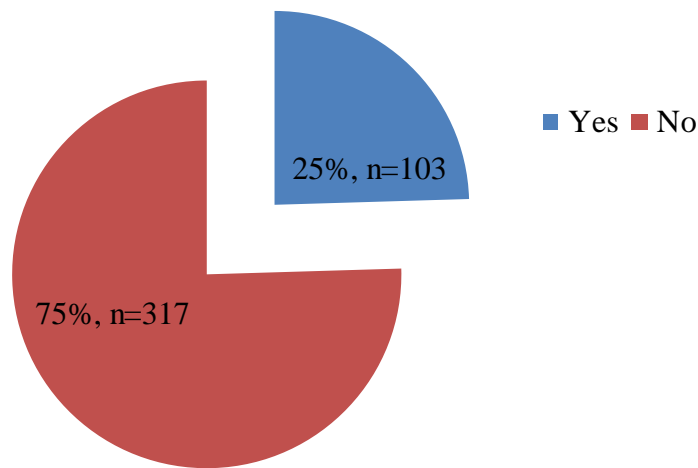


Figure 4.16: Awareness of existing policy provisions that support Innovation and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

The awareness and knowledge of policy provisions and incentives therein, influences significantly compliance on the part of those targeted (Ng'endo *et al.*,2013; Dooley & Chapman, 2014). Compliance in this case applies to adherence to provisions that support adoption of climate smart practices. The low awareness therefore had partly contributed to low adoption of climate smart practices among small scale farmers in Kitutu and Nyaribari Chache areas of Kisii County. These findings are contrary to Ng'endo *et al.* (2013), who found out that most farmers in Kibwezi and Meru were knowledgeable in

terms of national policies on land management, agriculture including specific policy incentives and disincentives.

The low awareness of policy provisions that support adoption of climate smart practices in the study area was attributed to poor dissemination of existing policies by the extension service providers. Enhanced efforts towards sensitization and building capacity among farmers with regard to these policies is therefore required as a way of promoting adoption of climate smart practices.

4.4.4 Awareness of Existing Payment for Ecosystem Services (PES) Linked to Adoption of Climate Smart Practices

Majority (92.1%, n=387) indicated lack of awareness of the existing Payment for Ecosystem Services (PES) in the study area (Table 4.14). These results showed the need to sensitize and link the farmers to available environmental payment services opportunities to support the adoption of climate smart practices.

Table 4.14: Awareness of Existing Environmental Payment Services Linked to Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Awareness of existing		
environmental payments services	Frequency (n)	Percentage %
Yes	33	7.9
No	387	92.1
Total	420	100.0

These results were corroborated by Waage *et al.* (2008), who noted low awareness of PES worldwide. Empirical evidence has shown significant impact of incentives addressing environmental objectives. For example, farmers in Europe, who were beneficiaries of environmental payment schemes were found to adopt practices friendly to the environment (Howley *et al.*, 2012). In Kenya, payment for ecosystem services has been piloted in Lake Naivasha for the last 10 years. The piloting had led to successful

adoption of climate smart practices by upstream farmers in the ecosystem (FAO, 2015). There is therefore need to document the lessons learnt for up scaling the project to other areas.

4.4.5 Awareness and Access to Funding for Adoption of Climate Smart Practices

Results, indicated majority (77.3%, n=329) of farmers were yet to receive any information or financial support towards adoption of climate smart practices (Table 4.15). Only (22.7%, n=99) confirmed having received some form of funding in this regard. Adoption of climate smart practices requires substantial investment that in most cases is beyond the capacity of small scale farmers (FAO, 2010). Promotion of their adoption among these farmers therefore requires fiscal support.

Table 4.15: Awareness and Access to Funding for Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Awareness and access to funds for adoption	Frequency (n)	Percentage %
Yes	91	22.7
No	329	77.3
Total	420	100.0

These findings revealed existence of low awareness and access to financial support towards adoption of climate smart practices among farmers in the study area. The low awareness and access was attributed to limited information with regard to available funding opportunities (Waage *et al.*, 2008). This was not restricted to farmers but also technical officers who ostensibly were not well conversant with existing funding opportunities for climate smart practices implementation. This showed inadequacy on the part of the County and National governments, and other development agencies in sensitization and linkage of farmers to existing funding opportunities. According to key informants, low access to funding was also attributed to low budgetary allocation both at the county and national levels, and lack of financial packages for adoption of climate smart practices by most of the financial institutions. Similarly, these results revealed apparent lack of knowledge by financial institutions and government agencies on the importance of packages that can

support farmers to adopt climate smart practices. These results were in agreement with the *National climate change Action plan draft* in the Ministry of Agriculture, Livestock and Fisheries Development which expressed lack of budgetary allocation and funding from other sources to support the adoption of climate smart practices (MOALFD, 2014).

4.4.6 Operational Knowledge of the Climate Smart Practices

Majority (85%, n=357) of the respondents indicated dearth of working knowledge with regard to these practices, only a few (15%, n=63) acknowledged possession of operational knowledge (Table 4.16).

Table 4.16: Operational Knowledge of Climate Smart Practices among Small Scale Farmers in Kitutu and Nyaribari Chache of Kisii County

Operational knowledge	Frequency (n)	Percentage %
Yes	63	15.0
No	357	85.0
Total	420	100.0

This showed the enormous ground yet to be covered in terms of enhancing knowledge levels among these farmers, in order to promote adoption of climate smart practices. FGDs and Key informant interviews with farmers and technical officers affirmed limited understanding of the concept of climate smart practices not only amongst farmers but also extension service providers. These findings are in agreement and affirm the outcomes of several studies (Ajayi *et al.*, 2006; Sanginga & Woomer, 2009; McCarthy *et al.*, 2011; Blanco & Lal, 2008), which indicated knowledge as a fundamental constraint to adoption of agroforestry practices, pasture management and rehabilitation, intercropping, soil and water conservation structures, cover crops and improved fallows.

These findings were in congruence with the lessons learnt from a 3 year Mitigation of Climate Change in Agriculture (MICCA) pilot project in Kaptumo, Nandi County of Kenya, which promoted adoption of climate smart practices such as agroforestry,

improved fodder production, tree nurseries, manure management, composting and biogas generation (FAO, 2015). At the end of the project it was apparent adoption of the select climate smart practices was constrained by lack of knowledge (FAO, 2015).

4.4.7 Perceived Level of Knowledge of Climate Smart Practices among Farmers

Among respondents (15%), who had indicated as having knowledge of climate smart practices, very few of them had high (5.2%) to very high (0.2%) knowledge levels, majority (9.76%) had low knowledge level (Figure 4.17). According to key informants, the low level of knowledge was attributed to inadequate knowledge on the part of extension service agents with regard to climate smart practices, lack of training materials and opportunities for learning climate smart practices and lack of explicit policy for implementation of climate smart practices. This explicitly showed that low level and lack of knowledge on climate practices, was a key factor constraining the adoption of climate smart practices in the study area. This was in agreement to the findings by FAO (2015) in Nandi County, Kenya and Fanen *et al.* (2014) in Northern Nigeria.

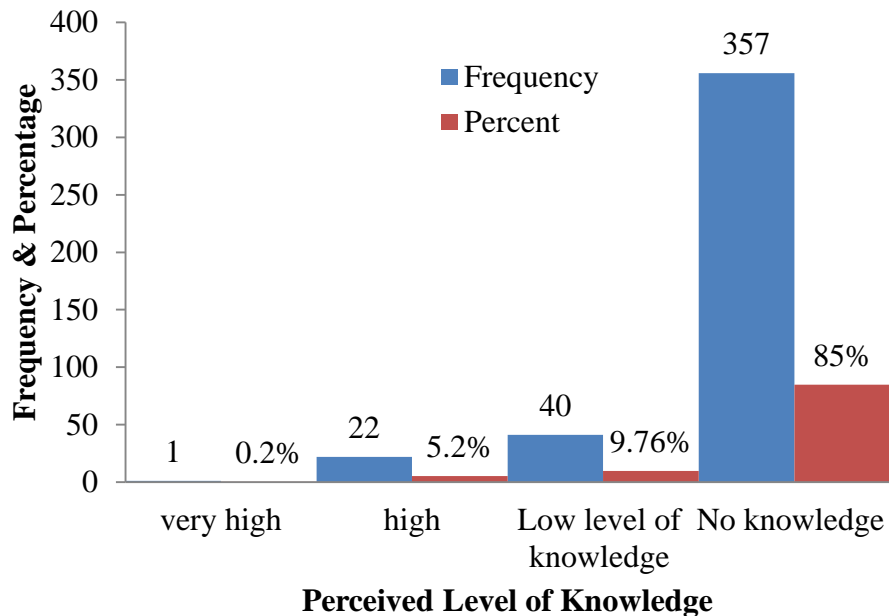


Figure 4.17: Level of Knowledge of Climate Smart Practices among Farmers of Kitutu and Nyaribari Chache of Kisii County

4.4.8 Knowledge of Benefits of Climate Smart Practices

Most (60.2%) of the respondents in Kitutu and Nyaribari Chache areas of Kisii County showed a general understanding about the benefits of climate smart practices; while a few (39.8%) apparently had no knowledge of the benefits (Table 4.17). These findings affirmed the farmers appreciation of the benefits of climate smart practices. Some of the technical officers also showed some level of awareness and knowledge emanating from previous programs, which they were involved such as NALEP, NAAIAP and ASDSP.

Table 4.17: Knowledge of the Benefits of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Knowledge of the benefits of climate smart practices	Frequency (n)	Percentage %
Yes	261	60.2
No	158	37.6
Total	420	100.0

Knowledge of specific benefits of climate smart practices	Frequency (n)	Percentage %
Increases productivity	231	55.0
Enhances resilience to climate change	6	1.4
Are efficient in the use of natural resources	10	2.4
Enhances food security	11	2.6
More profitable and less costly	4	1.0
No Knowledge	158	37.6
Total	420	100.0

The high acknowledgement of the benefits is likely to boost immensely the adoption of climate smart practices in this area. Empirical evidence suggests that where benefits are high, farmers were more likely to adopt introduced technologies (McCarthy *et al.*, 2011). In terms of knowledge of specific benefits, majority (55%), of farmers were aware of their potential to enhance productivity, while very few (7.4%) of them were conversant with other benefits such as enhancement of resilience to climate change, efficiency in the use of natural resources and enhancement of food security (Table 4.17).

These findings were supported by lessons learnt from the MICCA pilot project in Kaptumo division of Nandi County, where farmers reported increased income, food and firewood (FAO, 2015). Nevertheless, this study clearly revealed deficiency of knowledge on many other benefits associated with climate smart practices amongst the farmers. The results were also similar to those of Okoba & De Graaff (2005) in the central highlands of Kenya, where farmers perceived that soil and water conservation measures would increase yield and soil water retention; however, they did not recognize agroforestry as soil erosion control measure.

4.4.9 Sources of Knowledge on Climate Smart Practices

Majority (85%) of the respondents did not indicate specific source of knowledge about climate smart practices (Table 4.18). These findings implied that most of the farmers in the study had not received knowledge with regard to these practices. However, out of the (15%) who had knowledge, most (7.85%) of them indicated having acquired their knowledge from extension services providers of Agriculture, Livestock, Forestry and other related departments such as Veterinary Services. While the remaining specified attaining knowledge through farmer field days (3.1%), on farm trials (3.33%) and the media (0.72%) (Table 4.18).

Table 4.18: Sources of Knowledge about Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Sources of knowledge about climate smart practices	Frequency (n)	Percentage %
Farmers field days	13	3.1
On farm trials	14	3.33
Extension services visits	33	7.85
Media	3	0.72
Not reached	357	85
Total	420	100.0

This clearly revealed that extension services was the main avenue through which farmers in the study area can acquire knowledge of technologies. Use of the media to enhance knowledge on climate smart practices apparently was quite low (0.72%). These findings

concluded with Howley *et al.* (2012) and Millar (2010) who indicated the significant contribution of extension services to awareness and knowledge of technologies among farmers.

4.4.10 Training on Climate Smart Practices among Farmers

Very few farmers (4.5%) had undergone training on climate smart practices (Table 4.19). This showed not much had been done in bid to enhance the knowledge level on climate smart practices.

Table 4.19: Training on Climate Smart Practices among Farmers in Kitutu and Nyaribari Chache of Kisii County

Training on climate smart practices	Frequency Percentage	
	(n)	%
Yes	20	4.5
No	400	95.5
Total	420	100.0

These findings were consistent with the outcome of a survey undertaken by Agriculture Sector Development Support programme in Kisii County. The survey revealed that only (12%) had been trained on climate change strategies such as soil and water conservation, tree planting, change of crop type, water harvesting, feed conservation and diversification of enterprises (ASDSP, 2014). The low level of training with regard to climate smart practices was also affirmed by Kipkoech *et al.* (2015) during a study on the state of knowledge of CSA practices in Kenya, Ethiopia and Uganda.

4.4.11 Awareness and Knowledge of Specific Climate Smart Practices

Awareness and knowledge of respective climate smart practices was low compared to general awareness of climate smart practices. For example, while the general awareness scored (66.2 %) (Figure 4.7), awareness of use of appropriate crop and livestock varieties in varied biophysical conditions scored as low as (36%) (Table 4.13). The trend applied to all other climate smart practices examined in this study concerning awareness and

knowledge of specific climate smart practices. This demonstrates a significant knowledge gap among farmers with regard to specific climate smart practices.

4.4.11.1 Awareness and Knowledge of Appropriate Crop and Livestock Varieties

The study revealed very low awareness and knowledge of suitable crop and livestock varieties. Majority (64%, n=269) of farmers were unaware of adaptation to climate change through adoption of flood, drought, pest and diseases resistant varieties of crops or livestock breeds (Table 4.20), considered a key response to the threat of food security from climate change (Maina *et al.*, 2013). Alteration in climate characteristics such as temperature, rainfall and extreme events i.e. floods and droughts and effects such as emergence of pests, diseases and weeds has severely threatened the survival of a wide spectrum of vegetation and animals including crops and livestock. For example, areas which were considered suitable for tea are no longer appropriate. In bid to adapt, adoption of new appropriate varieties and breeds that would survive the changes has been suggested (IPCC, 2007).

According to these findings, only (36%, n=151) were aware of this practice. Similarly, fewer (13%, n=55) respondents indicated possession of knowledge with regard to this practice compared to those who had indicated awareness (Table 4.20).

Table 4.20: Awareness and Knowledge of Appropriate Crop and Livestock Varieties in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	151	36.0	55	13
No	269	64.0	365	87
Total	420	100.0	420	100.0

These

findings implied limited understanding among farmers with regard to necessary responses to climate change risks as a result of low sensitization and training by extension officers.

A study by Kipkoech *et al.* (2015) on the state of knowledge of Climate Smart Agriculture (CSA) practices in Africa with focus to Kenya, Ethiopia and Uganda, revealed low awareness and knowledge among farmers as a result of lack of training.

4.4.11.2 Awareness and Knowledge of Mixed Cropping

The study established very high understanding and practice of mixed cropping in Kitutu and Nyaribari Chache areas of Kisii County. From the responses, it was clear most (64%, n=267) of the farmers were aware of mixed cropping in Kitutu and Nyaribari Chache sub counties (Table 4.21). Similarly, almost all (64%, n=267) who were aware of this practice, demonstrated skill and knowledge with regard to adoption of this practice (Table 4.21). These findings were in consonant with ASDP baseline survey conducted in Kisii County, which revealed that (79%) had knowledge of mixed cropping (ASDSP 2014).

Table 4.21 Awareness and Knowledge of Mixed Cropping in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	267	64	267	63.6
No	153	36	153	36.4
Total	420	100.0	420	100.0

4.4.11.3 Awareness and Knowledge of Integrated Crop and Livestock Systems

Awareness and Knowledge of integrated crop and livestock farming was quite low among farmers in the study area. Majority (74.3%, n=312) of the respondents were unaware of the practice. Of the (25.7%) who were aware of the practice, only 15%, (n=63) demonstrated skill, ability and knowledge with regard to adoption of this practice (Table 4.22). The low understanding of integrated crop and livestock system accounted

for low livestock rearing in Kitutu and Nyaribari Chache areas of Kisii County (Figure 4.3).

Table 4.22: Awareness and Knowledge of Integrated Crop and Livestock Systems in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	108	25.7	63	15
No	312	74.3	357	85
Total	420	100.0	420	100.0

This study affirms the findings of a scoping study by FAO (2015) on Climate Smart Agriculture (CSA) initiatives in high agricultural potential areas of Kenya including Kisii County, which showed that while livestock contributes significantly to climate smart agriculture farming; it's yet to be embraced in crop based systems. The low awareness and knowledge of this practice was demonstrated, notwithstanding the high production, higher productivity, and efficient use of natural resources and enhanced resilience to climate change associated with the practice (Branca *et al.*, 2011; Branca *et al.*, 2012). The low knowledge in this practice was somewhat as a result of the commercial insignificance of the livestock subsector attributed to small land sizes (Fig 4.2), besides the weak extension services(FGDs).

4.4.11.4 Awareness and Knowledge of Improved Fallowing Practice

Very few (14.8%, n=62) of respondents were found to be aware of the practice. On the other hand, knowledge level was much lower (9%, n=38) among the respondents (Table 4.23). This showed very limited information and knowledge level amongst farmers with regard to the fallowing practice. The low awareness of this practice among farmers was shown in spite of the diminished soil fertility as a result of continuous and intensive farming in the study area.

Table 4.23: Awareness and Knowledge of Improved Fallowing in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	62	14.8	38	9.0
No	358	85.3	382	91
Total	420	100.0	420	100.0

In areas, where soil fertility has declined, fallowing and fallow periods are recommended to allow land to undergo natural renewal of soil fertility. However, due to high population continuous cultivation has become a norm particularly in entire Kisii County including Kitutu and Nyaribari Chache areas. This was in agreement with findings obtained during ASDSP baseline survey (ASDSP, 2014).

4.4.11.5 Awareness and Knowledge of Agroforestry

A fairly good number of farmers showed awareness and knowledge of agroforestry in the study area. According to this study, close to half (47.2%, n=198) of respondents knew about agroforestry practice. Similarly, knowledge of agroforestry practices was relatively high (11%, n=46) compared to other climate smart practices (Table 4.24). In spite of the high relative awareness and knowledge, these findings indicated lack of awareness and knowledge among majority of farmers in the study area.

Table 4.24: Awareness and Knowledge of Agroforestry in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	198	47.2	46	11
No	222	52.8	374	89
Total	420	100.0	420	100.0

These results concurred with those of Ajayi *et al.* (2007) who noted that one of the key constraints to adoption of agroforestry was scarce information and knowledge on suitable species of trees that are well adapted in particular localities and optimal management regime. In congruence with the foregoing, improved access to knowledge and training was shown to enhance the willingness to plant more trees (Kiptot *et al.*, 2006). These results were also affirmed by key informants, who cited the expansive growing of Eucalyptus trees in the study area blamed for over extraction of water, instead of suitable varieties that yield multiple adaptation and mitigational benefits.

4.4.11.6 Awareness and Knowledge of Green House Technology

Awareness of green house technology among farmers was found to be low with only (38.4%, n=162) of respondents indicating awareness (Table 4.25). This demonstrated the need for enhanced sensitization with regard to this practice among farmers in this area. Responses also indicated very low percentage of knowledge (13.1%, n=55) among the farmers in terms of application of green house technology (Table 4.25).

Table 4.25: Awareness and Knowledge of Green House Technology in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	162	38.4	55	13.1
No	258	61.6	365	86.9
Total	420	100.0	420	100.0

These findings were supported by Omoro (2014), who noted the low awareness and knowledge of green house technology in Kisii and Nyamira counties. According to Omoro (2014), many farmers were adopting and abandoning green house technologies failure occasioned by lack of experience and knowledge. The low knowledge was attributed to the newness of the innovation in the area (introduced in 2009) and limited extension visits to farmers. Green house technology involves construction of structure

covered with UV treated polythene paper with ventilation as shown in (Plate 4.1).



Plate 4.3: Tomatoes Almost Flowering in a Green House at Kiomokama, Kisii County

4.3.11.7 Awareness and Knowledge of Intercropping

Majority (68.1%, n=286) of respondents signified awareness of intercropping (Table 4.26).

Table 4.26: Awareness and Knowledge of Intercropping in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	286	68.1	112	26.7
No	134	31.9	308	73.3
Total	420	100.0	420	100.0

Thus, awareness of intercropping as a climate smart practice appeared to be high among farmers, because it was the best suited climate change adaptation practice under diminished land sizes setting, besides having been introduced several decades in the area.

These findings were found to be similar to ASDSP baseline survey, which revealed that most (79%) of the farmers were familiar with intercropping practice in the entire Kisii County (ASDP, 2014).

Though intercropping practice was pertinent in ensuring resilience to climate change shocks and highly known in the study area, responses indicated lack of knowledge among majority (73.3%, n=308) of the farmers. Only (26.7%, n=112) of the respondents apparently had knowledge with regard to intercropping practice (Table 4.26). These findings were affirmed during focus group discussions with farmers, where they indicated lack of knowledge with regard to appropriate species for intercropping.

The low knowledge level concerning intercropping among farmers presented a very significant challenge to the adoption of the practice, which usually requires greater management skill (Sanginga & Woomer, 2009). According to Blanco & Lal (2008), adequate skill is usually required in terms of choice of suitable species and timing of intercropping to minimize competition with the main crop, knowledge that most farmers indicated to be lacking. According to key informants, lack of knowledge among majority of farmers was attributed to weak extension services caused by low staffing levels and limited funding attributed to devolved system of governance that is not keen with regard to extension services. There was therefore need to rekindle efforts towards empowering farmers with knowledge on this practice critical in enhancing resilience to climate change and improving productivity.

4.4.11.8 Awareness and Knowledge of Crop Rotation

Responses showed low (47.9%, n=201) awareness of crop rotation among farmers, with majority (52.1%, n=219) indicating lack of awareness (Table 4.27). In spite of the low awareness of the practice, comparatively crop rotation was among climate smart practices that were highly known among farmers. This was as a result of being a fairly old practice in farming activities in the study area.

Table 4.27: Awareness and Knowledge of Crop Rotation in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	201	47.9	63	15
No	219	52.1	357	85
Total	420	100.0	420	100.0

Similarly, knowledge of crop rotation practice among farmers was found to be relatively high among the various climate smart practices, however, responses indicated majority of the farmers (85%, n=357) lacked knowledge, only 15% (n=63) showed skill and understanding of crop rotation (Table 4.27). These results were consistent with findings of McCarthy *et al.* (2011), who indicated low access to information on conservation agriculture.

4.4.11.9 Awareness and knowledge of Water Harvesting Techniques

A fairly good percentage (44.2%, n=186) of farmers, showed awareness of rain water harvesting practice. However, majority (55.8, n=234) lacked information concerning it (Table 4.28).

Table 4.28: Awareness and Knowledge of Rain Water Harvesting in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	186	44.2	59	14
No	234	55.8	361	86
Total	420	100.0	420	100.0

Findings concerning knowledge of rain water harvesting among the respondents showed that most (86%, n=361) of the farmers were yet to acquire working knowledge on various rainwater harvesting technologies, only 14% (n=59) of the respondents, stated to have obtained knowledge necessary to undertake the practices (Table 4.28). In the light of erratic and unreliable rainfall attributed to climate change there was need for enhanced information among farmers in this area, with regard to rainwater harvesting and storage. This will ensure steady supply of water for production even during dry spells.

4.4.11.10 Awareness and Knowledge of Irrigation

Majority (67.6%, n=284) of respondents were unaware of irrigation as an important practice, particularly during the dry spell. Similarly, majority (85%, n=357) of respondents apparently had no knowledge concerning irrigation in Kitutu and Nyaribari Chache sub counties; only 15% (n=63) demonstrated knowledge of irrigation (Table 4.29).

Table 4.29: Awareness and Knowledge of Irrigation in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	136	32.4	63	15
No	284	67.6	357	85
Total	420	100.0	420	100.0

The low awareness and knowledge of this practice could be as a result of high rainfall conditions that have characterized the area over a long time. However, with the trend changing, and longer dry spells emerging under climate change scenario, there was need for farmers to be trained in irrigation practice to ensure farming activities are not interrupted during dry periods.

4.4.11.11 Awareness and Knowledge of Construction of Water Retention Structures on the Farm

Very few (28.5%, n= 120) farmers had an idea about the need to construct water retention structures on the farm as a practice necessary for adaptation to climate change, the rest (71.5%, n=300) expressed lack of awareness (Table 4.30). In the same way, few (10%, n=42) respondents had knowledge of constructing water retention structures. Many (72.6%, n= 378) of the respondents indicated lack of knowledge about this practice (Table 4.30).

Table 4.30: Awareness and Knowledge of Water Retention Structures on the Farm in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency %	Percentage %
Yes	120	28.5	42	10
No	300	71.5	378	90
Total	420	100.0	420	100.0

The low awareness and knowledge was attributed to low perception regarding the climate change and necessary adaptation strategies. There was therefore need to focus on empowering farmers with knowledge in relation to climate change and practices that are likely to enhance resilience among farmers during the dry spells in the study area. The need to popularize water retention structures on the farms is occasioned by the long dry spells that were emerging in Kisii County, an area known to be humid throughout the year.

4.4.11.12 Awareness and Knowledge of Planting Cover Crops

The results revealed low awareness of planting cover crops among farmers, only (28.2%, n=118) showed awareness of the practice, while majority (71.8%, n=302) expressed lack of awareness (Table 4.31). At the same time, knowledge relating to planting cover crops appeared much lower among majority of farmers. Responses showed that few (14%,

n=59) had knowledge about this practice, while majority (86%, n=361) lacked the knowledge (Table 4.31).

Table 4.31: Awareness and Knowledge of Planting Cover Crops in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	percentage %
Yes	118	28.2	59	14
No	302	71.8	361	86
Total	420	100.0	420	100.0

These findings clearly showed that the practice of planting cover crops was not well known and there were low knowledge levels concerning it, in spite of high erosion problem that requires its adoption in the study area. As a result of low awareness and knowledge among farmers, planting of cover crops such as sweet potatoes, lima beans, sunnhemp and velvet beans were in existence but low in practice (27.6%, n=116) (Table 4.51). These findings were in agreement with two case studies in Laikipia and Siaya where slow pace of adoption of conservation practices including cover crops was witnessed among farmers as a result of lack of equipment, unavailability of seeds for appropriate cover crop varieties and lack of knowledge. However, where farmers had been trained, adoption of cover cropping was immensely successful. For, example, findings from Siaya indicated as high as (90%) adoption among registered farmers in farmer field schools (Kaumbutho *et al.*, 2007).

4.4.11.13 Awareness and Knowledge of Mulching

Only (36.4%, n=153) of the respondents' demonstrated awareness of using mulching. Likewise, application of mulch cover is simple, but requires relevant knowledge; however, few (12%, n=50) respondents indicated having acquired this knowledge (Table 4.32).

Table 4.32: Awareness and Knowledge of Mulching in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency	Percentage %
Yes	153	36.4	50	12
No	267	63.6	370	88
Total	420	100.0	420	100.0

Mulching is useful in conserving moisture in the soils during dry spells, however, responses signified low awareness and knowledge of this practice among farmers. Majority (88%, n=370) of respondents lacked the adequate knowledge to practice mulching effectively (Table 4.32). The mulch, which they were aware and had knowledge about in the study area involved use of crop residues and stubble mulch. The low awareness and knowledge among most farmers concerning this practice, often relevant during dry spells, was due to usually humid conditions in the study area. The low awareness and knowledge of mulching was affirmed by McCarthy *et al.* (2011) in his study.

4.4.11.14 Awareness and Knowledge of Zero or Minimum Tillage

Very few (22.3%, n=94) respondents signified awareness of zero or minimum practice.

Table 4.33: Awareness and Knowledge of Zero or Minimum Tillage in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency	Percentage %
Yes	94	22.3	63	15
No	326	77.7	357	85
Total	420	100.0	420	100.0

On the other hand, most of the respondents (85%, n=357) were found to be deficient of knowledge concerning zero and minimum tillage practices (Table 4.33). Only 15% of respondents had knowledge of minimum tillage practices such as conservation and ridge tillage. The low application of zero or minimum tillage practice was also found by ASDSP (2014) during the baseline survey. The study noted that the low awareness and knowledge level was due to weak extension services delivery attributed to low staffing and poor facilitation by the county government.

4.4.11.15 Awareness and Knowledge of Biogas Production

Only (31.9%, n=134) of respondents were aware of biogas production from livestock manure considered an appropriate practice for minimizing methane (one of the greenhouse gases). Similarly, while biogas production from livestock manure is considered a knowledge intensive process, most (87.7%, n=386) of the respondents ostensibly lacked knowledge (Table 4.34).

Table 4.34: Awareness and Knowledge of Biogas Production in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	134	31.9	52	12.3
No	286	68.1	368	87.7
Total	420	100.0	420	100.0

The low awareness and knowledge was established against a backdrop of ongoing sensitization and training of skilled technicians on installation of biogas production structures by GIZ in the county (Key informant). The existing training on biogas installation was enough evidence of the existing gap in terms of knowledge. The low awareness and knowledge was partly attributed to low involvement in livestock activities due to small land sizes (Fig 4.2). These results were in line with survey findings on main constraints to adoption of improved manure management practices, which indicated lack

of knowledge on biogas installation (FAO, 2015).

4.4.11.16 Awareness and Knowledge of Farm Yard Composting

Farm yard composting was one of the practices that were found popular with farmers in comparison with others. Half (50%, n=210) of the respondents were aware of farm yard composting, while the remaining (50% n=210) were not. Many farmers (15%) apparently, had knowledge about farm yard composting in relation to other practices, however, majority of the farmers (85%) demonstrated lack of the necessary knowledge to adopt this practice (Table 4.35). According to the views of focus group participants, this was attributed to lack of interest and lack of livestock on their farms. These findings were similarly supported by a survey in Nandi County on barriers and incentives of adopting climate smart practices (FAO, 2015).

With higher relative knowledge levels concerning this practice among farmers, these findings indicated existing higher potential for adoption of farm yard composting as compared to other climate smart practices in the study area. However, there is much ground yet to be covered with regard to transmitting knowledge to the majority of farmers, who either lack or are limited in knowledge of the practice.

Table 4.35: Awareness and Knowledge of Farm Yard Composting in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency	Percentage %
Yes	210	50.0	63	15
No	210	50.0	357	85
Total	420	100.0	420	100.0

In spite of explicit evidence of soil exhaustion from continuous cultivation, most small scale farmers are unable to adopt conventional agriculture practices such as application of chemical fertilizers resulting into decline in production and productivity. Farm yard

composting is therefore one of the suitable soil nutrient management climate smart practices for low income small scale farmers. The practice uses the natural process of turning organic material readily available on the farm into humus.

4.4.11.17 Awareness and Knowledge of Making of Hay

While making and conservation of hay ensures availability of feeds all the time particularly during dry spells that apparently have intensified in the study area, few farmers (34.2%, n=144) were found to be aware of the practice. Majority (65.8%, n=276) were not aware of this practice (Table 4.36). During high rainfall seasons, fodder is normally in abundant and in excess supply in the study area, however during the dry spell, scarcity for fodder is experienced resulting into low production of milk. To ensure continuous supply of good quality feeds in sufficient amounts during the dry periods making and preserving of hay is required. However, a high percentage of the respondents (85%, n=357) signified deficiency in knowledge about the practice (Table 4.36).

Table 4.36: Awareness and Knowledge of Hay Making in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	144	34.2	63	15
No	276	65.8	357	85
Total	420	100.0	420	100.0

These findings were consistent with Kiptot *et al.* (2015) who found out low technical knowledge of hay making among farmers in Kenya. This shows low preparedness for increasing dry spells under climate change scenario in Kitutu and Nyaribari Chache. Apart from the weak extension services, the low awareness and knowledge of this practice was attributed to the low livestock involvement (Fig. 4.3) in the study area.

4.4.11.18 Awareness and knowledge of Pasture Rehabilitation and Management

Practices

Compared to other climate smart practices, awareness with regard to proper pasture rehabilitation and management is relatively one of the lowest in the study area. Majority (87.8%, n=369) of the respondents were not aware of this practice, only (12.2 %, n=51) of the respondents reported awareness (Table 4.37). A very high percentage (89.1%, n=374) of respondents showed lack of knowledge, only (10.9%, n=46) acknowledged as having this knowledge (Table 4.37).

Table 4.37: Awareness and knowledge of Pasture Rehabilitation and Management in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	51	12.2	46	10.9
No	369	87.8	374	89.1
Total	420	100.0	420	100.0

The low awareness in this practice was attributed to low rearing of livestock (3%) in the study area (Figure 4.3), caused by limited sizes of land and high competition from crops. To enhance livestock production, there is need for adoption of best practices in terms of pasture rehabilitation and management. However, the process of adopting these practices is knowledge intensive and requires adequate knowledge levels among farmers. Proper pasture and fodder management ensures availability of good quality and quantity forage at all times and builds resilience among livestock keepers during dry spells and drought period (Kohler *et al.*, 2014; Kuria *et al.*, 2015). These results point to low awareness and knowledge among livestock farmers in terms of adaptation to climate change through adoption of this practice.

4.4.11.19 Awareness and Knowledge of Silage Making

Awareness of silage making was explicitly low, with most (76.9%, n=323) respondents expressing lack of awareness. Only (23.1%, n=97) of the respondents indicated

awareness (Table 4.38). Against the background of fodder scarcity during the dry spells that are intensifying in the study area under climate change scenario, silage making and conservation has been considered appropriate. Successful silage making requires adequate knowledge; however, according to these findings, only (15%, n=63) had knowledge of this practice. The rest (85%, n=357) who constituted a large majority indicted otherwise (Table 4.38).

Table 4.38 Awareness and Knowledge of Silage Making in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	97	23.1	63	15
No	323	76.9	357	85
Total	420	100.0	420	100.0

The level of awareness and knowledge of silage making resonates well with other feed related climate smart practices such as hay making and appropriate pasture management in the study area (Key informants). This clearly showed low levels of fodder conservation for enhanced resilience to climate change.

Efforts should be undertaken by extension officers to sensitize and train farmers about the current change in weather patterns, the relevance and process of silage making. This was corroborated by evidence from a study carried out by Kiptot *et al.* (2015) on preferences and adoption of livestock feed practices among farmers in dairy management groups in Kenya. According to this study only (40.9%) and (24.9%) of the respondents were aware and adopting ensiling and hay balling.

4.4.11.20 Awareness and Knowledge of use of Organic Manure

While awareness of manuring featured relatively high compared to other climate smart practices, the responses indicated low awareness. Only (41.9%, n=176) of the

respondents expressed awareness (Table 4.39). The low awareness and use of organic manure was attributed to the limited livestock kept in the area according to Focus Group Discussions (FGDs). In spite of the low level of awareness, key informants held the view that use of manure is a cost effective measure that should be undertaken to improve soil fertility.

Table 4.39 Awareness and Knowledge of Organic Manure Application in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	176	41.9	55	13
No	244	58.1	365	87
Total	420	100.0	420	100.0

Low percentage of farmers (13%, n=87) showed understanding of application of organic manure on the farm (Table 4.39). The low knowledge level was due to the fact that most farmers had not applied on their farms in spite of the lack of alternative cheap means of fertility improvement practices.

4.4.11.21 Awareness and Knowledge of Index Based Agricultural Insurance

One of the least known climate smart practice in the study area was index based agricultural insurance. From the findings, only 5.2% (n=22) of the farmers were aware of the existence of index based agricultural insurance (Table 4.40). The low awareness is partly due to the fact that the practice is relatively new and requires more sensitization among the farmers. Adoption of Index based agricultural insurance is knowledge and capital intensive, however, very few respondents (4.5%, n=19) indicated as having knowledge of this practice (Table 4.40)

Table 4.40: Awareness and knowledge of Index based Agricultural Insurance in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	22	5.2	19	4.5
No	398	94.8	401	95.5
Total	420	100.0	420	100.0

Knowledge with regard to the practice in this area is the lowest in relation to all other climate smart practices. To enhance its adoption, there is need for enormous commitment on the part of the county government and development agencies to build capacity of farmers with regard to the practice. The findings of this study were in consonant with findings from a review of evidence of application of index-based insurance in the developing countries among small scale farmers, which found low knowledge levels (Carter *et al.*, 2014).

4.4.11.22 Awareness and Knowledge of Farm Specific Nutrient Management and Precise Fertilizer Application

Not many people were found to be familiar with farm specific nutrient management and precise fertilizer application, only 15.2% (n=64) had information about the practice, while the rest (84.8%, n=356) who constituted the majority had no idea (Table 4.41)

Table 4.41: Awareness and Knowledge of Farm Specific Nutrient Management Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency	Percentage	Frequency	Percentage
	(n)	%	(n)	%
Yes	64	15.2	59	14.0
No	356	84.8	361	86.0
Total	420	100.0	420	100.0

Similarly, most (86%, n=361) of respondents stated as lacking knowledge on how to undertake farm specific nutrient management and precise fertilizer application (Table 4.41). This showed majority of the farmers required capacity building about this practice to facilitate its spread and eventual adoption. Even though site-specific nutrient management ensures ideal supply and efficient utilization of nutrients required by crops, very few farmers are conversant with the technology, particularly in terms of knowledge of soil properties and the skill to keep track of the nutrient status of crops and subsequent adjustment of fertilizer levels (Richards *et al.*, 2015).

4.4.11. 23 Awareness and Knowledge of Feed Management (Balance of Roughage and Concentrates) to reduce Methane Emissions

Study showed that most of the respondents (83%, n=349) were not acquainted with feed management (balance of roughage and concentrates) aimed at reducing methane emissions (Table 4.42).

Table 4.42: Awareness and Knowledge of Feed Management (Balance of Roughage and Concentrates) to reduce Methane Emissions in Kitutu and Nyaribari Chache of Kisii County

Responses	Awareness		Knowledge	
	Frequency (n)	Percentage %	Frequency (n)	Percentage %
Yes	71	17.0	53	12.7
No	349	83.0	367	87.3
Total	420	100.0	420	100.0

An indication that very little effort has been undertaken towards sensitization of farmers about this practice. The results further indicated very low levels of knowledge among small scale famers with regard to this practice. Very few (12.7%, n=53) respondents positively indicated possession of knowledge concerning this technology (Table 4.42). Since the practice requires intensive understanding before application, necessary measures should be put in place by the relevant agencies to fill this knowledge gap. The significance of this practice is based on the premise that microbial breakdown of fibrous

feed materials under normal circumstances, result in high output of methane, and a critical greenhouse gas that contributes to climate change (IPCC, 2007). However, with increased proportion of concentrate in the diet and feed additives such as nitrates and lipids, rumen microbial efficiency is enhanced resulting in reduction of methane production.

4.4.12 Attitude towards Climate Smart Practices

4.4.12.1 Preference for Climate Smart Practices

Most (84.5%) farmers expressed enormous preference for the practices (Figure 4.18). FGDs affirmed the positive attitude amongst farmers concerning climate smart practices. This implies most farmers were willing to apply the practices, but are constrained by other factors such as lack of finances. These findings were in contrast with those of Margues *et al.* (2015) in central Spain, who found that most (68%) farmers were unwilling to use cover crops to control soil erosion. This revealed the negative attitude attributed to lack of knowhow.

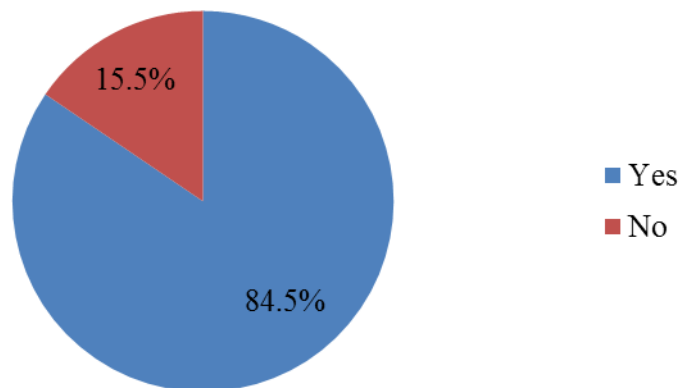


Figure 4.18: Preference for climate smart practices in Kitutu and Nyaribari Chache of Kisii County

4.4.12.2 Reasons for Preferring Climate Smart Practices

Most (79.9%) farmers considered climate smart practices favorably mainly because of their potential to contribute to increased income (28.5%, n=120), high productivity (16.2%, n=68), production (24.5%, n=104) and better planning of farming (10.7%, n=45) linked to use of agro weather information (Table 4.43). These results clearly showed that

most farmers were more inclined to practices that enhanced income, productivity and production within the context of small land sizes in the study area. This affirmed the argument of Woelcke (2012) that farmers were more likely to adopt practices which contributed to increase in production and income.

Table 4.43: Reasons for Preference of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Responses	Frequency (n)	Percentage %
Increases productivity	68	16.2
Improves soil fertility	29	6.9
Enhances resilience to climate change	11	2.6
Better planning of farm activities	45	10.7
Improves production	104	24.8
Increases income	120	28.5
Enhances food security	16	3.8
No preference	27	6.4
Total	420	100.0

4.4.12.3 Profitability of Climate Smart Practices

It was clear most (79%, n=330) farmers considered climate smart practices as more profitable compared to conventional practices i.e. use of chemical fertilizers and pesticides possibly due to the fact that most of them are less costly in the long run. Only (18%, n=77) of the farmers found them unprofitable (Figure 4.19). This was consistent with lessons learnt from MICCA pilot project in Nandi County, where farmers indicated realizing high profits from produce attributed to climate smart practices (FAO, 2015). The high perceived profitability is likely to boost adoption of climate smart practices amongst farmers. This shows the high potential that exists for the adoption of climate smart practices in Kitutu and Nyaribari Chache areas of Kisii County.

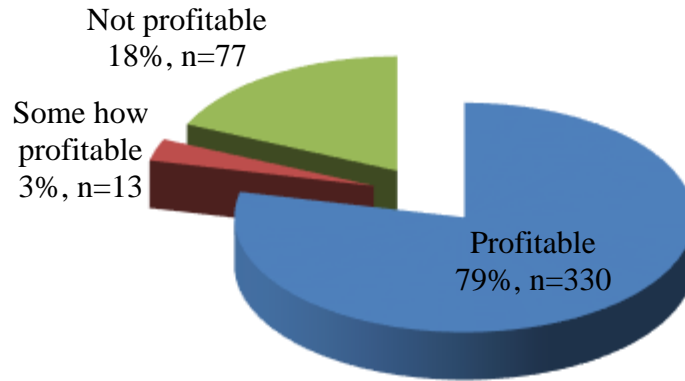


Figure 4.19: Profitability of climate smart practices in Kitutu and Nyaribari Chache of Kisii County

According to Crook & Decker (2006) and Kelly *et al.* (2003) perceived net returns or profitability is one of the most important factors that govern investment in farming activities including adoption of innovations. When a study was conducted by Cary & Wilkinson (2008) to assess the influence of perceptions of profitability, technical feasibility and personal environmental concern on adoption of conservation practices, perceived profitability emerged as the most important factor.

4.4.12.5 Cost of Adopting Climate Smart Practices

Majority (53.8%, n=226) of farmers ostensibly perceived climate smart practices as cost effective. However, (46%, n=194) were of the view that adoption of climate smart practices was exorbitant in cost (Table 4.44). The divergent opinions on the cost depended on the varying experiences of adoption of different climate smart practices. According to Hallam *et al.* (2012) many climate smart practices entail extra costs to farmers both in terms of initial capital investment and operational expenses which in the opinion of farmers hinder them from adopting. These findings indicate that adoption of climate smart practices had been hampered to some extent by the perceived high cost among some of the farmers in the study area.

Table 4.44: Cost of Adopting Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Responses	Frequency (n)	Percentage %
High	194	46.2
Low	226	53.8
Total	420	100.0

4.4.12.6 Risks and Uncertainties of Adopting Climate Smart Practices

Majority (60.5%, n=254) of the respondents, perceived adoption of climate smart practices as risky and uncertain, only (39.5%, n=166) viewed adoption of climate smart practices as posing either moderate or low risk at all (Table 4.45).

Table 4.45: Level of Risk of Adopting Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Level of risk of adopting climate smart practices	Frequency (n)	Percentage %
High	254	60.5
Moderate	163	38.8
Low	3	0.7
Total	420	100

This affirms the postulation that adoption of most innovations face uphill task in a population when it's first introduced, with only a few early adopters taking up the challenge because of risk averseness (Rogers, 2003). There were several perceived risks that respondents gave in relation to adoption of climate smart practices, however, high capital and labor requirement per unit area (61%) and uncertain returns (32.1%) featured prominently compared to others such season specificity of these technologies limiting economic benefit to certain type of seasons (6.9%) (Table 4.46). This unequivocally shows high capital and labor requirement and uncertainty of returns constitutes the most

serious risks that had hindered adoption of climate smart practices in the study area.

Table 4.46: Risks of adopting Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Risks of adopting climate smart practices	Frequency (n)	Percentage %
Season specificity of these technologies	29	6.9
High requirement of labor and capital investments	256	61
Uncertain returns	135	32.1
Total	420	100.0

4.4.13 Practice of Climate Smart Practices

Findings show that some (65.7%, n=276) farmers attempted to practice climate smart practices (Table 4.47). However, 36.8% of the farmers abandoned the practices for various reasons, and only few (28.9%) continued with adoption of practices.

4.4.13.1 Attempted Practice of Climate Smart Practices

The study showed majority (65.7%, n=276) of the respondents had attempted adoption of one or several of climate smart practices (Table 4.47). This shows that many of the farmers were aware and had attempted adoption of climate smart practices; however, the low adoption against the backdrop of this experience indicates existence of other constraints such as lack of knowledge that could be hindering eventual uptake and continued application of these practices by farmers.

Table 4.47: Attempted Practice of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Attempted practice of climate smart practices	Frequency (n)	Percentage %
Yes	276	65.7
No	144	34.3
Total	420	100.0

This corroborates findings by Omoro (2014) who found that several farmers abandoned green house technology even after high initial capital investment in Kisii and Nyamira Counties due to low production and sometimes total failure of the crops. According to the same study, the poor performance was attributed to lack of knowledge and skill (Omoro, 2014).

4.4.13.2 Duration of Attempted Practice

Among those who had attempted adopting climate smart practices, majority (19.28%, n=81) abandoned the practices immediately after 1 year. While other farmers (17.61%) abandoned after 2 to 4 years of attempted practice. However, (28.9%, n=121) attempted and adopted successfully beyond the period of 5 years (Table 4.48).

Table 4.48 Duration(Years) of Attempted Practice of Climate smart practices in Kitutu and Nyaribari Chache of Kisii County

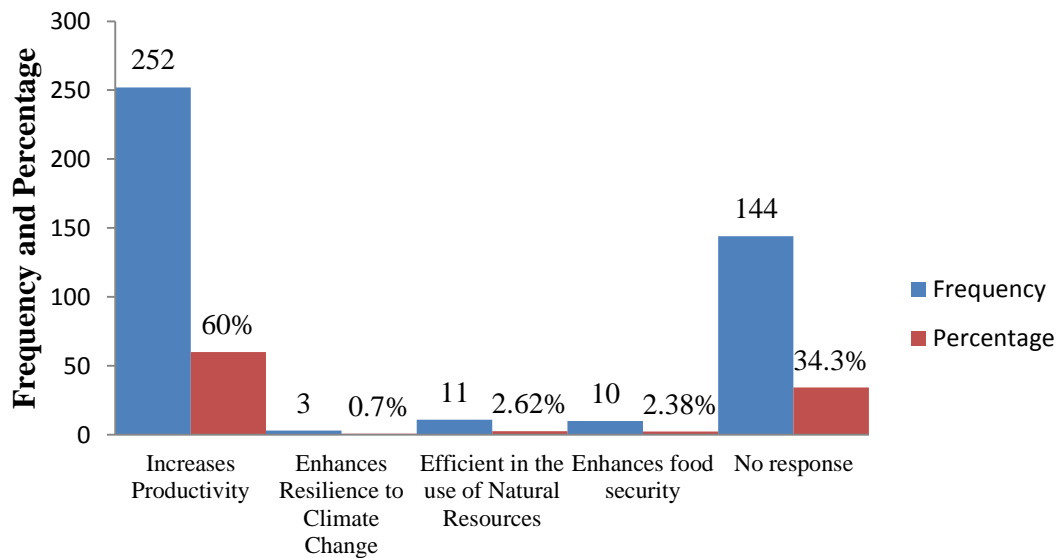
Duration in years of practice of climate smart practices	Frequency (n)	Percentage %
1	81	19.28
2	38	9.04
3	20	4.76
4	16	3.81
5 and above	121	28.9
Total	276	65.7

This showed majority of the farmers had attempted the practices for some time under programmes like National Agriculture and Livestock Extension Programme (NALEP), however withdrew upon the end of this programme. This suggests the need for appropriate approaches that ensures sustainability.

4.4.13.3 Reasons for Attempted Practice of climate smart practices

Majority (60% n=252) of the respondents indicated increase in productivity as their main reason for attempted adoption of climate smart practices, with a small number of respondents mentioning other reasons (Figure 4.20). This clearly showed that most of those who attempted practice of climate smart practices were doing so, because of their

potential to increase productivity not because of environmental considerations such as enhancing resilience to climate change (0.7%, n=3) and efficiency in the use of natural resources (2.62%, n=11) (Figure 4.20). This was in agreement with Woelcke (2012) of the World Bank’s Agriculture and rural development unit in the Africa Region, who noted that farmers were only going to adopt and maintain climate smart practices upon realizing upsurge in productivity and incomes.



Reasons for Attempted Practice of Climate Smart Practices

Figure 4.20: Reasons for Attempted Practice of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

4.4.13.4 Reasons for not Attempting Practice of Climate Smart Practices

Many reasons (Table 4.49) were cited by respondents for not taking up the practices. However, majority of those who had not attempted indicated low income (12.3%), lack of training (11.4%, n=48) and limited practical experience (10.2%, n=42) as the main constraints, while a few (0.4%) indicated limited extension services as another deterrent. This clearly affirmed lack of knowledge and assets as the main causes that had hindered farmers from adopting climate smart practices. This was supported by Dooley &Chapman (2014) who argued that in spite of the benefits associated with adoption of climate smart practices, barriers such as lack of finance, lack of technical knowledge and possible short-term yields reductions, lack of risk management options (insurance), and

lack of access to information regarding new technologies can make farmers reluctant to adopt them.

Table 4.49: Reasons for not Attempting Practice of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Reasons for not attempting practice of climate smart practices	Frequency (n)	Percentage (%)
Limited Extension Services	2	0.4
Limited Practical Experience	42	10.2
Lack of Training	48	11.4
Low Income	52	12.3
None Response	276	65.7
Total	420	100

Measures should therefore be undertaken to enhance their financial capabilities and knowledge levels concerning climate smart practices.

4.4.13.5 Reasons for Continued Practice of Climate Smart Practices

Many (21.9%) of the respondents indicated continued adoption of climate smart practices as a result of quick realization of benefits. However, very few felt motivated because of favorable market (0.71%, n=3, low risk (5.49%) and sufficient knowledge of climate smart practices (0.71%, n=3) (Table 4.50). This was contrary to the argument that adoption of climate smart practices takes long to realize benefits (Giller *et al.*, 2009).

Table 4.50: Reasons for Continued Practice of the Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Reasons for continued practice of climate smart practices	Frequency (n)	Percentage (%)
Risks are low	23	5.49
Benefits are realized quickly	92	21.9
Market is favorable	3	0.71
Have sufficient knowledge of climate practices	3	0.71
No response	299	71.19
Total	420	100.0

4.4.13.6 Reasons for Abandoning Practice of Climate Smart Practices

Many (23.8%, n=100) of those who abandoned practice of climate smart practices indicated financial constraints as the reason for abandoning climate smart practices, followed by lack of technical knowledge (9%, n=38), with a few specifying slow realization of benefits (2.12%, n=9) and high level of uncertainty (1.9%, n=8) as indicated in Figure 4.21. This was consistent with the findings of Okoba & De Graaff (2005) in the central highland of Kenya, who found that farmers were constrained to adopt soil and water conservation measures as a result of inadequate technical knowhow, capital, equipment and labour. This shows that the main reasons which discouraged adoption of climate smart practices could be financial constraints and lack of operational knowledge of climate smart practices. The ministry of Agriculture should therefore make efforts to address these constraints for enhanced adoption of climate smart practices among small scale farmers.

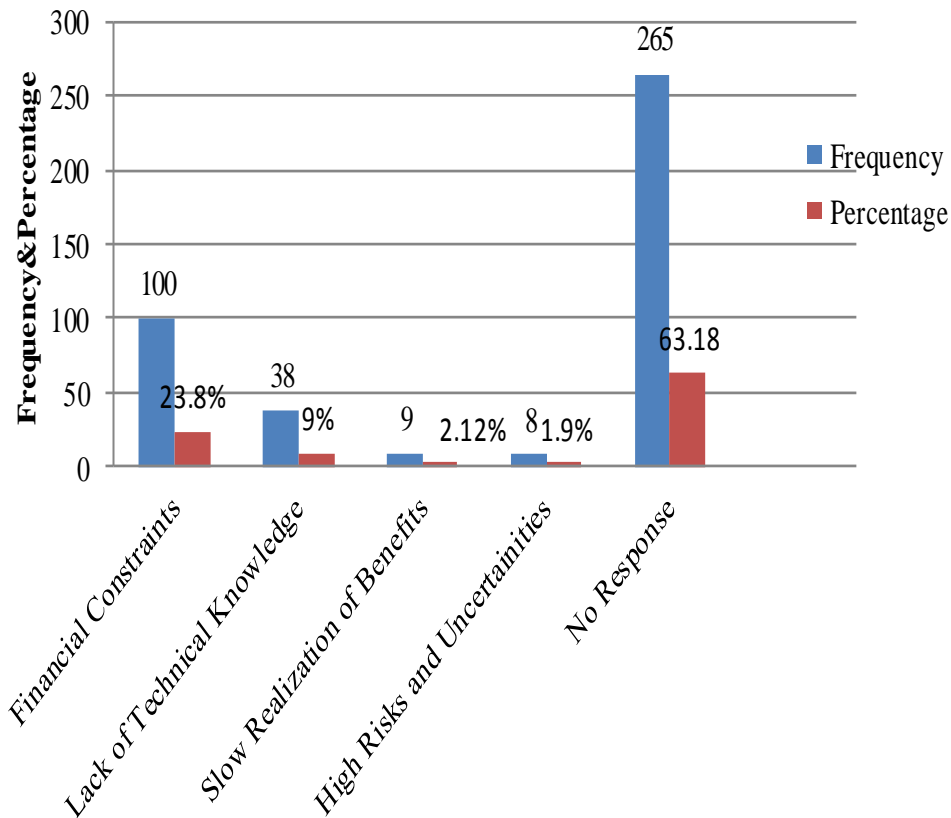


Figure 4.21: Reasons for Abandoning Practice of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

4.4.14 Practice of Specific Climate Smart Practices

In terms of adoption of specific climate smart practices, the extent was very low (40% and below) with the exception of mixed cropping (59%). There were also varying levels of adoption among various climate smart practices (Table 4.51).

Table 4.51: Climate Smart Practices Adopted and Frequency of Adoption in Kitutu and Nyaribari Chache of Kisii County

Climate smart practices adopted	Frequency (n)	Percentage %
Appropriate crop and livestock varieties	120	28.57
Mixed cropping	249	59.28
Integrated crop and livestock systems	72	17.1
Improved fallowing	30	7.1
Agroforestry	167	39.76
Green house technology	34	8.1
Intercropping with legumes and fertilizer fodder crops	118	28.1
Crop rotation	146	34.8
Rain water harvesting	139	33.09
Irrigation	32	7.6
Construction of water retention structures	116	27.4
Mulch cover	127	30.4
Biogas production	23	5.5
Preservation of hay	28	6.6
Planting of cover crops	110	27.6
Pasture management	34	8.09
Silage making	21	5.0
Use of organic manure	168	41.7
Index-based agricultural insurance	8	1.9
Feed management to reduce methane emissions	29	7.3
Farm-specific nutrient management & precise (micro-dose) fertilizer application	50	11.90

The low levels of adoption shows that majority of the farmers are yet to adopt climate smart practices in Kitutu and Nyaribari Chache sub counties. However, the varying levels, probably points to the relevant and most preferred practices in this area. These findings resonated well with several studies (McCarthy *et al.*, 2011; Ogada *et al.*, 2014) that had shown slow pace of adoption of various climate smart practices particularly in sub-Saharan Africa including Kenya and some parts of Asia. This is supported by study by Uaiene *et al.* (2009) in Mozambique who found that less than (7%) of farmers adopted improved cultivars of Maize, in spite of the efforts the government had put in over a decade.

Climate smart practices, which showed higher levels of adoption (ranged between 17% to 59%) comparatively included planting and rearing of appropriate crop and livestock varieties (drought, disease, pest and flood tolerant and early maturing), mixed cropping, intercropping with legumes and fertilizer fodder crops, integrated crop and livestock systems, agroforestry, rainwater harvesting, crop rotation, soil conservation and use of organic manure (Table 4.51). Many other climate smart practices such as green house technology, biogas production, farm specific nutrient management & precise (micro-dose) fertilizer application, pasture rehabilitation and management, use of agro weather advisories, feed management rated very low in terms of adoption (ranging between 1-12%). This was due to low awareness and knowledge among small scale farmers (Table 4.51).

4.4.14.1 Practice of Appropriate Crop and Livestock Varieties

Adoption of these practice was found to be quite low (28.57%, n=120) among farmers (Table 4.51). The low adoption implies that many of the crop and livestock systems in the study area are not resilient to climate change impacts and may account for the declining farm yield and productivity. The low adoption is as a result of the aforementioned low knowledge levels among farmers. These findings are in agreement with Kipkoech *et al.* (2015), who demonstrated low adoption of this practice in Kenya due to lack of knowledge among farmers.

4.4.14.2 Practice of Mixed Cropping

Mixed cropping ranked as one of the highest (59%, n=248) adopted climate smart practice among farmers (Table 4.51). This was due to high understanding and myriad benefits that farmers had gained from the practice such as maintenance and enhancement of soil fertility, ability to minimize spread of diseases, pests and insects, and control of weeds. The practice was also highly practiced as a result of increased contribution to soil cover, reduction in risk of crop failure and efficient use of resources in the light of prevailing climate change challenges according to key informants. Similarly, biophysical features of this area, such as high rainfall and topography, which result in high erosion and loss of fertility contributed significantly to the adoption of this practice. These results affirm ASDSP baseline survey which revealed high practice of mixed cropping among farmers in Kisii County (ASDSP, 2014).

4.4.14.3 Practice of Integrated Crop and Livestock Systems

Very few (17.1%, n=82) respondents had adopted this practice (Table 4.51). The low adoption was due to low involvement of farmers in the study area in livestock activities. Similarly, the low adoption was attributed to small land sizes and lack of knowledge of farmers by farmers on the immense benefits associated with the practice such as enhanced efficiency and productivity. These findings were found to be in line with FAO study, which established similar low levels of adoption of the practice in Nandi County (FAO, 2015).

4.4.14.4 Practice of Improved Fallowing

A mere (7.1%, n=30) were practicing fallow periods on their farms (Table 4.51). These findings clearly explained, unabated intensive and continuous farming that dominated the study area. This was attributed to high demand for food inextricably linked to high population pressure. This affirmed and pointed to more degradation of the soils with further exacerbation of decline in soil fertility, crop and pasture production and productivity. These results showed a significant disparity between the study area and other parts of western Kenya in terms of adoption of improved fallows. A study by Pisanell *et al.* (2008) on adoption of improved tree fallows in Western Kenya showed a

higher adoption rate of (79%).

The low adoption was as a result of low awareness and knowledge and dwindling farm size (Personal communication with County Director of Agriculture). The findings revealed unsustainable land use and dismal effort by the county government and other development practitioners towards enhanced adoption of the following practice. Measures which could boost adoption of the practice such as provision of incentives i.e. payment for environmental services schemes; awareness creation and building of knowledge base among small scale farmers were conspicuously lacking.

4.4.14. 5 Practice of Agroforestry

Relatively, agroforestry practices were fairly high (39.76%, n=167) in terms of adoption in the area after mixed cropping (59.28 %,) and use of organic manure (41.7%) (Table 4.51), mainly because they are less costly and more affordable to small scale farmers and play a significant role in terms of control of soil erosion, maintenance and improvement of soil fertility (Young, 1997). Due to the hilly nature and high rainfall that predisposes the area to massive soil erosion; agroforestry practice was found to be the most appropriate climate smart practice. Other incentives linked to fairly high adoption of this practice included returns from wood sales, fruit harvests, litter for soil enrichment and fodder for livestock.

4.4.14.6 Practice of Greenhouse Technology

In spite of the appropriateness of the technology in the study area, responses during the study indicated very few farmers (8.1%, n=34) had embraced the technology (Table 4.51). It's widely practiced in areas with scarcity of water and land. The technology has also gained wide attention in the light of adverse effects of climate change such as drought, floods and emergence of diseases. According to Omoro (2014) there were only 209 greenhouse units in the entire Nyamira and Kisii Counties. According to Key informants, the low adoption was due to low awareness and knowledge, high capital outlay beyond the reach of most of the farmers, high incidence of diseases and price fluctuations of agricultural products.

4.4.14.7 Practice of Intercropping

Compared with other climate smart technologies, practice of intercropping rated higher (28.1%, n=118) (Table 4.51), because of the benefits that underlie adoption of this practice. The advantages linked to intercropping include maintenance and enhancement of soil fertility, ability to minimize spread of diseases, pests and insects and reduction in risk of total crop failure in the light of prevailing climate change (McCarthy *et al.*, 2011; Conant, 2009). In spite of the high relative practice of intercropping, majority (71.9%, n=302) of the farmers were not adopting the practice (Table 4.51). Apart from the low knowledge level, the low adoption of this practice was also as a result of high labor requirement and up-front investment costs based on the observations made during Focus Group Discussions (FGDs).

4.4.14.8 Practice of Crop Rotation

The practice of crop rotation like intercropping was found to be relatively high (34.8%, n=246) (Table 4.51), compared to many other climate smart practices. This was because it was an old practice that farmers were highly aware of and offered many benefits such as enhancement of soil fertility, ability to minimize spread of diseases, pests and insects, control of weeds, maintenance of soil cover. Despite the high comparative adoption of crop rotation, the results showed majority (65.2%, n=274) of the farmers were yet to adopt the practice (Table 4.51). Based on the views of focus group participants, the low adoption was mainly due to lack of information of the practice among most of the farmers and limited management skill. These findings were also similar to those of Ogada *et al.* (2014) and FAO, (2015), who indicated that despite the promotion of this practice, among farmers through programmes such as NAAIAP, NALEP and KAAPAP, its adoption still remained low.

4.4.14.9 Practice of Water Harvesting Technologies

This technology apparently is one of the most highly practiced technologies (33.09%, n=139) probably an indicator of shortage of water that is occurring as a result of enhanced dry season under climate change scenario (Table 4.51). Despite of high comparative adoption of this technology, its adoption among majority farmers remains

low because of the high investment costs and laxity in the ministry of water and irrigation. These findings were in agreement with those of Kimani *et al.* (2015), who indicated low adoption of rain water harvesting technologies in Makueni County as a result of lack of training programmes and limited technological transfer to the beneficiaries (donor funded projects). The purpose of rain water harvesting is to collect or concentrate water for productive purposes such as growing of crops, fodder, and pasture or for supplying livestock or for domestic use during temporal water shortages occasioned by inadequate rains or outside growing seasons. This results into increased production efficiency and steady supply of food. There were several examples of water harvesting technologies i.e. Zai pits, retention ditches, roof catchment, rock catchment, ponds, water pans and dams practiced in the study area.

4.4.14.10 Practice of Irrigation

Findings in terms of extent of adoption of this technology remains very low (7.6%, n=32) (Table 4.51). The low adoption was due to high capital involved in the establishment of the irrigation systems and lack of awareness of the advantages of this technology during the dry spells. Irrigation is very useful practice in farming activities, particularly in dry areas or during dry periods. The practice involves artificial application of water for either growing of crops or fodder. In the study area, adoption of irrigation is quite pertinent given the long dry spells, erratic rainfall patterns that have been observed in the recent past as a result of climate change. These findings are consistent with Monteiro *et al.* (2010), who found that only 3% of the cultivated land in Kenya was under irrigated agriculture as a result of lack of training and appropriate awareness building, poor water management, low priorities in irrigation, inadequate credit and lack of financing for irrigation projects.

4.4.14.11 Practice of soil and Water Conservation Structures

Soil and Water conservation practice adopted in the study area, included construction of water retention structures (27.4%) (Table 4.51). Soil and water conservation is based on the principles of minimum soil disturbance, maintenance of soil cover and conservation of water by use of water retention structures. Based on the responses adoption of soil and

water conservation practice remains low in spite of high erosion attributed to the hilly nature of the terrain of the study area, high rainfall and intensive cultivation. The practice was low among farmers perhaps due to limited knowledge as suggested by McCarthy *et al.* (2011).

4.4.14.12 Practice of Mulch Cover

The adoption of mulching as an important adaptation practice to climate change was apparently low (30.4%, n=128) (Table 4.51). The low practice of mulching was affirmed by McCarthy *et al.* (2011) who attributed it to lack of knowledge.

4.4.14.13 Practice of Minimum Zero Tillage

Minimum or Zero tillage was quite low (12.1%) in terms of adoption among farmers in the study area (Table 4.51). This was well supported by several case studies in Africa, where minimum and zero tillage was shown to take place albeit slowly because of several challenges such as weed control, unavailability of equipments and scarce family labour (Kaumbutho *et al.*, 2007).

4.4.14.14 Practice of Biogas Technology

Adoption of this practice remains very low, only 5.5% (n=23) respondents confirmed uptake of this practice (Table 4.51). Mitigation of greenhouse gases from livestock manure is one of the climate smart practices that has gained increased attention in the recent past. Cattle and livestock manure generate methane and nitrous oxide gases that constitute 36% of all agricultural greenhouse gases (IPCC, 2007). To mitigate these greenhouse gases and create an opportunity for clean energy in the form of biogas, manure from cattle and other livestock is fed into a biogas digester. Apart from mitigation of greenhouse gases, this practice reduces overreliance on wood fuel which contributes to deforestation.

Views of participants in focus group discussions indicated that installation of biogas digester was highly technical, an art, which they had not fully mastered. The low awareness and knowledge was attributed to limited outreach by the GIZ project, as

indicated by the key informants. There was therefore need for scaling up sensitization and capacity building among farmers and extension officers about this practice to augment the ongoing efforts.

4.4.14.15 Practice of Farm Yard Composting

The study revealed that 38.4% (n=153) of respondents were practicing farm yard composting (Table 4.51). Though high comparatively with adoption of other practices, these findings indicate low adoption of farm yard composting. The low application of this technology was as a result low venture in livestock farming and lack of knowledge on the operation and importance of the technology. This was supported by a Study by Babalola & Olayemi. (2013) in Ogun State in Nigeria and FAO study in Nandi County in Kenya. Which revealed low practice of this technology by farming households because of low availability of materials, technical complexity involved and great cost of application.

4.4.14.16 Practice of Hay making

Only 6.6% (n=28) of the farmers were applying this practice (Table 4.51). These findings were consistent with Kiptot *et al.* (2015) who found out low adoption (24.9%) of hay bailing as a result low technical knowledge and labour intensiveness in Kenya. This shows low preparedness for increasing dry spells under climate change scenario in Kitutu and Nyaribari Chache among livestock farmers.

4.4.14.17 Practice of Pasture Rehabilitation and Management Practices

In spite of vital role played by improved pasture management and rehabilitation during unreliable rainfall periods, results indicate low adoption of this practice (8.09%, n=34) among small scale farmers in Nyaribari and Kitutu Chache areas (Table 4.51). The low adoption is attributed to lack of land for pasture development and low involvement in livestock activities. This has contributed to scarcity of fodder and decline in milk production in the study area during the dry spells. These findings were similar with those of FAO, (2015) in Kenya.

4.4.14.18 Practice of Silage Making

Adoption of feed conservation for livestock through silage making was quite low (5%, n=21) (Table 4.51). These findings were consistent with observations, made in the study area, during the recent long dry spell (January 2015), where milk production declined due to limited supply of pasture. Reasons for the low adoption included absence of planting materials, limited land, exorbitant cost of planting material, lack of technical knowhow and high labour requirements. This was in agreement with Kiptot *et al.* (2015). There was therefore need to sensitize more farmers on the importance of conservation of feeds during rainy season, where surplus occurs. This practice involves conservation of high moisture fodder material through fermentation in the absence of oxygen. It involves ensiling of fodder material with a high water-soluble sugar content and moisture ranging between 20% and 70% (Kiptot *et al.*, 2015).

4.4.14.19 Practice of Organic Manuring

Use of organic manure was one of the highest (39.9%, n=168) in terms of adoption (Table 4.51). This was most likely because of the need to address the low fertility levels of the soils attributed to exhaustion as a result of continuous and intensive cultivation and soil erosion. The high use of organic manure is probably also due to high productivity and affordability by majority of farmers who otherwise are unable to afford alternative inorganic fertilizers. In spite of the high adoption, widespread application of organic manure is limited by its insufficient supply due to few animals kept in the study area.

4.4.14.20 Index based Agricultural Insurance

Findings indicate extremely low (1.9%) usage of conventional insurance practice which involves field damage assessment (Table 4.51). These findings are consistent with the observations made during the survey conducted by ASDSP at household level, where it was found that none of the households had accessed or was using insurance services (ASDSP, 2014). Index based insurance is risk mitigation tool that protects farmers from weather shocks and helps them cope with crop and income losses, which are likely to increase under enhanced weather extremes associated with climate change scenario. This reduces vulnerabilities and enhances resilience of poor rural small-scale farmers. The

insurance scheme helps to manage covariate risks (risks that affect many people at the same time) such as droughts or excess rainfall. The scheme operates on market based principles, with social and development agenda (FAO 2013). The insurance scheme apart from insuring against risks associated with weather, enhances access of farmers to quality inputs, market and other services. The scheme also funds disaster recovery assistance and is more appropriate to farmers affected by low or medium frequency events (once every five to seven years) or else insurance premiums will be too high (FAO 2013). The scheme is based on the objective parameter e.g. measurement of temperature or rainfall at a weather station during an agreed period of time. It's best suited to weather hazards that are well correlated over a large area and where there is a close correlation between weather and crop yield, however it's less useful where there are multiple causes of crop or livestock loss. Currently the scheme is being implemented in 30 counties under Kenya Agricultural Insurance and Risk Management Program. This is a public private partnership programme supported by World Bank and GIZ.

4.4.14.21 Practice of Farm Specific Nutrient Management

From the results, it was clear adoption of this practice remained low with only 11.9% of the respondents indicating uptake (Table 4.51). The low uptake is as a result of low knowledge levels. Farm specific nutrient management method involves application of required fertilizer rates on the farm based on soil tests. This aims at efficient use of fertilizers. The practice enhances yield and quality of produce, however, requires state of art technology and intensive knowledge. Study on the impact of site specific nutrient management for high yielding rice Variety in Mekong Delta, revealed high yields and efficient nutrient management (Hach & Tan, 2007).

4.4.14.22 Practice of Feed Management to reduce Methane Emissions

Responses indicated low (7.3%, n=31) adoption of the practice of proper feed management (Table 4.51). The low adoption was due to low livestock rearing in the study area and lack of awareness, knowledge on the causes of climate change and mitigation measures. Bryan *et al.* (2013) in his study in Kenya on adaptation and mitigation strategies found that improved livestock feeding was one of the few strategies that

delivered the three triple wins (increased productivity, resilience and reduction in methane emissions) across all agro ecological zones in Kenya.

4.4.15 Relationship between Knowledge and Practice of Climate Smart Practices

The chi-square test results on the relationship between knowledge and adoption of all climate smart practices were all within the significant level ($p < 0.05$) (Table 4.52).

Table 4.52: Relationship between Knowledge of Climate Smart Practices and their Adoption in Kitutu and Nyaribari Chache of Kisii County

Level of knowledge and % adoption of respective climate smart practices									
Climate smart practices	Very high	High	Satisfactory	Low	Very low	No knowledge	Chi-square test results χ^2	df.	P
Appropriate crop and livestock varieties	0.2	2.1	11.7	11.7	1.4	1.4	32.423	5	.000
Mixed cropping	0.3	4.4	22.1	25.4	3.1	3.62	45.604	10	.000
Integrated crop and livestock systems	0	1.4	8.09	6	0.7	0.9	22.545	10	.013
Improved fallowing	0.2	0.7	4.76	0.7	0.7	0	34.567	10	.000
Agroforestry	0.2	2.3	14.7	17.8	2.8	1.67	47.353	10	.000
Green house technology	0.2	1	5.23	1.1	0	0.4	39.797	5	.000
Intercropping	0.2	2.1	11.7	11.4	1.4	1.2	33.202	5	.000
Crop rotation	0.2	2.4	17.1	11.9	0.7	2.38	64.779	5	.000
Water harvesting	0.2	1.9	14.5	12.8	1.4	2.1	40.937	5	.000
Irrigation	0.2	1.2	4.28	3.33	0	0.9	27.228	5	.000
Water retention structures	0.2	1.4	10.9	10	1.4	1.90	28.706	5	.000
Planting of cover crops	0.2	1.2	13.1	9.5	0.7	1.42	43.097	5	.000
Mulch cover	0.2	1.4	10.9	10.9	0.7	0.7	38.040	5	.000
Zero or minimum tillage	0.2	0.2	5	5.71	0	0	30.703	5	.000
Biogas production	0	0.4	2.85	2.1	0	0	11.504	5	.042
Farm yard composting	0.2	2.1	14.8	16	1.4	1.9	51.574	5	.000
Hay making	0.2	0.2	3.80	1.4	0.7	0.2	23.468	5	.000
Use of organic manure	0.2	2.4	16.4	18.1	1.4	1.4	67.801	5	.000
Pasture rehabilitation	0.2	0.2	6.9	0.7	0	0	64.423	5	.000
Silage making	0.2	0.2	2.9	0.7	0	0.9	33.684	5	.000
Use of agro weather advisories	0	1.2	2.9	3.8	0	0.2	18.917	5	.002
Indexed based agricultural insurance	0.2	0.2	0.7	0	0	0.7	62.785	5	.000
Feed management	0	0.4	4.0	1.4	0	1	16.978	5	.005
Farm specific nutrient management	0.2	0	6.9	3.6	0	1	34.526	5	.000

Similarly, most of the chi-square test results were very significant ($P = 0.00$). Therefore, the hypothesis that level of knowledge of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County had significant influence on their adoption was accepted. This evidently indicated the critical role that knowledge of climate smart practices among farmers plays on their adoption. For enhanced adoption of climate smart practices in the study area, knowledge concerning climate smart practices through measures such as improved extension service, farmer's field days and on farm demonstrations is therefore quite necessary. These findings were in agreement with several studies (Weir *et al.*, 2000; Jones *et al.*, 2010; Deressa *et al.*, 2009; Dulal *et al.*, 2010), which showed that better informed farmers are always on the forefront in terms of adoption of new technologies.

4.5 Factors Influencing Adoption of Climate Smart Practices

The third objective of this study was to examine factors influencing adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County. Similarly, since socioeconomic and farm characteristics had been shown to affect adoption of agricultural innovations (Deressa *et al.*, 2009), it was hypothesized in this study that they have significant influence on the adoption of climate smart practices among small scale farmers in this area.

4.5.1 Age

Adoption of virtually all climate smart practices was relatively high with regard to mixed cropping, agroforestry and appropriate crop varieties and livestock breeds. It also increased with age. Only 5.4% of youths between the age of 18-30 were engaged in mixed cropping as opposed to 23% of old men of 50 years and above. However, Chi-square test results showed no significant influence of age on adoption of all climate smart practices i.e. mixed cropping ($\chi^2=6.614$, $df=6$, $P= 0.358$), improved fallowing- ($\chi^2=8.934$, $df=6$, $P= 0.177$), agroforestry ($\chi^2=4.870$, $df=6$, $P= 0.561$) (Table 4.53). This evidently, indicated that age differences among farmers in the study area, had little or no impact on adoption of virtually all climate smart practices.

Table 4.53: Relationship between Age and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate Smart Practices	Age								Chi square test		
	18- 30		31-40		41-50		>50		x ²	df.	P
	F	%	F	%	F	%	F	%			
Appropriate crop and livestock varieties	10	2.3	32	7.6	34	8.1	44	11	1.408	3	.704
Mixed cropping	22	5.4	61	15	70	17	95	23	6.614	6	.358
Improved fallowing	4	9.5	6	1.4	6	1.4	14	3.3	8.934	6	.177
Agroforestry	15	3.6	40	9.5	49	12	63	15	4.870	6	.561
Rain water harvesting	15	3.6	36	8.6	36	8.6	52	12	5.989	3	.112
Irrigation	7	1.7	6	1.4	13	3.1	16	3.8	7.772	3	.051
Water retention structures	13	3.1	23	5.5	30	7.1	43	10	6.387	3	.094
Planting cover crops	7	1.7	29	6.9	34	8.1	40	9.5	1.281	3	.734
Zero or minimum tillage	1	0.2	13	3.1	18	4.3	15	3.6	3.385	3	.336
preservation of hay	3	0.7	6	1.4	11	2.6	8	1.9	1.476	3	.688
Pasture rehabilitation	3	0.7	7	1.7	13	3.1	11	2.6	.926	3	.819
Agro weather advisories	1	0.2	9	2.1	11	2.6	13	3.1	1.597	3	.660
Indexed based	1	0.2	2	0.4	3	0.7	2	0.4	.501	3	.919
Agricultural insurance											
Farm specific nutrient management	3	0.7	10	2.4	14	3.3	23	5.5	4.938	3	.176

These findings, were contrary to the assumption that older people with time, accumulate wealth, experience and resources, and were therefore more likely to adopt the climate smart practices (Deressa *et al.*, 2009), it was also inconsistent with argument that young people tend to be more educated, open minded and more likely to understand the advantages associated with innovations and therefore more likely to adopt the technologies (Murage *et al.*, 2013). The results of this study were also contrary to other studies (Howley *et al.*, 2012; Okuthe *et al.*, 2013) that had shown negative correlation between age and adoption of technologies, where old people were considered to be conservative, less flexible and highly skeptical. These findings could be attributed to lack of interest in farming on the part of youths, partly due to lack of access to land and lack of knowledge of climate smart practices by the old.

4.5.2 Gender

Generally, more males adopted climate smart practices compared to women. This was more explicit with adoption of agroforestry (25%) and farmyard composting (24%)

(Table 4.54). Chi square test revealed mixed results in terms of relationship between gender and adoption of climate smart practices. For example, there was a significant relationship between gender and adoption of climate smart practices, particularly appropriate crop and livestock varieties ($\chi^2 = 4.496$, df. =1 p=0.034), preservation of hay ($\chi^2 =5.811$ df. =1 p=.016), use of agro weather advisories ($\chi^2=9.263$, df.=1, p=.002) (Table 4.54).

Table 4.54: Relationship between Gender and Adoption of Climate Smart Practices In Kitutu and Nyaribari Chache of Kisii County

Climate smart practice	Male		Female		Chi square test		
	F	%	F	%	χ^2	df	P
Appropriate crop and livestock varieties	79	19	41	9.7	4.496	1	.034
Integrated crop and livestock systems	47	11	25	6	2.188	2	.335
Improved fallowing	20	5	10	2	1.162	2	.559
Agroforestry	105	25	62	15	3.859	2	.145
Green house technology	26	6	8	2	5.384	1	.20
Intercropping	75	18	43	10	2.371	1	.124
Crop rotation	93	22	53	13	3.378	1	.066
Water harvesting	79	19	60	14	.071	1	.079
Irrigation	27	6	15	3.6	.939	1	.333
Water retention structures	60	14	49	12	.420	1	.517
Planting of cover crops	68	16	42	10	.891	1	.345
Mulch cover	60	14	45	11	.056	1	.812
Zero or minimum tillage	32	8	15	3.6	.414	1	.120
Biogas production	13	3	10	2	.013	1	.911
Farm yard composting	101	24	52	12	7.308	1	.007
Preservation of hay	10	2	18	4.3	5.811	1	.016
Use of organic manure	95	23	73	17	.070	1	.791
Pasture rehabilitation	19	5	15	3.6	.058	1	.810
Silage making	16	4	5	1.2	3.145	1	.076
Use of agro weather advisories	28	7	6	1.4	9.263	1	.002
Indexed based agricultural insurance	7	2	1	0.2	2.886	1	.089
Feed management	19	5	10	2	.731	1	.393
Farm specific nutrient management	37	9	13	3	6.447	1	.011

There was apparent existence of differences in adoption rates of the aforementioned practices between men and women. However, there was no significant relationship between gender and adoption of some climate smart practices such as integrated crop and livestock systems ($\chi^2=2.188$, df.= 2, p = 0.335), improved fallowing ($\chi^2=1.162$, df.=2 p=

0.559), agroforestry ($\chi^2=3.859$, $df.=2$, $p= 0.145$) (Table 4.54). It was therefore clear in terms of gender that men and women differed in terms of use and adoption of some climate smart practices depending on the type of technology that was being adopted. A study by Omoro (2014) in both Kisii and Nyamira counties showed more male (62%) involvement in greenhouse technology farming than females (38%).

The gender differences in adoption of climate smart practices was attributed to variance in socioeconomic status, exclusion and skewed and limited access to extension services and information, particularly on the part of women. This was supported by Okuthe *et al.* (2013) in a study on socio-cultural determinants of Integrated Natural Resource Management technologies by small scale famers in Ndhiwa Division, who found out that men were more likely to adopt the technologies than women because of skewed dissemination of information in favor of men. During key informant interviews and focus group discussions, it was also explicit; that women and men played different roles in agricultural activities and had diverse technological needs, which required differentiated treatment by change agents. The findings of this study, therefore undoubtedly, showed that gender disparity, had implications on adoption of different climate smart practices in the study area.

4.5.3 Gender of Household Head

Table 4.55 shows that except for agroforestry ($\chi^2=7.412$, $df=2$, $p= 0.025$), irrigation ($\chi^2=3.919$, $df= 1$, $p=.048$), construction of water retention structures ($\chi^2=13.555$, $df=1$, $p=.000$) and Organic manure use ($\chi^2=4.845$, $df=1$, $p=.028$, chi-square test results indicated no significant relationship between gender of household head and adoption of most of the climate smart practices.

These results clearly pointed to the fact that there were differences in terms of adoption of agroforestry, irrigation, construction of water retention structures and use of organic manure between male and female headed households. However, there were no differences in terms of use and adoption of most climate smart practices between male headed households and female headed households.

Table 4.55: Relationship between Gender of Household Head and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practice	Male		Female		Chi square test		
	F	%	F	%	χ^2	df	P
Appropriate crop and livestock varieties	98	23	22	5.2	2.844	1	.092
Mixed cropping	211	50	38	9	1.666	2	.435
Integrated crop and livestock systems	59	14	13	3.1	1.974	2	.373
Improved fallowing	25	6	5	1.2	.849	2	.654
Agroforestry	135	32	32	7.6	7.412	2	.025
Green house technology	30	7	4	1	0.130	1	.718
Intercropping	98	23	20	4.8	1.359	1	.244
Crop rotation	125	30	21	5	0.050	1	.823
Water harvesting	117	28	22	5.2	0.967	1	.325
Irrigation	32	7.6	10	2.4	3.919	1	.048
Water retention structures	82	20	27	6.4	13.555	1	.000
Planting of cover crops	101	24	9	2.1	3.760	1	.052
Mulch cover	93	22	12	2.9	0.391	1	.532
Zero or minimum tillage	43	10	4	1	1.089	1	.297
Biogas production	20	5	3	0.7	0.011	1	.915
Farm yard composting	130	31	23	5.5	0.307	1	.579
Preservation of hay	124	30	13	3.1	3.190	1	.074
Use of organic manure	28	6.7	0	0	4.845	1	.028
Pasture rehabilitation	32	7.7	2	0.5	1.899	1	.168
Silage making	18	4.3	3	0.7	0.015	1	.903
Use of agro weather advisories	31	7.3	3	0.7	0.724	1	.395
Index based agricultural insurance	8	1.9	0	0	1.286	1	.257
Feed management	24	5.7	5	1.2	0.287	1	.592
Farm specific nutrient management	45	11	5	1.2	0.771	1	.380

This therefore revealed that gender of household head had no influence on adoption of most of the climate smart practices in the study area. However, these results were inconsistent with Oywaya (1995) who found out significant differences in adoption between female headed households and male headed households in Makueni County. The difference between this study and the findings of Oywaya (1995) were attributed to negative socio-cultural challenges that Makueni female headed households were subjected to. This also applied to the few climate smart practices in the study area such as adoption of irrigation and agroforestry, which apparently was man's domain.

4.5.4 Education Level

Chi-square test results indicated significant influence of educational level to adoption of most of the climate smart practices with exception of a few practices such as mulch covering ($\chi^2=8.144$, df. =4, p=.086), zero or minimum tillage ($\chi^2=9.276$, df. =4, p=.055), farm yard composting ($\chi^2=7.501$, df=4, p=.112), preservation of hay ($\chi^2=6.624$, df=4, p=.157), pasture rehabilitation ($\chi^2=7.905$, df=4, p=.095) and use of organic manure ($\chi^2=5.042$, df=4, p=0.283) (Table 4.56).

Table 4.56: Relationship between Level of Education and Adoption of CSA Practices in Kitutu and Nyaribari Chache of Kisii County

	Primary	Sec.	College	Univ.			
Climate smart practices	%	%	%	%	χ^2	df	p
Appropriate crop and livestock varieties	10.95	13.57	2.1	2	6.828	4	.145
Mixed cropping	21	21.36	5.71	11	20.722	8	.008
Integrated crop and livestock	4.28	8.09	2.1	5	37.506	8	.000
Improved fallowing	2.14	2.3	1.4	2	20.683	8	.008
Agroforestry	16.19	17.38	2.8	5	17.250	8	.028
Green house technology	2.6	1.6	2.8	1	44.840	4	.000
Rain water harvesting	14.52	10.95	5	5	28.385	4	.000
Intercropping	10.71	11.19	3.57	5	16.639	4	.002
Crop rotation	12.61	15.23	5	5	13.093	4	.011
Irrigation	3.57	2.8	2.8	0	33.717	4	.000
Water retention structures	13.09	8.80	2.1	5	14.637	4	.006
Planting of cover crops	10.95	9.76	4.2	2	12.262	4	.016
Mulch covering	10	10.23	2.8	5	8.144	4	.086
Zero or minimum tillage	5	4.04	0.7	0	9.276	4	.055
Biogas production	0.9	2.38	0.7	3	31.181	4	.000
Farm yard composting	16.6	14.28	3.5	2	7.501	4	.112
preservation of hay	2.3	2.8	1.4	0	6.624	4	.157
Pasture rehabilitation	3.3	2.8	1.4	2	7.905	4	.095
Silage making	1.6	1.9	1.4	0	11.647	4	.020
Use of organic manure	16.9	17.61	2.8	5	5.042	4	.283
Agro weather advisories	3.33	2.61	1.4	0	12.725	4	.013
Index agricultural insurance	0.9	0.2	0.7	0	10.079	4	.039
Feed management	2.1	1.9	2.1	0	29.190	4	.000
Farm specific nutrient	5	2.85	2.8	2	25.592		.000

This was in agreement with a hypothesis, which posited that education level has significant influence on adoption of technologies/innovations (Weir & Knight, 2000).

The hypothesis is based on the premise that education increases one's ability to understand and evaluate the information of new products and processes. It is also based on the assumption that it influences the attitude and acceptability of information in such way that educated people tend to be open minded, rational and able to assess and compare the advantages and disadvantages of the innovation (Weir & Knight, 2000). These results were consistent with findings of various studies (Jones *et al.*, 2010; Rogers, 2003; Frank & Penrose, 2012) and clearly affirmed education has significant influence on adoption of climate smart practices. However, it should be emphasized that the highest level of education does not necessarily translate to highest significance on adoption but rather the possession of basic level of education (Weir & Knight, 2000).

4.5.5 Farm Size

Farm size had significant influence on adoption of most of the climate smart practices with exception of few practices, such as appropriate crop and livestock varieties ($\chi^2=6.631$, $df=5$, $p=0.250$), mixed cropping ($\chi^2=8.945$, $df=10$, $p=0.537$), intercropping ($\chi^2=7.886$, $df=5$, $p=0.163$), construction water retention structures ($\chi^2=8.116$, $df=5$, $p=0.150$). Other exceptions include mulch cover ($\chi^2=10.949$, $df=5$, $p=0.052$), farm yard composting ($\chi^2=7.369$, $df=5$, $p=0.195$), organic manure ($\chi^2=8.178$, $df=5$, $p=0.147$), use of agro weather advisories ($\chi^2=9.596$, $df=5$, $p=0.088$) and farm specific nutrient management ($\chi^2=10.829$, $df=5$, $p=0.055$) (Table 4.57). This shows that the bigger the farm size, the more these practices will be adopted.

These findings were in agreement with another study by Parwada *et al.*(2010), which indicated that large scale farmers were always on the forefront in adoption of new technologies. As noted earlier the average farm size in the study area was low (2 acres) and therefore had adversely affected adoption of most of the climate smart practices. However, in some cases farm size had been shown to be negatively associated with adoption of innovations. This is often due to shift to intensive practices that efficiently utilize the scarce land resources and increase productivity, where the option of increasing production by expansion of land does not exist (Deressa *et al.*, 2009). Based on these findings, dwindling farm size in Kisii County has significantly accounted for the low

adoption of climate smart practices.

Table 4.57: Relationship between Farm Size and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practice	Size of the farm in acres & % adoption of Climate Smart Practices						Chi square test		
	<1	1	2	3	4	5	x ²	df	p
	%	%	%	%	%	%			
Appropriate crop and livestock varieties	3.3	11.7	5.5	0.2	2.1	1.9	6.631	5	.250
Mixed cropping	7.5	20.1	16.2	7.5	3.9	4.5	8.945	10	.537
Integrated crop and livestock	0.4	4.5	6	4	0.7	6	38.430	10	.000
Improved fallowing	0.4	1.4	1.2	3.3	0	0.7	37.193	10	.000
Agroforestry	4.5	14.8	12.6	4.3	1.4	2.1	19.852	10	.031
Green house technology	1.7	0.7	1.4	2.4	0	1.9	41.855	5	.000
Intercropping	3.8	10	6.9	4.0	0.7	2.6	7.886	5	.163
Crop rotation	5.5	9.3	9.3	5.5	3.1	2.1	14.332	5	.014
Water harvesting	8.3	9.8	6	4.8	1.7	2.6	19.519	5	.002
Irrigation	1.2	4.3	1.7	1.4	0	1.4	11.020	5	.051
Water retention structures	3.8	7.6	6.9	4.8	0.7	2.1	8.116	5	.150
Planting of cover crops	4.3	6.2	6.7	5.5	2.1	1.4	14.166	5	.015
Mulch cover	4.5	5.7	7.1	4.8	1.4	1.4	10.949	5	.052
Zero or minimum tillage	3.5	2.4	2.9	1.4	0.9	0	15.728	5	.008
Biogas production	0.2	0.9	2.9	0.7	0	0.7	17.073	5	.004
Farm yard composting	4.8	14.8	8.8	14	1.4	2.6	7.369	5	.195
Preservation of hay	1.9	0.9	1.7	0.7	0	1.4	24.859	5	.000
Use of organic manure	6.2	15	9.8	5.5	0.7	2.6	8.178	5	.147
Pasture rehabilitation	0.9	0.9	1.4	2.6	0	2.1	55.227	5	.000
Silage making	0.2	1.7	1.7	0	0.7	0.7	13.614	5	.018
Agro weather advisories	1.4	3.8	2.1	0	0	0.7	9.596	5	.088
Indexed agricultural insurance	0.2	0.2	0.7	0	0.7	0	22.140	5	.000
Feed management	0.7	2.9	1.2	2.1	0	0	10.935	5	.053
Farm specific nutrient management	1.7	3.1	2.4	3.3	0.7	0.7	10.829	5	.055

4.5.6 Choice of Farm Enterprises

Choice of farm activities either crop or livestock enterprises had no significant influence on the adoption of climate smart practices, with the exception of pasture rehabilitation and management ($x^2=17.254$, $df=1$, $p=0.000$) (Table 4.58). This showed that the use and adoption of climate smart practices between crop and livestock farmers was not different.

Table 4.58: Relationship between Farm Enterprises and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practice	Livestock rearing		Crop farming		Chi square test		
	F	%	F	%	χ^2	df	p
Appropriate crop & livestock varieties	5	1.2	115	27.38	1.026	1	.311
Mixed cropping	16	3.8	233	55.47	4.109	2	.128
Integrated crop & livestock systems	2	0.5	70	16.7	.468	2	.791
Improved fallowing	2	0.5	28	6.7	1.785	2	.410
Agroforestry	3	0.7	164	39	1.309	2	.520
Green house technology	1	0.2	33	7.9	.001	1	.976
Intercropping	5	1.2	113	26.9	1.126	1	.289
Crop rotation	2	0.5	144	35	1.919	1	.166
Water harvesting	6	1.5	133	32.7	1.381	1	.240
Irrigation	0	0	42	10.4	1.431	1	.232
Water retention structures	6	1.5	103	26.3	3.037	1	.081
Planting of cover crops	5	1.3	105	26.4	1.218	1	.270
Mulch cover	5	1.3	100	25.4	1.428	1	.232
Zero/Minimum tillage	3	0.7	44	11.3	1.945	1	.163
Biogas production	0	0	23	5.8	.757	1	.384
Farm yard composting	6	1.5	147	36.9	.698	1	.403
Preservation of hay	0	0	28	7.1	.939	1	.333
Use of organic manure	6	1.5	162	40.2	352	1	.553
Pasture rehabilitation	5	1.3	29	7.3	17.254	1	.000
Silage making	0	0	21	5.2	.680	1	.410
Agro weather advisories	1	0.2	33	8.2	.000	1	.992
Index based agricultural insurance	0	0	8	2	.250	1	.617
Feed management	0	0	29	7.3	.981	1	.322
Farm specific nutrient	2	0.5	48	12	.193	1	.660

4.5.7 Experience in Farming

The results of this study showed that farming experience had generally no influence on adoption of most climate smart practices with exception of a few. Climate smart practices that were positively associated to farming experience included; green house technology ($\chi^2=14.555$, $df=3$, $p=0.002$), intercropping ($\chi^2=8.850$, $df=3$, $p=0.031$), water harvesting ($\chi^2=9.124$, $df=3$, $p=0.028$), zero or minimum tillage ($\chi^2=8.857$, $df=3$, $p=0.031$), pasture rehabilitation and management ($\chi^2=11.384$, $df=3$, $p=0.010$) and farm specific nutrient

management ($\chi^2=19.972$, $df=3$, 0.000) (Table 4.59). In this case, the higher the farm experience the higher the adoption rate of these practices.

Table 4.59: Relationship between Experience in Farming and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practices	Farm Experience in Years				Chi-square test		
	1	2-5	6-10	>10	χ^2	df	p
	%	%	%	%			
Appropriate crop and livestock varieties	0.7	4.5	6.9	16.4	2.602	3	.457
Mixed cropping	1.1	11.1	13.7	32.9	3.205	6	.783
Integrated crop and livestock systems	0	3.3	4.76	2.1	10.463	6	.106
Improved fallowing	0	0.7	2.1	4.3	4.843	6	.564
Agroforestry	0.7	8.8	9.52	20.71	3.870	6	.694
Green house technology	0.7	1.42	0.2	5.71	14.555	3	.002
Intercropping	0	4.0	7.4	16.67	8.850	3	.031
Crop rotation	0.7	7.61	8.57	17.85	1.437	3	.697
Water harvesting	0.7	4.5	7.85	20	9.124	3	.028
Irrigation	0.7	0.7	2.6	5.95	7.269	3	.064
Water retention structures	0.7	4.76	5	15.47	3.958	3	.266
Planting of cover crops	0	5.95	5.71	14.52	6.884	3	.076
Mulch cover	0	6.19	5.47	13.33	6.758	3	.080
Zero or minimum tillage	0	1.1	2.1	7.85	8.857	3	.031
Biogas production	0	1.42	0.9	3.09	1.976	3	.577
Farm yard composting	0.7	7.61	8.8	19.28	1.584	3	.663
Preservation of hay	0	2.3	1.19	3.1	5.329	3	.149
Use of organic manure	1.4	8.57	9.76	20.2	.895	3	.827
Pasture rehabilitation	0	0	2.6	5.47	11.384	3	.010
Silage making	0	1.42	1.90	1.6	4.199	3	.241
Use of agro weather advisories	0	1.9	1.9	4.2	1.491	3	.684
Indexed based agricultural insurance	0	0	0.4	1.4	2.644	3	.450
Feed management	0	0.7	1.1	0.05	5.736	3	.125
Farm specific nutrient management	0	0.4	1.9	9.52	19.972	3	.000

This showed that the long experience farmers had in their farming activities in the study area had not influenced them to adopt most of the climate smart practices. This was inconsistent with the hypothesis that more years in farming were positively correlated to adoption of technologies. This is because experience is often linked to more information in terms of farming technologies (Rogers, 2003). This showed explicitly that, while farmers had experience in farming, they lacked experience with regard to adoption of some specific climate smart practices i.e. Mixed cropping, integrated crop and livestock

systems. These findings were consistent with those of Okuthe *et al.* (2013) who found no relationship between farming experience and adoption of Integrated Natural Resource Management Technologies in Ndhiwa Sub County.

4.5.8 Income Level

Income level had significant influence on adoption of most of the climate smart practices, with the exception of a few such as improved fallowing ($\chi^2=19.972$, $df=3$, $p=0.000$), preservation of hay ($\chi^2=5.325$, $df=4$, $p=0.256$), silage making ($\chi^2=5.964$, $df=4$, $p=0.202$) and index based agricultural insurance ($\chi^2=4.063$, $df=4$, $p=0.398$) (Table 4.60).

The findings were in consonant with a hypothesis in this study that the more the income (earnings from both farm and off-farm work), the more the ability the farmers had to respond to environmental variations through adoption of innovations and technologies including climate smart practices. Therefore, the hypothesis was accepted.

According to Jones *et al.* (2013), income enables farmers to buy inputs, innovate in the face risks, and support long term sustainable adaptation. They further argued that adoption of innovations or technologies involved substantial capital requirement that depended on income level. These results also concurred with Watsula (2000), who found out that farm income had positive impact on adoption of soil conservation measures. Another study by Gedikoglu & Parcel (2013) on impact of off-farm income on adoption of agricultural technologies in United States of America similarly, revealed a positive relationship. Generally, poverty is a major concern in Kisii County, whose incidence stands at 49.3% against the national average of 47% (KCG, 2014). This clearly showed that poverty and low incomes among farmers had immensely contributed to the low adoption of climate smart practices in the study area.

Table 4.60: Relationship between Income Level and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Adoption of Climate smart practices	Income level					Chi-square test		
	1*	2*	3*	4 *	5*	x^2	df	p
	%	%	%	%	%			
Appropriate crop & livestock varieties	11	12	2.9	2.1	0	20.373	4	.000
Mixed cropping	23	30	2.2	3.2	0	20.471	8	.009
Integrated crop and livestock systems	7.4	7.6	0.7	1.4	0	16.365	8	.037
Improved fallowing	3.6	2.8	0.7	0	0	19.972	3	.000
Agroforestry	17	16	2.1	2.8	0	18.890	8	.015
Green house technology	1.7	5	0	1.4	0	30.187	4	.000
Intercropping	10	13	1.4	2.8	0	24.998	4	.000
Crop rotation	12	18	2.1	1.4	0	18.34	4	.001
Water harvesting	11	17.	2.1	2.1	0	19.404	4	.001
Irrigation	2.8	5.6	0	1.4	0	21.572	4	.000
Water retention structures	11	11	1.4	2.1	0.7	9.929	4	.042
Planting of cover crops	7.9	16	1.4	1.4	0	28.742	4	.000
Mulch cover	8.8	13	0.7	2.1	0	24.104	4	.000
Zero or minimum tillage	1.2	7.9	1.4	0.7	0	37.000	4	.000
Biogas production	1.7	1	1.4	1.4	0	56.558	4	.000
Farm yard composting	14	17	2.1	2.8	0	23.947	4	.000
Preservation of hay	3.5	2.3	0	0.7	0	5.325	4	.256
Use of organic manure	17	17	2.1	2.8	0.7	10.895	4	.028
Pasture rehabilitation	2.6	4.0	0.7	0.7	0	7.120	4	.130
Silage making	1.9	2.3	0.7	0	0	5.964	4	.202
Agro weather advisories	2.1	5.2	0	0.7	0	14.191	4	.007
Index based agricultural insurance	0.5	1.4	0	0	0	4.063	4	.398
Feed management	1	4.5	0	1.7	1.7	34.445	4	.000
Farm specific nutrient management	4	5.7	0	2.1	0	38.262	4	.000

1*(\leq 5000), 2*(15001-15000), 3*(15001- 25000), 4*(25001- 35000), 5*(\geq 35000)

4.5.9 Access to Credit

Chi-square test results showed no influence of credit to adoption of most of climate smart practices. The few climate smart practices, which were shown to be influenced by credit included water harvesting ($x^2 = 3.951$, $df=1$, $p=0.047$), irrigation ($x^2 = 5.135$, $df=1$, $p=0.023$), construction of water retention structures, planting of cover crops, mulch cover, organic manure and application of farm specific nutrient management (Table

4.61). The influence of credit on adoption of these practices is due to heavy capital outlay required involved. According to Jones *et al.* (2013), access to credit enhances the resource base of farmers, hence improving their ability to invest in technologies on the farm, which may be costly beyond their capability. These results were however, found to be inconsistent with the aforementioned argument. This was attributed to low access and uptake of credit among majority of farmers in the study area (Figure 4.4).

Table 4.61: Relationship between Access to Credit and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practice	No. adopting CSPs	No. access/ad opting	% credit/ adopting	access	Chi test x^2	square df	p
Appropriate crop& livestock varieties	120	16	38.1		2.042	1	.153
Mixed cropping	249	29	69		1.547	2	.461
Integrated crop and livestock systems	72	2	4.8		5.442	2	.066
Improved fallowing	30	3	7.1		.449	2	.799
Agroforestry	167	11	26.2		4.322	2	.115
Green house technology	34	2	4.8		.697	1	.404
Intercropping	118	10	23.8		.424	1	.515
Crop rotation	146	11	26.2		1.779	1	.182
Water harvesting	139	8	20		3.951	1	.047
Irrigation	42	0	0		5.135	1	.023
Water retention structures	109	4	10		7.036	1	.008
Planting of cover crops	110	11	27.5		.000	1	.984
Mulch cover	105	11	27.5		.016	1	.898
Zero or minimum tillage	47	6	16.2		.658	1	.417
Biogas production	23	3	7.7		.296	1	.587
Farm yard composting	153	10	24.4		3.814	1	.051
Preservation of hay	28	0	0		3.375	1	.066
Use of organic manure	168	11	26.8		4.145	1	.042
Pasture rehabilitation	34	3	7.7		.044	1	.834
Silage making	21	0	0		2.441	1	.118
Agro weather advisories	34	2	4.9		.741	1	.389
Index based agricultural insurance	8	0	0		.922	1	.337
Feed management	29	1	2.4		1.616	1	.204
Farm specific nutrients	50	0	0		6.547	1	.011

4.5.10 Membership in Farmers Organization

Only the uptake of farm specific nutrient application was found to have a significant relationship $\chi^2=4.021$, $df=1$, $p=0.045$, with membership in farmers organizations (Table 4.62). The high membership (86.7%, $n=364$ in Figure 4.5) in farmers groups had not translated into adoption of climate smart practices, due to poor functioning of the groups, which had undermined the realization of other multiple group benefits as indicated during the focus group discussions and key informant interviews.

Table 4.62: Relationship between Membership in Farmer Groups and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Adoption of climate smart practices	Members of famers org.		Not members of organization		Chi-Square test		
	F	%	F	%	χ^2	df	p
Appropriate crop and Livestock Varieties	107	25.47	13	3.09	.775	1	.379
Mixed Cropping	228	54.19	21	5	5.724	2	.057
Integrated Crop and Livestock Systems	64	15.2	8	1.9	5.551	2	.062
Improved Fallowing	27	6.4	3	0.7	.766	2	.682
Agroforestry	146	34.76	21	5	.577	2	.750
Green house technology	31	7.3	3	0.7	.651	1	.420
Intercropping	100	23.8	18	4.2	.524	1	.469
Crop rotation	132	31.4	14	3.33	2.681	1	.102
Water harvesting	126	0.3	13	3.09	1.893	1	.169
Irrigation	40	9.5	2	0.4	1.893	1	.169
Water retention structures	96	22.85	13	3.09	.017	1	.897
Planting of cover crops	97	23.09	13	0.3	.017	1	.896
Mulch cover	91	21.6	14	3.33	.393	1	.531
Zero or minimum tillage	40	9.5	7	1.6	.805	1	.370
Biogas production	23	5.4	0	0	3.159	1	.076
Farm yard composting	131	31.19	22	5.2	3.038	1	.081
Preservation of hay	27	6.4	1	0.2	1.856	1	.173
Use of organic manure	143	34.04	23	5.4	1.491	1	.222
Pasture rehabilitation	33	7.8	1	0.2	2.876	1	.090
Silage making	17	4	4	0.9	1.300	1	.254
Agro weather advisories	27	6.4	7	1.6	3.382	1	.066
Indexed based agricultural insurance	7	1.6	1	0.2	.000	1	.998
Feed Management	27	6.4	2	0.4	.899	1	.343
Farm specific nutrient management	48	11.42	2	0.4	4.021	1	.045

These findings were different from a study conducted by Kolade & Harpham (2014) on

impact of cooperative membership on farmers uptake of technological innovations in Southwest Nigeria, which revealed that cooperative membership had the highest impact as compared to other socioeconomic factors i.e. educational level, access to credit. According to a policy brief on challenges and opportunities for Strengthening Farmers Organization in Africa: Lessons from Ethiopia, Kenya and Malawi, Thompson *et al.* (2009) observed that most farmer organizations are dogged with meager resources, and limited organizational and technical capacity that undermines their performance.

4.5.11 Period of realization of Benefits from Adoption of Climate Smart Practices

Most farmers (54.8%, 230), felt benefits from adoption of climate smart practices could be realized after a long period of time (Table 5.63). This clearly showed that one of the reasons that had demotivated adoption of climate smart practices among some farmers was the perceived long period that they took to realize benefits derived from implementation of climate smart practices.

Table 4.63 Perceived Time for Realization of Benefits from Adoption of Climate Smart Practices

Perceived time of realization of benefits	Frequency (n)	Percentage %
Short	190	45.2
Long	230	54.8
Total	420	100

The finding was in agreement with Giller *et al.* (2009) who indicated that most of the sustainable land management practices increases productivity only in the medium to long term through improved soil and water management but causes a decline in production in the short run. He argues that this can be a disincentive to adoption of some of the climate smart practices. This echoes the argument of Woelcke. (2012) who noted that any short term reductions or increases in yield or income could respectively either discourage or encourage farmers to adopt the climate smart practices.

4.5.12 High Rainfall and Steep Topography

Majority (83%, n=349) affirmatively indicated that there was significant influence of high rainfall and steep terrain on adoption of climate smart practices (Figure 4.22). The high influence was associated with high erosion attributed to the confluence of the two factors. This is in agreement with Shiferaw *et al.* (2009) who argues that in high rainfall areas, soil and water conservation practices are emphasized for the purposes of curbing soil erosion.

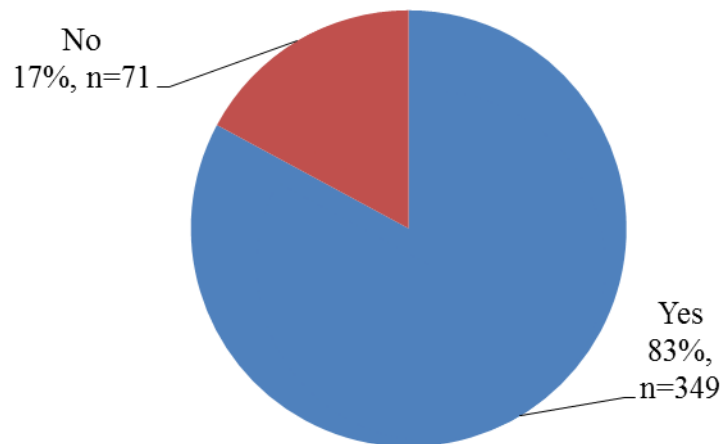


Figure 4.22: Influence of High Rainfall and Steep Topography on Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

However, Deressa *et al.* (2009) in their study in the Nile Basin of Ethiopia found out that increased rainfall led to low adoption of climate smart practices and vice versa. Increase in precipitation diminishes the limitations imposed by increased temperature on soil moisture content and thus crop growth. The study therefore revealed the need for adoption of climate smart practices that would help in addressing the problem of soil erosion i.e. conservation agriculture.

4.5.13 Extension Service Providers Promotion of Climate Smart Practices

Most respondents (68.3%, n=287) acknowledged having been enlightened by extension service providers, on the value of climate smart practices in terms of enhanced adaptation to climate change. However, over (30%) had either not been reached (17.4%, n=73) or had no idea at all (14.3%, n=60) as shown in Figure 4.23.

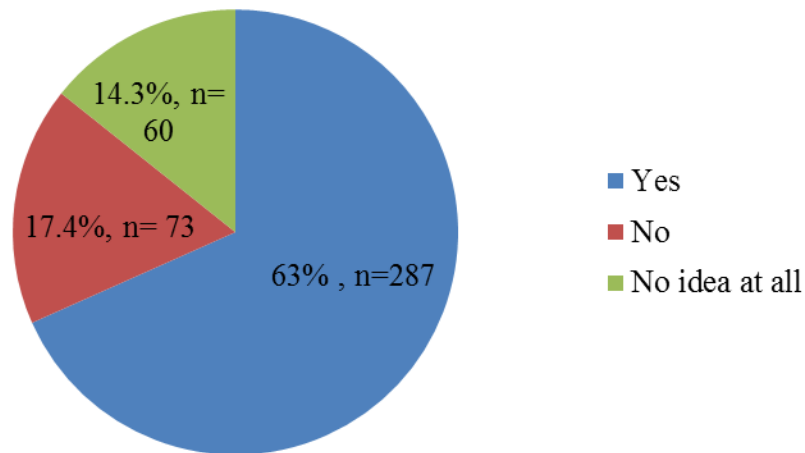


Figure 4.23: Extension Services Promotion of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

These findings indicate some significant effort toward adoption of climate smart practices by extension service providers in the study area. This is likely to enhance the adoption of these practices. Substantial literature shows extension services are positively associated with adoption of agricultural innovations (Howley *et al.*, 2012; Millar, 2010; Thorlakson, 2011). This could be that the more the extension services and visits, the more farmers are made aware of the potential benefits of adopting the innovations. Extension services also significantly influences uptake of technologies, because of their positive impact on the level of knowledge and attitude of farmers (Thorlakson, 2011).

In terms of frequency of extension service visits, the responses indicated interaction of once in a month (45.7%, n=192) or two months (18.8%, n=79). However, very few indicated several times within a period of one month (5%, n=21). Others indicated interaction of only once in a year (6.9%, n=29) as shown in Table 4.64

Effectiveness in extension service delivery has been shown to depend on frequency and quality of interaction between extension agents and farmers (Howley *et al.*, 2012; Millar, 2010). As a measure of effectiveness of extension service delivery with regard to climate smart practices, this study therefore used the frequency as a proxy indicator.

Table 4.64: Frequency of Extension Visits to Farmers in Kitutu and Nyaribari Chache of Kisii County

Frequency of extension visits	Frequency (n)	Percentage %
Once a month	192	45.7
Several times in a month	21	5.3
Once in two months	79	18.8
Once in a year	29	6.9
No response	99	23.3
Total	420	100

These statistics indicated inadequate reach by extension services to farmers, which could be contributing to low adoption of climate smart practices. This was due to low extension staff against the number of farmers (1:2500) or low financial support for extension services in the study area (ASDSP, 2014). Effective extension services provision requires a ratio of 1:1500 farmers which is often not the case (Howley *et al.*, 2012; Millar, 2010).

4.5.14 Farmer to Farmer Recommendation for Adoption of Climate Smart Practices

Majority (66 %, n=278) of the respondents were affirmative in terms of encouraging other farmers to adopt the practices (Table 4.65). It was clear from their responses that farmers were willing to promote these practices to other farmers. In this study, recommendation of climate smart practices to other farmers for adoption was used as a proxy measure of their confidence and approval of these practices.

Table 4.65: Farmer to Farmer Recommendation for Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Responses	Frequency (n)	Percentage %
Yes	278	66
No	142	34
Total	420	100.0

These findings demonstrated the high potential for diffusion and adoption of climate smart practices among farmers given the willingness among themselves to promote them. According to Kiptot *et al.* (2006), farmer to farmer dissemination is an effective and potential alternative way of enhancing adoption of agricultural innovations. This argument was affirmed by Deressa *et al.* (2009) who looked on determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia and found that farmer to farmer advices increased the likelihood of adopting climate change adaptation strategies such as planting of appropriate varieties and agroforestry.

4.5.15 Policy Framework and Adoption of Climate Smart Practices

Analysis of National and county documents showed lack of sector specific climate risk management plans, due to limited or lack of awareness concerning climate change effects. Similarly, while there were provisions that support adoption of climate smart practices, they were inconsistent, weak and are faced with implementation and enforcement challenges. Similarly, county government apparently don't seem to adhere to the provisions, because of weak national and county government linkage. During Focus Group Discussions, the agriculture sector service providers acknowledged existence of weak policies and poor implementation due to financial constraints. They contended that policies do not adequately address environmental concerns; they also indicated weak research-extension-farmers and County- National government linkages. This is supported by Maina *et al.* (2013) who found that existing lack of policy coherence posed the risk of weakening long term policy goals on climate change and Agriculture.

The policy and regulatory documents identified and analyzed included; Vision 2030, Environmental Management and Coordination Act 1999, Agriculture Sector Development Support Programme, National Climate Change Response Strategy, National Climate Change Action Plan, Water Act 2002, Forest Act 2005, National Food Security and Nutritional Security Policy, Crops Act 2013, Farm Forestry Rules, Agriculture , Fisheries and Food Authority Act 2013, Kenya Agriculture and Livestock Research Organization Act 2013, Lands Act 2012 and the Constitution of Kenya 2010.

4.6 Climate and Weather Information Dissemination and its Influence on Adoption of Climate Smart Practices among Small Scale Farmers

4.6.1 Extent of Climate and Weather Information Dissemination in Kisii County

Findings of this study revealed very low (23.3%) access to weather and climate information disseminated in the form of agro weather advisories (Appendix 5). Majority (76.7%) of the respondents indicated they were oblivious of the information that included technical advises on appropriate practices undertaken to ensure resilience to climate and seasonal weather shocks (Figure 4.24).

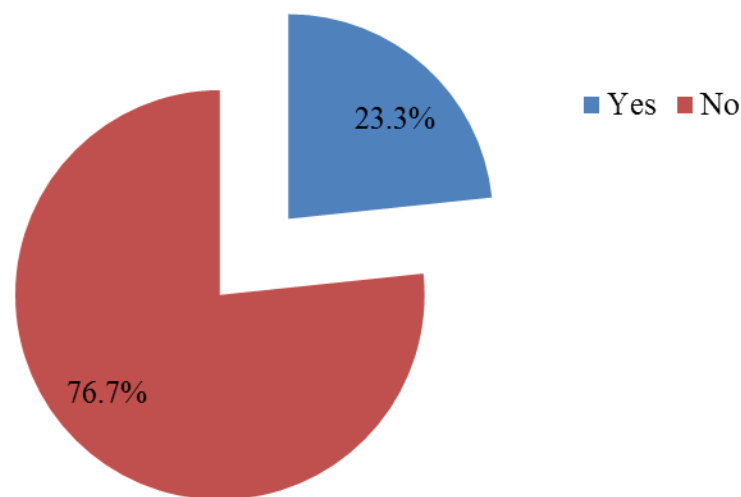


Figure 4.24: Extent of dissemination of Climate and Weather Information in Kitutu and Nyaribari Chache of Kisii County

This revealed the low extent of dissemination of agro weather advisories, and hence the high vulnerability among farmers to climate change risks in the study area. The low access was as a result of weak and limited dissemination of agro weather advisories (Key Informants and FGDs). These findings were consistent with Harvey *et al.* (2009), who expressed concern over inadequate sharing of climate information in Africa, which had led to limited access to climate information particularly among small scale farmers. These results were similar to the outcome of a survey conducted by Jha *et al.* (2012) in Bundelkhand region of Central India which showed that farmers relied mostly on local and traditional sources of information to make their farming decisions. Only 15% of the respondents during the survey indicated access to agro meteorological information in this

region of India. This affirms low access of agro meteorological information among farmers in developing countries, in spite of the high vulnerabilities to the vagaries of weather.

4.6.2 Channels used in Dissemination of Agro Climate and Weather information to Farmers in Kisii County

From the findings it was explicit, the main mode of communication that reached a wider audience among respondents with agro weather advisories was both electronic (TV, Radio) and print media (Newspapers) (42%) (Figure 4.25).

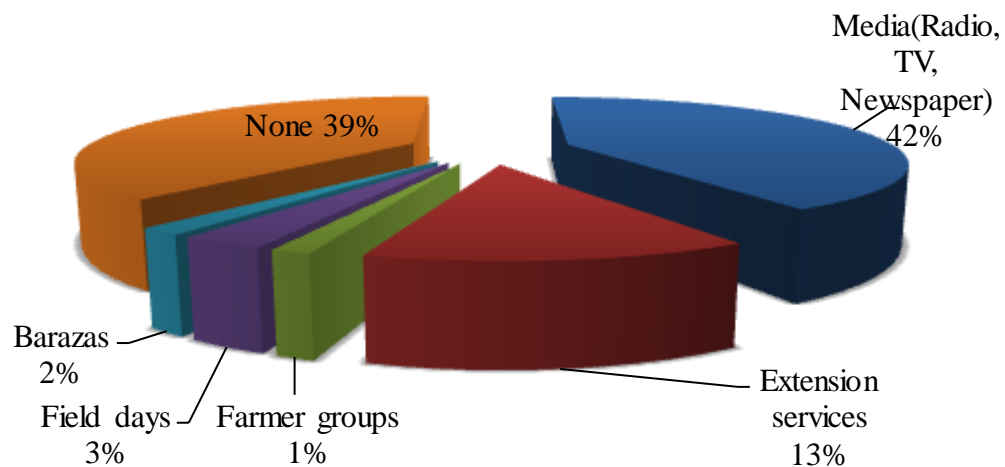


Figure 4.25: Channels of Communication Used During Dissemination of Climate Information in Kisii County

This revealed that the most effective way that agro weather information can be disseminated in the study area was through the media, particularly through the local vernacular FM radios, which have a wide audience among the rural farmers. This corroborates WMO (2009) and Weiss *et al.* (2000) assertion that television and radio remains the most reliable means of dissemination of agro weather information among small scale farmers, and particularly when broadcasted in the local languages.

Other ways through which agro weather information was provided to farmers included barazas (2%), extension service (13%), field days (3%) and farmer groups (1%) but to a very limited extent (Figure 4.25). Similarly, there was a significant portion (39%) of farmers who were not accessible to any channel of dissemination. These results indicated significant shortcomings in dissemination of agro weather information through extension services and farmer organizations, which once strengthened would lead to enhanced access of agro weather information among farmers. These results were also in agreement with a study carried out by Zendera (2011) among smallholder farmers in Perkerra and Lari-Wendani Irrigation schemes in Kenya. The study revealed that 98% of the farmers received agro meteorological information through radio, but to a very limited extent through bulletins, mobile phone, internet, agricultural extension services and barazas.

4.6.3 Knowledge of application of Agro -Climate and Weather Information

Only 11% of the respondents had the understanding on the working knowledge of agro weather information, while majority (84%) indicated lack of knowledge (Figure 4.26). This is a sharp decline from the proportion that indicated awareness (23.3%) (Figure 4.24). This shows that even though some farmers have awareness, they lack the how and why knowledge with respect to agro weather advisories considered vital in influencing farmers decisions (Roger, 2003).

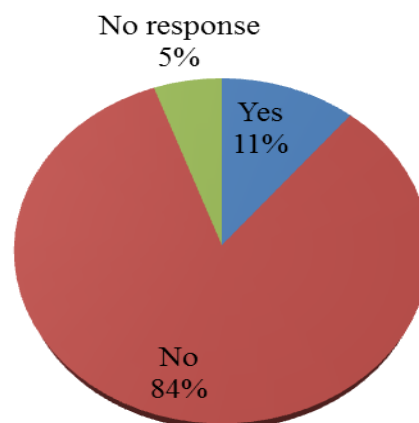


Figure 4.26: Knowledge on application of Agro Weather and Climate Information by Small Scale Farmers in Kitutu and Nyaribari Chache of Kisii County.

The low knowledge level was attributed to low access to climate information and lack of training on interpretation of the information in terms of management strategies to be undertaken according to key informants & focus group discussions. This is in congruence with Chamboko *et al.* (2008), who found similar results in his study in Zimbabwe. As recourse participatory process involving farmers, traditional forecasters, extension service and meteorological services providers has been suggested (WMO, 2012) and is currently being promoted by ASDSP in all 47 counties. This approach referred to as Participatory Scenario Planning (PSP) ensures sharing and interpretation of weather and climate information for enhanced understanding and application by all agricultural stakeholders including farmers.

4.6.4 Application of Agro Weather and Climate Information

Very few (8.1%, n=34) respondents were applying weather and climate advisories in their farming activities (Table 4.66). This was a further drop from the previous (11 %) respondents who had indicated they had practical knowledge about the use of weather and climate information (Figure 4.26). Application of knowledge of weather and climate information involves adoption of management measures which could be beyond their financial capability.

Table 4.66: Application of Agro-Weather and Climate Information in Kitutu and Nyaribari Chache of Kisii County

Application of agro-weather advisories	Frequency (n)	Percentage %
Yes	34	8.1
No	386	91.9
Total	420	100.0

This revealed the low utilization of weather information alongside appropriate practices to mitigate the adverse effects of weather changes attributed to climate change in the study area. The low application was as a result of lack of skill among extension services providers and farmers with regard to interpretation and application of weather forecasts,

and lack of budgetary support for integration of weather/climate information and climate smart practices in farming activities (Key informants & Focus group discussions). The low uptake of the information was also attributed to delay in forecasts, development of advisories and subsequent dissemination of advisories. Similar findings were established and pointed out by Chamboko *et al.* (2008) and WMO (2012) who attributed the limited use of the information to lapses in dissemination systems in terms of reliability, timing, infrastructure development, language and depth of content and lack of skill in the use of the information.

4.6.5 Extent of Weather and Climate Information Dissemination and Adoption of Climate Smart Practices

Adoption of climate smart practices in response to weather and climate information revealed positive correlation. Apparently, adoption was low and ranged between (1.2% to 21.9%) (Table 4.67). The low adoption of practices was a consequence of limited access to the information among farmers (Figure 4.24). According to Deressa *et al.* (2009) availing climate information enhanced the adoption of appropriate crop varieties by 17.6% in the Nile basin of Ethiopia.

Findings similarly showed varying levels of adoption of climate practices in response to agro weather information. For instance some practices ranked highly among farmers compared to others i.e. use of organic manure (21.9%), agroforestry (19.28%), mixed cropping (17.3%) and rain water harvesting (17.1%) ranked relatively higher in terms of adoption. While adoption of index-based agricultural insurance (1.2%), silage making (2.14%), preservation of hay (2.85%), improved fallowing (3.3%, n=14) was quite low (Table 4.67). The difference was likely attributed to low awareness of practices such as index based insurance, limited livestock rearing and low awareness of climate change phenomenon among some farmers. This shows the need for simultaneous access of agro weather information with appropriate climate smart practices knowledge among farmers.

Table 4.67: Intensity of Adoption of Climate Smart Practices in Response to Weather and Climate Information Dissemination in Kitutu and Nyaribari Chache of Kisii County

Climate smart practices	Intensity of adoption	
	Frequency (n)	Percentage %
Appropriate crop and livestock varieties	54	12.85
Mixed cropping	73	17.3
Integrated crop and livestock systems	31	7.4
Improved fallowing	14	3.3
Agroforestry	81	19.28
Green house technology	24	5.71
Intercropping with legumes and fertilizer fodder crops	59	14.04
Crop rotation	62	14.76
Rain water harvesting	72	17.14
Irrigation	26	6.2
Construction of water retention structures	59	14.05
Biogas production	14	3.3
Preservation of hay	12	2.85
Planting of cover crops	36	8.5
Pasture management e.g. controlled grazing, improved forage varieties, deferment, Reseeding, control of weeds	23	5.48
Silage making	9	2.14
Use of organic manure	92	21.9
Index-based agricultural insurance	5	1.2
Feed management to reduce methane emissions	21	5
Farm-specific nutrient management & precise (micro-dose) fertilizer application	33	7.85

4.6.6 Relationship between use of Agro Weather Information and Adoption of Climate Smart Practices

Chi-square test results on the relationship between use of agro weather information and adoption of climate smart practices showed significant relationship (Table 4.68). These findings were in consonant with many other studies (Thornton *et al.*, 2006; Roncoli *et al.*, 2009; Patt *et al.*, 2005). In Burkina Faso, after farmer workshops, where the interpretation and management implications of forecast information on farming was discussed, most of the participants (91%) reported changing at least one management strategy in response to forecast information (Roncoli *et al.*, 2009).

Table 4.68: Relationship between Awareness of Weather and Climate Information and Adoption of Climate Smart Practices in Kitutu and Nyaribari Chache of Kisii County

Climate smart practices	Chi square test results		
	χ^2	df	P
Mixed cropping	63.144	2	.000
integrated crop and livestock systems	17.677	2	.000
Intercropping	60.077	1	.000
Green house technology	41.968	1	.000
Irrigation	35.155	1	.000
Biogas production	16.766	1	.000
Improved fallowing	12.414	2	.002
Agroforestry	91.398	2	.000
Crop rotation	37.552	1	.000
Rainwater harvesting	88.825	1	.000
Planting cover crops	7.302	1	.007
Mulching	10.383	1	.001
Farm yard composting	1.1662	1	.000
Hay making	5.649	1	.017
Pasture rehabilitation and management	34.024	1	.000
Organic manure	1.4152	1	.000
Index based agricultural insurance	5.940	1	.015

In another study carried out in four villages of Zimbabwe, out of the (75%) farmers who received seasonal forecast information during 2002/03 and 2003/04 growing seasons, (57%) reported changing their management, primarily time of planting and cultivar selection in response (Patt *et al.*, 2005). This affirms the argument by Thornton *et al.* (2009) that provision of timely, reliable, easy to use and accurate climate information that includes early warning signals and weather forecasts to small scale farmers, enhances farmers capacity and disaster preparedness to changing climate. Findings of this study revealed that the more farmers access agro weather information, the more they are likely to adopt climate smart practices.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The purpose of the study was to establish the factors hindering adoption of climate smart practices among small scale farmers in Kisii County. This was achieved by investigating four objectives. The first objective of the study was to examine the perception of climate change risks and their effects on farming among small scale farmers of Kitutu and Nyaribari Chache in Kisii County and its influence on adoption of climate smart practices. The study established growing understanding of climate change problem among the farmers. This was based on observed increase in temperature, change in rainfall patterns and increase in rainfall for over 3 decades. This perception was in tandem with the observed changes by weather experts in the region.

The study also demonstrated climate change impacts such as decline in crop yield, emergence of new strains of diseases, pests, and instability in production, which had consequently, compelled farmers to adopt climate smart practices though to a small extent. In spite of the growing understanding of the climate change problem among farmers, the study found low appreciation of this predicament among some farmers and county government officials in the study area as demonstrated by a significant proportion of farmers that lacked awareness and weak policy focus respectively.

The second objective of the study was to determine the existing knowledge, attitude and practice of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County. The study found high general awareness of climate smart practices among majority of small scale farmers. The high general awareness was attributed to sensitization that had been previously undertaken during programmes such as NALEP and NAAIAP. However, knowledge of specific climate smart practices was found to be quite low. This was attributed to little understanding of the concept of climate smart agriculture among the technical staff and farmers, inadequate extension services, and lack of training on the specific climate smart practices. In terms of relative knowledge concerning specific practices, the study established higher knowledge among

old practices such as application organic manure compared to most recent innovations such as index based agricultural insurance. In terms of statistical findings, knowledge level was shown to be positively correlated with adoption of climate smart practices.

The general attitude of small scale farmers concerning climate smart practices was found to be positive. The positive attitude towards the practices was attributed to perceived potential to increase production, productivity and profitability, to conserve soil and water, and their cost effectiveness. However, the major setback to their positive outlook was the perceived high risk and uncertainties concerning the practices, particularly the high capital and labor requirement. The findings of the study also revealed very low practice of climate smart practices compared to high level of awareness and positive attitude. However, old practices such as soil and water conservation practices showed relatively higher adoption compared to the recent innovative climate smart practices such as insuring crops and livestock from vagaries of weather and climate change.

The third objective of the study was to examine socio economic factors that were influencing adoption of climate smart practices among small scale farmers of Kitutu and Nyaribari Chache in Kisii County. The study established that uptake of climate smart practices in Kitutu and Nyaribari Chache was influenced by factors which ranged from farm and farmer characteristics to institutional weaknesses. The main factors found to influence adoption of climate smart practices among majority of the farmers in this area were lack of knowledge of climate smart practices, dwindling farm size and limited financial capacity.

The lack of knowledge and small farm sizes was attributed to low level of training coverage among farmers and high population density in the area. While, the limited financial capacity was linked to high poverty levels in the study area and limited financial support for adoption of climate smart practices by the government, development agencies and financial institutions. Majority of farmers were found to be poor, and derived very low incomes and livelihoods largely from farming activities. The study found very limited off farm income avenues among small scale farmers. There were also significant

differences found between men and women in terms of income, with men having more income from both the farm and off farm sources than women. This was due to limited involvement of women in commercial farm enterprises. The low financial capability among farmers was also attributed to limited access to credit and lack of awareness of existing environmental payment services and funding opportunities.

Farming experience, income level, access to credit, gender, and educational level were found to have significant influence on adoption of climate smart practices among small scale farmers in this area. Similarly, adoption of these practices was influenced by their perceived potential for enhanced productivity and profitability and prevailing high rainfall and steep topography in the study area. Institutional factors that were shown to hamper adoption of climate smart practices included inadequate extension services, weak policy framework and limited promotion of awareness of policy provisions that support adoption of climate smart practices.

Finally, this study looked at the extend of climate information dissemination among small scale farmers, and its impact in terms of adoption of climate smart practices. The study found limited outreach in terms of climate and weather information among small scale farmers. Consequently, very few farmers showed understanding and application weather and climate information in their farming activities. However, the few who had received the information had responded accordingly by adopting some climate smart practices. Statistical analysis of relationship between access to weather and climate information and adoption of climate smart practices was significant. This indicated, the more the access to climate and weather information, the more the farmers were likely to adopt climate smart practices.

5.2 Conclusions

Based on the findings of this study, the following conclusions were made;

There was growing awareness of climate change problem among small scale farmers and emerging need for adaptation to climate change effects through adoption of climate smart practices. However, a significant proportion of farmers and county policy makers were

still oblivious of the climate change challenge. Hence the limited focus on climate change adaptation and adoption of climate smart practices

There was significant knowledge gap and low practice of climate smart practices, in spite of the positive outlook to climate smart practices attributed to collapse of extension services over the years and particularly after devolution of governance.

Adoption of climate smart practices was hampered mainly by dwindling farm sizes, limited knowledge of climate smart practices, limited outreach of weather and climate information, low financial capability and weak policy framework

While these findings affirmed the importance of access to climate and weather information in enhancing adoption of climate smart practices. Its access and its use was low and patchy

5.3 Recommendations

Based on the conclusions above, the study recommends the following;

The National Government and development partners to enhance sensitization of farmers and policy makers at the County level regarding climate change and its impacts on agriculture.

The Ministry of Agriculture, Livestock and Fisheries at both National and the County level of Kisii should undertake capacity building and strengthening of extension service delivery to enhance awareness, skill and knowledge for adoption of climate smart practices among farmers.

The Ministry of Agriculture, Livestock and Fisheries at National and County level to provide budgetary support and strengthen public-private partnership to leverage funds for adoption of climate smart practices. The County Government should also set up Climate Change Unit that will target carbon related funds i.e. REDD+, CDM, adaptation fund.

The Ministry of Agriculture, Livestock and Fisheries to develop sound policy and legal framework for adoption of Climate Smart Practices. The National Government and County government of Kisii to undertake deliberate measures to curb land fragmentation.

The Ministry of Agriculture, Livestock and Fisheries at National and County level and Kenya Meteorological Services to upscale dissemination of climate information by packaging it into user friendly formats and using channels that are effective and accessible to small scale farmers.

5.4 Areas of further Research

- a) The market plays a fundamental role in adoption of innovation. There is therefore need to carry out further research on the role of the market towards improvement of adoption of climate smart practices among small scale farmers.
- b) Current research dwelled more on micro-level (household) factors influencing adoption of climate smart practices, further research is therefore required to explore factors at macro level (policy and institutional).
- c) Further research is required on ways of strengthening research, extension and farmers linkages for enhanced adoption of climate smart technologies.
- d) In order to tap into climate change funding, more research should be undertaken to establish the potential contribution of climate smart practices to carbon credit market.

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APPENDICES

Appendix 1: Farmers' Questionnaire

Dear Respondent

This is to request you to kindly take a few minutes to reflect and answer the following questions. Note that the information given shall exclusively be used for the sake of this study being undertaken by the undersigned at Kenyatta University.

Thank you for your cooperation.

Isaac Wafula Wamalwa

A. Demographic and socio economic profile

1. Name.....
2. Ward.....
3. Sub county
4. Agro ecological zone
5. Age
() 18 - 30 () 30-40 () 40 -50 () over 50
6. Gender
() Male () Female
7. Gender of household () Male () Female
8. Level of education
() Primary () Secondary () University
9. Size of your farm?
() 1 acre () 2 acre () 3 acres () 4 acres () more than 5 acres
10. Farming activities involved in?
() Livestock rearing

Crop Farming

Fish Farming

Mixed Farming

11. If its crop farming, indicate crops grown on farm?.....

12. Main sources of income?

Farm income

Non-farm income (business, employment, any other)

13. Level of income per month in kshs.

< 5000 5000 - 15 000 15000 - 25 000 25000 - 35000 ≥ 35000

14. Indicate whether you received any credit for farming

Yes No

15. Period in farming

1 year 5 years 10 years More than 10 years

16. Are you a member of farmers' organization? Yes No

17. Indicate benefits received as a member

Access to credit

Access to extension services

Learn new methods of farming

Any other benefit (indicate)

Perception about climate change

18. In your view is climate change taking place?

Strongly agree

Agree somewhat

Neutral

Disagree somewhat

Strongly disagree

I don't know

19. If you agree, please indicate from the list below what you have observed for the last 20 years that makes you conclude climate change is occurring?

increase in temperature

Increase in rainfall

Decrease in rainfall

Change in rainfall patterns

increased frequency and intensity in floods

increased frequency and intensity in droughts

20. Are you concerned about these changes in climate?

Yes No

21. If yes, why?

I am unable to plan my farming activities

crop yields have declined

crops have been destroyed and livestock died

pasture is insufficient for my animals

any other reason

B. Perception about effects of climate change on farming

22. Would you agree that the changes you mentioned, have negatively affected your farming activities

Strongly agree

Agree somewhat

Neutral

Disagree somewhat

strongly disagree

I don't know

23. If yes, what impact would you say, these changes have had on your farming?

Changes	Effects	
Increase in temperature	Emergence of new strains of pests and diseases	
	Decline in crop yield	
	Reduced moisture in the soil which lead to wilting of crops	
Increase in rainfall and increased frequency and intensity in floods	Exacerbated soil erosion	
	Destruction of crops as a result of flooding	
	Decline in crop yield	
	Pests and diseases outbreak	
	Poor quality pasture as result of nutrient leaching	
	Low production of milk and meat	
Change in rainfall patterns	Crop failure, inability to plan farming activities, instability in production	
increased frequency and intensity in droughts and decline in rainfall	Crop failure	
	Lack of pasture	
	Death of animals	
	Low production of milk	

C. Responses to climate change and its effects

24. Have you changed your farming practices in response to climate change effects

Yes No

25. What current practices are you undertaking to mitigate the negative effects of climate change?

- Planting different varieties of crops and rearing different breeds of livestock
- Moved from farming to non-farming activities,
- Practicing increased water conservation using shading and sheltering techniques.
- Varying planting date
- Insuring crops /livestock
- planting trees (agroforestry)
- irrigation using the most efficient technology

() Using seasonal weather forecasts

D. Knowledge about climate smart practices

26. Are you aware of climate smart practices?

() Yes

() No

27. If yes, which practices in your farming activities are you aware of, have knowledge and practice? Indicate in the table below

Checklist of climate smart practices	Aware00- Yes xx- No	Knowledge00- Yes xx- No	Practice 00-Yes xx- No
Appropriate crop and livestock varieties (drought, disease, pest and flood tolerant and early maturing varieties)			
Mixed cropping			
Integrated crop and livestock systems			
Improved fallowing			
Agroforestry			
Green house technology			
Intercropping with legumes and fertilizer fodder crops			
Crop rotation			
Mixed cropping			
Rain water harvesting			
Irrigation			
Soil and water conservation- construction of water retention structures			
- crops using little water			
- planting cover crops			
- mulch cover			
- Zero or minimum tillage			
Biogas production			
Farm yard composting			
Preservation of hay during dry season			
Pasture rehabilitation and management e.g. controlled grazing, improved forage varieties, deferment, Reseeding, control of weeds			
Silage making			
Use of organic manure			
Use agro weather advisories			

Index-based agricultural insurance			
Feed management (balance of roughage and concentrates) to reduce methane emissions			
Farm-specific nutrient management & precise (micro- dose) fertilizer application			

28. How did you hear of these climates smart practices you have indicated above?

- Farmers field days
- On farm trials/ demonstration center
- Extension services visits
- Media (Newspapers, Internet, Radio/TV)
- Neighbor
- Farmer groups

29. Do you have the full knowhow of applying above mentioned climate smart practices in your farming activities

- No
- Yes

30. If yes, how did you acquire the knowledge?

- Through personal experience
- Farmers field days
- On farm trials/ demonstration centre
- Extension services visits
- Media (Newspapers, Internet, Radio/TV)
- Neighboring
- Farmer groups

31. Have you undergone any training on climate smart practices for more than 2 weeks in an institution?

- Yes No

32. What is your level of knowledge about these climate smart practices

- Very high
- High
- Satisfactory

Low

Very low

33. Do you know the benefits associated with adoption of climate smart practices

Yes No

34. If yes what are the benefits

Increases productivity

Enhances resilience to climate change

Are efficient in the use of natural resources

Enhances food security

More profitable and less costly

35. Are you aware that climate smart practices help in adapting to climate change and climate variability effects?

Yes No

E. Attitude towards climate smart practices

36. Are you in favor of climate smart practices

Yes No I don't know

37. If yes, why are you in favour of climate smart practices?

38. If not why are you not in favour of climate smart practices?

39. Do you agree that climate smart practices are beneficial in terms enhancing resilience (adaptation) to climate change, increasing productivity, enhancing food security and efficient in terms of use of natural resources?

Yes No I don't know

32 Are they profitable compared to older practices? Yes No

33 Do you encourage other farmers do adopt these practices?

Yes No

34 Do these practices require any modification before adoption?

Yes No

35 In your own view do you think it takes long do realize the benefits?

Yes No

36 In your own assessment are these practices costly?

Yes No

37 In your own understanding are there risks and uncertainties of adopting these practices?

Yes No

38. If yes, what are the risks

Season specificity of these technologies limiting economic benefits to certain type of seasons

High requirement of labour and capital investments per unit area

High input costs

Uncertain returns

F. Practice of climate smart practices

39. Have you ever tried climate smart practices on your farm?

Yes No

40. For how long have tried them on your farm?

1 year 3 years 5 years over 5 years

41. What climate smart practices are you currently practicing?

use of climate tolerant varieties and breeds

use of agro-weather advisories

Index-based agricultural insurance

Feed management (balance of roughage and concentrates) while reducing Methane emissions

Farm-specific nutrient management & precise (micro- dose) fertilizer application

42. If you have tried these practices, what do you intend to do?

Continue

Abandon

G. Factors influencing adoption

43. If you have never tried climate smart practices on your farm, what factors hindered you and why?

Factors influencing adoption	Why?	
Lack of knowledge	Lack of extension services	
	Has never been demonstrated in our area	
	Never heard of climate smart practices	
	Never been trained on climate smart practices	
Lack of finances	Not accessible to credit due to lack of collateral	
	Not accessible to credit because of high interest rates	
	Low income	
Inaccessibility to insurance cover for farming activities	Not aware of insurance products	
	Insurance products not available	
Market influence	Tools of implementation are not readily available on the market	
	Prices of inputs associated with climate smart practices are high	
	Prices of products from climate smart practices are low	
	Lack of market for products	
Risks and uncertainty of their effects	Weather	
	Time taken before realizing benefits long	
	Not sure of profitability of the practices	
	Investment costs high	
Other factors	Labour constraints	

44. If you have tried climate smart practices on your farm, what reasons initially motivated you?

() Increases productivity

- Enhances resilience to climate change
 - Are efficient in the use of natural resources
 - Enhances food security
 - More profitable
 - less costly
 - Saves labour and time
45. If you wish to continue applying these practices, indicate the reasons why?
- Risks are low
 - Benefits are realized quickly
 - market is favourable (tools and inputs are readily available, prices of inputs are low, prices of outputs are high and market for products is available)
 - Have sufficient knowledge of climate practices and their benefits
46. If you wish to abandon climate smart practices, what are the reasons?
- Financial constraints
 - Lack of technical knowledge
 - Market not favourable (tools of implementation are not readily available on the market, prices of inputs associated with climate smart practices are high, products associated with climate smart practices fetch low prices)
 - Benefits are not realized quickly from adoption of climate smart practices
 - High risks and uncertainties
 - There are no insurance products supporting the implementation of climate smart practices
47. Given the high rainfall, steep topography in this area; have you thought of adopting climate smart practices? Yes No

H. institutional and policy Context

48. Are there provisions in the agriculture sector policies that support innovation and adoption of climate smart practices? Yes No
49. Are there environmental payment services associated with adoption of climate smart

practices? () Yes () No

48. Have you ever received funding for adoption of climate smart practices indicated before? () Yes () No

51 Are extension service providers promoting the use of climate smart practices as way of adapting to climate change effects?
() Yes () No

52 If yes, how frequent are these extension visits in a year?
() Once in a month () several times in a month () once in two months () once in a year

Dissemination of climate information

53 Do you receive climate information? () Yes. () No.

54 If yes, what channels of communication do you receive this information from?

Radio	
Television	
Bronchures	
Newspapers	
Posters	
Internet	
SMS services	
Extension services	
Neighbors and friends	
Local administrators	
Indigenous forecasters	
Participatory scenario planning	

55 Do you have working knowledge of weather and climate information?

56 If you have received climate information, are using the information? () Yes () No

57 If not why

- 58 Does the information you receive of any implication to your management options?
Yes) () No
- 59 If yes has it influenced you to change management practices
- 60 If yes what management options?

Appendix 2: Key Informant Interview Guide

A. Perception about climate change, its effects on farming and influence on adoption of climate smart practices

1. Would you say climate change and climate variability is taking place in this area?
2. What have you observed for the last 20 years that makes you conclude climate change and climate variability is occurring?
3. Are these changes in climate attributes of concern to farming activities in this area? If yes, explain why?
4. In what way are farming activities affected by the various specific climate change attributes?
5. Do you think the concerns about change in climate attributes and their effects have influenced farmers to adopt climate smart practices?

B. Knowledge about climate smart practices

6. Are small scale farmers aware of climate smart practices?
7. How is information on climate smart practices transmitted to small scale farmers?
8. Do small scale farmers have full knowhow of applying above mentioned climate smart practices in your farming activities? If yes, how did you acquire this knowledge?
9. Do small scale farmers know the benefits associated with adoption of climate smart practices? If yes what benefits are they familiar with?
10. Has knowledge on climate smart practices and its benefits influenced small scale farmers to adopt climate smart practices?

C. Attitude towards climate smart practices

11. Are small scale farmers in favor of climate smart practices? If yes, why?, If not, why?
12. Do the small scale farmers appreciate the benefits of climate smart practices?
13. If yes, do they consider adopting them?
14. From your experience, do famers fear adopting climate smart practices because of perceived risks and uncertainties? If yes, what risks and uncertainties?
15. Do they believe climate smart practices can help in adapting to climate change effects in their farming activities?

D. Practice of climate smart practices and factors influencing their adoption

16. Have these climate smart practices been tried in this area? If yes, what climate smart practices?
17. For how long have these practices been tried?
18. After trying these practices, do small scale farmers intent to continue applying them? If yes, why?
19. If they wish to abandon climate smart practices, what are the reasons?
20. If these practices have never been tried, what are the reasons?
21. Has the high rainfall, steep topography and poor soil quality influenced small scale farmers to adopt climate smart practices in your area?

E. Institutional and policy Context with regard to adoption of climate smart practices

22. As an organization is there provisions in the agriculture sector policies that support for innovation and adoption of climate smart practices? If yes in what way?
23. As an organization are extension service providers equipped with knowledge and skills on climate smart practices? If yes, in what way are they promoting the use of these practices among small scale farmers?
24. Have the extension services enhanced the adoption of climate smart practices?
25. As an organization have you ever funded adoption of climate smart practices by small scale farmers? If not why?

26. If yes, has the funding enhanced the adoption of climate smart practices among small scale farmers?

F. Dissemination of climate information?

27. Do you understand what climate information is all about?

28. Do you receive the climate information?

29. Do you consider the information accurate and reliable to famers?

30. Do you disseminate this information to famers? If yes, do you disseminate it in the form you receive it? If not do you package it? If you do how do you package this information for famers?

31. Do you disseminate it in a timely manner?

32. What channels do you use to disseminate the information?

33. Are they effective in delivering the information to famers?

34. To what extend has this information reached famers?

35. Are they using the information?

36. If not why?

37. Does the information they receive of any implication to their management options?

() Yes () No

38. If yes, what management options?

Appendix 3: Focus Group Discussion guide

A. Perception about climate change, its effects on farming and influence on adoption of climate smart practices

1. Would you say climate change and climate variability is taking place in this area? If yes what have you observed for the last 20 years that makes you conclude climate change and climate variability is occurring?
2. Are these changes in climate attributes of concern to farming activities in this area? If yes, explain why?
3. Do you think the concerns about change in climate attributes and their effects have influenced farmers to adopt climate smart practices?

B. Knowledge about climate smart practices

4. Are small scale farmers aware of climate smart practices relevant to their farming activities e.g. livestock keeping, crop farming, fish farming? If yes, which climate smart practices?
5. If the small-scale farmers are aware, how did they receive information on climate smart practices is transmitted to small scale farmers?
6. Do small scale farmers have full knowhow of applying above mentioned climate smart practices in your farming activities? If yes, how did you acquire this knowledge?
7. Do small scale farmers know the benefits associated with adoption of climate smart practices? If yes what benefits are they familiar with?

C. Attitude towards climate smart practices

8. Are small scale farmers in favor of climate smart practices? If yes why? If not why?
9. Do the small scale farmers appreciate the benefits of climate smart practices?

10. In your own understanding are there risks and uncertainties of adopting these practices? If yes, what are the risks?

D. Practice of climate smart practices and factors influencing their adoption

11. Have these climate smart practices been tried in this area and for how long? If yes, what climate smart practices?

12. After trying these practices, do small scale farmers intend to continue applying them? If yes, why?

13. If they wish to abandon climate smart practices, what are the reasons?

14. If these practices have never been tried, what are the reasons?

E. institutional and policy Context

15. As an organization are extension service providers knowledgeable in the use climate smart practices?

16. Do you promote the use of these practices among small scale farmers, If yes, how?

17. Have you ever received funding for adoption of climate smart practices indicated before?

F. Extent of dissemination of climate information and adoption of climate smart practices

18. Do you understand what climate information is all about?

19. Do you receive the climate information? If yes where do you get this information from?

20. Do you consider the information accurate and reliable to farmers?

21. Do you disseminate this information to famers? If yes, do you disseminate it in the form you receive it? If not do you package it? If you do how do you package this information for famers?

22. Do you disseminate it in a timely manner?

23. What channels do you use to disseminate the information?

24. Are they effective in delivering the information to farmers?

25. To what extend has this information reached farmers?

26. Are they using the information?

27. If not why?

28. In your own opinion has this information influenced farmers to shift their practices to climate smart practices

Appendix 4: Plates showing Focus Group Discussions and Administration of Questionnaires



Plate 4.4: Focus Group Discussions with Technical Officers of Agriculture



Plate 4.5: Research Assistant Administering a Questionnaire to Farmer at his Home



Plate 4.6: Research Assistant Administering a Questionnaire to a Farmer at her Home

Appendix 5: Example of Agro Weather Advisory Offered to Farmers in Kitutu and

Nyaribari Chache of Kisii County

Scenario: Above normal rainfall		
Type of enterprise	Hazards and Risks	Opportunity and Advisory
Livestock	<ul style="list-style-type: none"> - Prevalence of diseases e.g. foot rot, pneumonia, scouring, - Bloating due to consumption of rush pasture, - Washing away of acaricides after spraying, - Poor quality pasture as a result of nutrient leaching. - Prevalence of worm infestation e.g. round worms, tapeworms, flukes 	<ul style="list-style-type: none"> - Stockists to store enough quantities of drugs & inputs, - Ensure proper and adequate housing - Use additives and concentrates - Conduct Timely vaccination and deworming - Make silage and adequate feed storage arrangements - Increase the frequency of spraying, - Make hay before the rains
Crops	<ul style="list-style-type: none"> - Post-harvest loses due to high moisture - Soil erosion, - High disease and pest incidences, - Hail stones, - Lodging of crops and leaching of nutrients - Crop destruction 	<ul style="list-style-type: none"> - Early land preparation and timely planting - Plant flood, pests and diseases tolerant varieties - Use of greenhouses/shade nets, - Adopt soil conservation measures e.g. terracing, cover cropping - Stake of tall tomatoes varieties and prop bananas - Avoid cultivation on steep and riparian areas - Harvest water and store - Take crop insurance - Value addition for longer storage life
Scenario : Below normal rainfall		
Livestock	<ul style="list-style-type: none"> - High temperature, - Water scarcity, - Increased pests and diseases, - Reduced animal feed availability and quality - Grazing in fragile areas - Low production and productivity and occasional deaths 	<ul style="list-style-type: none"> - Routine vaccination and deworming, - Isolate and treat sick animals - Supplement feeding, - Keeping manageable herds
Crops	<ul style="list-style-type: none"> - Dry spells & drought, - High pest and diseases incidences - Wind erosion, - Wilting and total crop failure, 	<ul style="list-style-type: none"> - Early land preparation and timely planting - Supplementary irrigation - Use of greenhouses/shade nets. - Use of mulching to conserve moisture - Control of pests using IPM - Supplementary irrigation use - Diversification of crops - Crop insurance

Appendix 6: Research Permit



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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NAIROBI-KENYA

Ref: No.

Date:

25th September, 2015

NACOSTI/P/15/9262/7598

Isaac Wafula Wamalwa
Kenyatta University
P.O. Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "*Adoption of climate smart practices in Kitutu and Nyaribari Chache Sub counties.*" I am pleased to inform you that you have been authorized to undertake research in **Kisii County** for a period ending **23rd September, 2016.**

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: DIRECTOR GENERAL/CEO

Copy to:

The County Commissioner
Kisii County.

The County Director of Education
Kisii County.

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