FARMERS' INDIGENOUS KNOWLEDGE PRACTICES INFLUENCING UPTAKE OF CLIMATE CHANGE ADAPTATION STRATEGIES IN KAJIADO COUNTY, KENYA

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A thesis submitted in partial fulfillment of the requirement for the award of Degree of Doctor of Philosophy in Disaster Management and Humanitarian Assistance of Masinde Muliro University of Science and Technology

NOVEMBER, 2025

DECLARATION

I hereby declare that this thesis is my original work and has not been submitted for award of a degree in any other institution

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Masinde Muliro University of Science and Technology a research thesis entitled "**Farmers' Indigenous Knowledge Practices Influencing Uptake of Climate Change Adaptation Strategies in Kajiado County, Kenya**"

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DEDICATION

I dedicate this research work to the almighty God and my Lord Jesus Christ who has enabled me do ALL things in this thesis.

ACKNOWLEDGEMENT

I continue to appreciate the role of the Almighty God for strength, wisdom, grace and guidance. It is His strength that made a difference whenever I was on the verge of giving up in this journey.

I also recognize the important role that Dr. Edward Mugalavai and Dr. Ferdinand Nabiswa played in offering me technical and professional guidance throughout the process. Am sincerely grateful. My gratitude also goes to the entire staff of the department of Emergency Management Studies ably led by Dr. Nicholas Ombachi, they were readily available for me at every point of need. Professor Iteyo your unique contribution is well appreciated.

To the youngman at the SDMHA Dean's office Mr. David Recha Wahome, your administrative support at the tail end but critical phase of the process was so onerous. My peers at the entire SDMHA specifically Dr. Japheth Ogenga, Dr. Pepela and Dr. Otwori your role in encouraging and supporting me is highly appreciated. My research assistants in Kajiado County; Lesika, Ngotiek and Edward your contribution was impactful.

Last but not least I am so grateful to my family; my wife Dorothy my son Peter, my daughters Sylvia, Victory and Neema as well as my grandson Prince Abraham – you displayed a unique expectation from me which pushed me to keep going to achieve this feat.

ABSTRACT

Farmers in Kajiado County in Kenya have embraced different climate change adaptation strategies including the use of Indigenous Knowledge and scientific approaches. However, the farmers' uptake of scientific Climate Change Adaptation Strategies has been very low. The overall objective of this study was to examine the influence of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya. The specific objectives were to: assess indigenous knowledge factors influencing farmers' uptake of climate change adaptation strategies, determine the effect of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies, evaluate the effectiveness of existing climate change adaptation strategies and examine the strategies to enhance the integration of indigenous knowledge practices and the climate change adaptation strategies in Kajiado County, Kenya. Insights on the appropriate knowledge learning system and significance of the concept of policy co-creation towards enhancement of climate change adaptation formed the academic and policy justification of the study respectively. Two theories, namely the Situated Learning Theory and the Theory of Planned Behavior, formed the basis for illustrating the relationship between variables, while the Model of Private Proactive Adaptation to Climate Change and the Alaskan knowledge integration model were the key theoretical models employed. A mixed-methods research approach that involved the use of household questionnaire surveys, key informant interviews, focus group discussions, and observations was used to obtain data. A total of 382 small-scale rural household representatives randomly selected from 3 Kajiado sub-counties were the principal respondents, while 19 key informants that included representatives of relevant government departments and civil societies were purposively sampled. Three Focus Group Discussions for elders, women, and youth were conducted, while an observation checklist was used to gather data in line with research questions. Both qualitative and quantitative data were collated, coded and analyzed using SPSS version 20 to draw conclusions. The findings show that the CCAS are likely to be accepted by those with higher levels of education and higher levels of monthly income while those unwilling were more likely males, older, with larger household sizes and those who owned land. The overall conclusion drawn from Binary logistic regression analysis indicate that farmers' IK practices negatively influenced their uptake of CCAS significantly at $p<.001$. More specifically, farmers that practice an indigenous-knowledge-oriented nomadism are 72% less likely to do irrigation and 83% less likely to adopt sustainable water resource management. The existing climate change adaptation strategies are not impactful with 72% of farmers stating that the approaches are either ineffective or very ineffective. The results also indicated that there is no structure to facilitate integration of indigeneous knowledge and climate change adaptation strategies as only 7% of local farmers are involved in agricultural development plans yet information sharing shows a significant association with uptake of climate change adaptation strategies (CI = 99%, X^2 = 257.656, $p< .01$). Recommendations developed include prioritizing development of climate change adaptation strategies that address local farmers' geo-ecological, economic and socio-demographic conditions as well as targeting approaches that are in consonant with existing type of farming. Developed adaptation policies should specify mandates of key stakeholders, especially those that involve the extension workers. There is need to create all-inclusive information sharing platforms that can facilitate sufficient inputs from indigeneous knowledge practitioners to improve the effectiveness of the existing climate change adaptation strategies.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASAL:	Arid and Semi-Arid Lands
CCAS:	Climate Change Adaptation Strategies
CIAT:	International Center for Tropical Agriculture
CIDP	County Integrated Development Plan
CSA:	Climate Smart Agriculture.
CE:	European Commission
ET:	Evapotranspiration
EU:	European Union
FAO:	Food and Agriculture Organization
FGD:	Focus Group Discussions
GHG:	Greenhouse Gases
GOK:	Government of Kenya
IK:	Indigenous Knowledge
IPCC:	Intergovernmental Panel on Climate Change
KAP:	Knowledge, Attitude and Perception
KCIDP	Kajiado County Integrated Development Plan
KCSAP:	Kenya Climate Smart Agriculture Project
KEFRI:	Kenya Forestry Research Institute
KII:	Key Informant Interviews
KMD:	Kenya Meteorological Department
KNBS:	Kenya National Bureau of Statistics
LDC:	Least Developed Countries
MoALF:	Ministry of Agriculture, Livestock and Fisheries
MTAR	Mitigation Technical Analysis Report
NAP:	National Adaptation Plans
NAPA:	National Adaptation Programmes of Action
NCAP:	National Climate Change Action Plan

NCCAP:	Kenya's National Climate Change Action Plan
NCCRS:	National Climate Change Response Strategy
NDMA:	National Drought Management Authority
NEMA:	Kenya National Environment Management Authority
NENA:	Near East and North Africa
NSA:	Non-State Actors
OECD:	Organization for Economic Cooperation and Development
PAT:	Precision Agriculture Technology
SFDRR:	Sendai Framework for Disaster Risk Reduction
SGD	Sustainable Development Goals
SPSS:	Statistical Package for Social Scientists
SLT:	Situated learning theory
TPB:	Theory of Planned Behaviour
UNFCCC:	United Nations Framework Convention on Climate Change
UNISDR:	The United Nations International Strategy for Disaster Reduction

OPERATIONALIZATION OF CONCEPTS

Adaptation	Acquisition of capacity by the Kajiado County farmers to effectively respond to adverse effects of climate change and capitalize on the advantages brought about by expected or actual climate variability that may alter their economic, environmental or social systems.
Climate Change	A change in the state of climate within Kajiado County which by using statistical analyses indicates changes in the mean of rainfall and temperatures and/or the variability of their properties which has persisted for over 10 (ten) years, and which has negatively affected agricultural production.
Climate Change Adaptation Strategies	Measures developed by agriculture technological experts, that can be undertaken by local farmers in Kajiado County to adjust natural or human systems in response to actual or expected adverse climate impacts and which mitigates harm or exploits beneficial opportunities**.**
Climate Smart Agriculture	Sustained agricultural productivity that is built to create resilience among Kajiado County farmers to climate shocks and climate change
Farmers' Attitude	Opinions and beliefs of farmers in Kajiado County that have a potential to be the predictors of acceptance of Climate Change Adaptation Strategies
Indigenous Knowledge Practices	Agricultural traditional mechanisms that Kajiado County farmers use to sustain farming under increasingly unfavorable climatic conditions
Knowledge, Attitudes and Perceptions	Intrinsic characteristics of Kajiado County farmers that influence their decision to utilize and implement climate change adaptation practices

Local Institutions	Formal and/or informal human created community based mechanisms within Kajiado County that define a farmer's social and individual expectations, behavior and interactions
Maasai Pastoralism	Form of animal husbandry practiced as a livelihood production system by the Maasai ethnic groups within Kajiado County.
Nexus	An existence of a series of links of causation between indigenous knowledge parameters and the uptake of climate change adaptation strategies among farmers in Kajiado County, Kenya.
Nomadism	Way of life in which the livestock farming communities in Kajiado County move from place to place seasonally in search of pastures and water
Social Group	An entity made up of Kajiado community members who actively interact, sharing socio-cultural characteristics and agricultural practices (youth, women, elders, farmers groups etc.)
Uptake	The decision by farmers in Kajiado County to utilize and implement climate change adaptation practices

CHAPTER ONE

INTRODUCTION

This chapter explains the background of the study as well as presenting the statement of the problem, research objectives and questions that were used in guiding the study. The chapter also presents the discussions on the significance and the scope of the study.

1.1 Background to the Study

Effects of climate change on agricultural productivity globally have elicited significant response from agronomists, hydrologists, agriculturalists among other scientists who have designed mitigation measures to alleviate the resultant adverse effects (Capa-Mora *et al.* 2025; Cheng and Gong, 2021; Piontek *et al.*, 2014). However, despite all these efforts, there is a growing concern since previous studies indicate that only limited adoption of climate smart agricultural (CSA) practices by farmers is realised (Sain *et al*., 2018).

This is not withstanding that farmers in rural settings, particularly those without widespread use of advanced agricultural technologies, have borne the biggest brunt of adverse impacts of climate change particularly droughts, floods, pests and diseases (Aragón *et al*., 2021; Fahad & Wang, 2020; Malhi *et al*., 2021; Oloitipitip *et al*., 2024; Schlenker *et al*., 2010). Both scientifically developed technology and locally community developed indigenous practices are recognized knowledge systems for CC adaptation by the Intergovernmental Panel on Climate Change, a global body mandated to undertake research and develop CC policies(IPCC, 2014).

Scholarly arguments concur that indigenous knowledge can be considered as a science. This is based on its development from processes of experimenting, observing, experimentation, and practical applications of localized natural phenomena- just like the modern scientific knowledge (Jessen *et al*., 2021). The point of departure of these two knowledge systems emanates from epistemiological, cultural and universality contexts in which they are developed(Ijatuyi et al., 2025). Local communities encounter and embrace the use of IK more easily as it is passed on within socio-cultural environment among members.

Globally, farmers, especially in developed economies have been encouraged to adopt new farming technologies not just for purposes of increasing productivity, but more recently, for their products to be competitive in the international markets (Heeb *et al*, 2019; Macfadyen *et al*., 2018). However, in more rural relatively poor farming communities studies indicate that farmers utilize their immediate ecosystems to develop their livelihood options (Venugopal *et al*, 2019). There are some small hodler farming communities, notably in Pakistan, that have been found to be utilizing both scientific and indigenous knowledge almost in equal measure in climate change adaptation in their agriculture(Ali *et al*., 2025).

Agricultural production has a myriad of objectives including operating at optimal levels of production while meeting the current stipulated millennium sustainability goals (OECD, 2001). For example, within the western Europe countries, there has been a purposive initiative facilitated and sponsored by the European Union to adopt active management of agricultural practices by the farmers, focusing on applying appropriate technologies and practices, such as "Precision Agriculture", that decreases greenhouse gas (GHG) emissions while increasing agriculture productivity and income (European Union, 2019).

In these countries, the farmers receive adequate support such as subsidies and provision of information on current innovation as well as incentives which create extrinsic environment for them to make decisions on the uptake of the climate change adaptation strategies (European Union, 2019; Meijer *et al*., 2015; OECD, 2015). There are however hindrances even in these technology-endowed nations, to up-taking the precision agriculture technology (PAT). For example, decision on uptake by EU farmers in a survey conducted by the European Union (2019) show, "that high investment costs, farm size and age were identified as fundamental aspects hampering adoption". There are also the dangers posed to the farmers who may be overwhelmed by the magnitude of information from diverse government and industry sources, making choices on appropriate technologies more difficult (OECD, 2001).

In its recent report the Intergovernmental Panel on Climate Change (IPCC) have reported that Bio-energy with Carbon Capture Storage (BECCS), is believed to keep the global temperature low, yet other insights from the same body believe that the concept can easily surpass the sustainable levels in the land domain-land being the key resource for agricultural production (Creutzig *et al*. 2021). These conflicting technical opinions continue unabated as the global warming phenomenon increasingly continues to negatively impact farmers in traditional settings.

Some of the key elements that facilitate farmers' willingness to adapt to new ways of conducting their agricultural activities, especially as they get confronted by the adverse effects of climate change, include knowledge about the phenomena, risk perceptions and attitudes towards the new adaptation measures. As Tripathi and Mishra (2017) aver, a farmer needs to perceive the interconnectivity between climate change and agricultural production in such a manner that CC risks are grave enough to motivate a farmer to adapt to new ways of doing things.

In the Sub-Saharan Africa, most of the local farmers tend to stick to their traditional coping mechanisms to climate variability, rather than taking up the recommended strategies developed by the experts. Response by farmers in adapting to new farming strategies is rather slow (Ndjeunga and Bantilan, 2005), hampering the implementation of climate change farming policies. It has been observed that even in the cases where these agricultural innovations have been implemented by the farmers, they are soon abandoned particularly in Sub-Saharan Africa (Dahlquist *et al.,* 2007; Meijer *et al*., 2015; Kiptot *et al*., 2007). Moreover, many traditional communities especially in Africa find transferability of indigenous agricultural knowledge being easier than trying out more conventional scientific farming techniques (Tanyanyiwa, 2019).

Other studies have also indicated that there are underlying socio-cultural factors that could be hindering the adoption of climate-smart agricultural technologies by local rural farmers (Nugun *et al*., 2021). Further research outcomes indicate that addressing certain gender inequalities that exist in traditional farming communities enhances agro-ecological CC adaptation(Cáceres-Arteaga *et al*., 2020). Exposure to education and information also determines adaptation decisions among local farmers (Sarker and AlHassan, 2021).

In the foregoing, there was need to determine if the indigenous knowledge practices prevalent in Kajiado County may have an influence on the farmers' uptake of the scientifically developed climate change adaptation strategies. The farmer's internal factors such as the socio-demographic and economic attributes as well as the exogenous factors were examined to establish their influence on the a farmer's adaptation intentions and decision-making.

Regionally, a report by the Food and Agriculture Organization (FAO) on the Near East and North Africa (NENA) revealed that the region being one of the most affected regions by the ravages of climate change, the small-scale farmers still have challenges of accessing support systems (Lewis *et al*., 2018). This phenomenon is compounded by the fact that in poor rural communities, the effective dissemination of information on climate change adaptation strategies to mitigate adverse effects depends on the targeted farmers' climate change risk perceptions(Ncoyini *et al*, 2022). Apart from inaccessibility to the services of new agricultural technologies, the small-scale farmers who are absolutely dependent on rain-fed agriculture, are mainly illiterate and need elaborate capacity building programmes to ensure effectiveness.

In Kenya, and more specifically, Kajiado County, a recent and relevant study carried out in the county on the indigenous knowledge practices being utilized by farmers to cope with and adapt to adverse climate change impacts revealed in its findings that 98% of the respondents still apply Indigeneous Knowledge (IK) in managing their farms (Manei *et al*., 2016). In full appreciation of the importance the adverse effects of climate change on agriculture, the Kenya Government, through the Ministry of Environment and Mineral Resources, developed the 2010 National Climate Change Response Strategy (NCCRS). This strategy is what came up with the National Climate Change Action Plan (NCAP) developed in 2012 that stipulates the logical steps of reducing vulnerabilities related to climate and make advantage of the related opportunities (GOK, 2013).

These strategic plans may go a long way in alleviating problems of climate change on sustainable agriculture, enhance community's adaptive capacity but their effectiveness in implementation is a concern that this study is aimed at understanding and addressing. The government developed a National Climate Change Action Plan (NCCAP) in 2012 and last updated in 2018 as an adaptation strategy, but its effect not felt at grassroots as this depends on internal political and socio-economic contexts (Makuni, 2024)

Kajiado Profile prepared by the International Center for Tropical Agriculture (CIAT) shows that its agriculture sector has encountered persistent climatic challenges, especially, drought (CIAT, 2018). This has led to massive crop failure and livestock losses and has subsequently occasioned severe food shortages for years. For instance, CIAT (2018) reported that in 2009 "crop failure in the county was estimated at more than 90%, while livestock losses were in excess of 70% in most areas within the county". A more recent study by Waithira and Kathula (2020) actually paints a very grim picture stating that over 232,400 herds of cattle died due to extended periods of drought thereby affecting livelihoods of about 80% of livelihoods. Research-based organizations in Kenya such as Kenya Meteorological Department (KMD), National Drought Management Authority (NDMA), the Ministry of Agriculture, Livestock and Fisheries (MoALF) have findings that are key in establishing climate change challenges to agricultural production in Kajiado County (CIAT, 2018).

The Kenya National Environment Management Authority (NEMA), enumerates several climate adaptation programmes that have been rolled out in Kajiado County. It states that there are two Kenya Climate Change Adaptation Fund Programme sites including Loitokitok sub-county site, being implemented by Kenya Forestry Research Institute (KEFRI), and Kajiado west sub-county managed by NASARU which is a Community Based Organization. These programmes focus mainly on eradicating climate-change-related vulnerabilities by enhancing food security as well as establishing Climate Change resilient water management systems to enhance food security (NEMA, 2019). The research query here is whether these programmes have attracted ownership and significant involvement from Kajiado farmers, and if not, whether the low uptake is as a result of the intrinsic and extrinsic factors influencing their decisions.

The most recent Agriculture Research Conference on Kenya Climate Smart Agriculture Project (KCSAP) sponsored by the World Bank Group, held in September 2018 aimed at emphasizing on strategies such as improvement on agricultural productivity, building communities resilience to climate change and lowering greenhouse gas emissions (Chengula, 2018). The KCSAP which has attracted funding from World Bank Group to the tune of US$ 250 million for implementation in several Arid and Semi-Arid counties, Kajiado included, is a long-term endeavor but which will still need to pass the test of acceptability by the local farmers.

Targetted training of community groups with alternative advanced CC adaptation approaches is lacking and most of the strategies being viewed to threaten the farmers' existing coping mechanisms. It is actually reported that the impact of the agricultural extension work that is responsible to raise CCAS awareness among farmers is negligible or non-extent in most areas of the county (Mudany *et al*., 2024; Ndungu and Mwangi, 2022)

Based on theoretical underpinnings that help in explaining uptake of climate change agricultural technologies, this study examined the intrinsic variables that include the prevailing indigenous knowledge practices among the local farmers in Kajiado County as well as their attitudes, knowledge and perception and extrinsic factors such as the attributes of the suggested technologies. The environmental factors prevailing within particular locations in which the new practices are to be implemented were also examined (Meijer *et al*., 2015). The focus was therefore on identification of general small-scale farmers and selected large scale farmers within Kajiado County, profiled according to their legal status in the Agriculture Act, Chapter 318 (GOK, 2012). The nature of the agricultural activities that the farmers were involved in so as to qualify them for this study, were also considered as long as they fitted the description within the Agricultural Act as that which befits what is being done on the occupied land as agricultural.

The aim of this study therefore was to determine the role of indigenous knowledge practices in the uptake of climate change adaptation strategies among farmers in Kajiado County in Kenya.

1.2 Statement of the problem

Through extensive research undertakings involving stakeholders in agricultural production including agronomists, climatologists, hydrologists, agriculturalists among other scientists have established strategies that farmers should employ in climate change adaption. However, the recommended strategies have not been fully accepted by the farmers on the ground, hence hindering effective response and sustainability as indicated in the levels of agricultural productivity and persistent food insecurity concerns. A study in Kajiado County by Chepng'etich *et al*. (2024) conducted on household adaptive capacity (AC) in regard to climate change, gave an average index of 0.508 out of a maximum of 1. However, households with lower AC were also found to be those of small scale farmers and they had very low rates of less than 20% in adopting CCAS that would enhance their AC.

Research-based organizations such as Kenya Meteorological Department (KMD), National Drought Management Authority (NDMA) and the Ministry of Agriculture, Livestock and Fisheries (MoALF) are key in explaining climate change challenges to agricultural production in Kajiado County (CIAT, 2018). Despite the concerted scientific efforts in formulating climate change adaptation to mitigate the effects of global warming on agricultural productivity, there are persistent challenges related to agricultural production in Kajiado County. These problems include drought-related livestock deaths, declining water resource capacity and reduced soil moisture content suppressing vegetation growth for pasture. Adoption of scientifically developed climate change adaptive strategies by the local Kajiado County farmers is slow while the studies indicate that these farmers largely prefer IK (indigenous knowledge) practice as CC (climate Change) adaptation approach (Manei *et al*., 2016; Oloitipitip *et al*., 2024).

Available literature has shown that the uptake of climate change adaptation strategies among farmers in the ASAL areas of Kenya is low as compared to other ecological zones (Bryan *et al*., 2013; Ng'ang'a *et al*., 2020). Most of the local farmers tend to stick to their traditional coping mechanisms to climate variability, rather than embrace the recommended strategies by the experts. This slow uptake has subsequently reduced productivity in the agricultural sector. The low literacy rates coupled with high poverty levels further compound the challenges brought about by climate change and variability with more than 53% of the population living below the poverty line.

Efforts to enhance adaptive capacity through recognition and integration of indigenous knowledge into the conventional adaptive strategies have been ineffective because there is very little documentation of their application within academic or other conventional systematized channels. In the wake of these gaps the adverse effects of climate change continue to affect rural farmers in Kajiado County yet the uptake of suggested adaptation approaches among farmers continue to show dismal levels. A situation in which there is significantly low uptake of scientifically systematized CCAS by communities that practice IK needed empirical study to establish a nexus. On this backdrop, this study was aimed at determining the influence of indigenous knowledge practices on the farmers' uptake of climate change adaptation strategies in Kajiado County in Kenya.

1.3: Objectives of the study

The overall objective of the study was to examine farmers' indigenous knowledge practices influencing uptake of climate change adaptation strategies in kajiado county, Kenya. The specific objectives were to**:**

i. Assess the determinats of indigenous knowledge influencing farmers' uptake of climate change adaptation strategies in Kajiado County, Kenya.
ii. Determine the influence of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya.

iii. Evaluate the effectiveness of existing climate change adaptation strategies in Kajiado County, Kenya.

iv. Examine the strategies for enhancing the integration of indigenous knowledge practices and the climate change adaptation strategies in Kajiado County, Kenya.

1.4: Research Questions

This study was guided by the following research questions

i. What are the factors of farmers' indigenous knowledge practices that influence the uptake of climate change adaptive strategies in Kajiado County, Kenya?

ii. What is the effect of farmers' indigenous knowledge practices on uptake of the climate change adaptive Strategies in Kajiado County, Kenya?

iii. How effective are the existing climate change adaptation strategies in Kajiado County, Kenya.

iv. Which are the existing strategies for enhancing the integration of indigenous knowledge practices and the climate change adaptation strategies in Kajiado County, Kenya

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1.5: Significance of the Study

As society faces increased threats regarding decreased agricultural productivity as a result of climate change, there have been serious food security concerns especially in the Sub-Saharan Africa. As elucidated by Meijer *et al*.(2015), this kind of a situation can be compounded by the reluctance of the local farmers to use the recommended new farming technologies that are tailored to reduce food-security-related vulnerabilities among the communities which depend on the rain-driven agriculture.

The significance of this study was premised on the fact that solutions to the hindrances related to uptake of the climate change adaptive practices by farmers are vital in Kajiado County, Kenya, would work towards enhancing farm productivity, address food insecurity concerns and boost the adaptive capacity of the community facing climate change related hazards.

1.6: Justification of the study

The findings of this research were intended to provide empirical insight into the nature of Kajiado County farmers' indigenous knowledge practices on the scientifically developed agricultural adaptation strategies, and how they influence their (farmers) uptake thereof.

1.6.1: Academic Justification

Currently, there have been numerous studies (Bobadoye *et al*., 2016; CIAT, 2018; Chepkoech *et al*., 2018) that have analyzed indigenous knowledge practices as well as perceptions of famers in Kajiado County about climate change; but which have not empirically examined the role that these practices and resultant farmers' perceptions play in the uptake of new strategies, a gap that this study was aimed at addressing. Leveraging on the learning systems of IK, the study findings demonstrated the existence of inter-connectivity between key socio-cultural, economic and political enablers that characterize social learning and which then could acceletate the climate change adaptation among the farmers.

The findings also gave an insight into the significance of learning process of a knowledge system being more effective when it is done within a social context between acquaintances over time as is the case with IK practices among farmers in Kajiado County, Kenya. The appropriate climate adaptation strategy acquires community acceptance in a learning environment in which the targeted populations share their experience, success, opportunities, risks and threats posed by the phenomenon. The CCAS are only effectively adapted to when and if they are developed according to the prevailing geo-ecological cultural or economic settings of the location within which a farmer carries out their farming activities.

1.6.2: Policy Justification

In spite of the concerted efforts by policy makers in the field of climate change adaptation to design approaches that would be efficient and effective, the implementation process has always been problematic. The study findings highlights one of the problem of most policy approaches being that they are largely prescriptive and devoid of indigenous knowledge input, having been developed by external institutions/entities. The findings in this study have manifested the critical importance of co-creation in regard to policy development approaches that are meant to address climate change adaptation challenges that local farmers face from time to time.

With the findings highlighting fairly accurate weather predictions, effective treatment of pests and diseases and conservation of natural resources including forests and water towers, IK proves to be a reservoir of climate change adaptation innovations. The concept of co-creation in CC adaptaion policy development focusing on synergy identification and capitalizing on community engagement while managing both IK and scientific knowledge systems to obtain collaborative innovation cannot be gainsaid. When all key stakeholders are deliberately, purposefully and facilitatively involved in the process, a CC adaptation strategy that is effective and supported by the intended local farmers will be obtained.

These insights can therefore be considered by national and county government entities as well as other relevant stakeholders in their policy development mandate with a view of addressing dismal farmers uptake of climate change adaptive strategies in Kajiado County, Kenya. This will subsequently enhance farm productivity, address food insecurity concerns and boost the adaptive capacity of the community facing climate change related hazards.

1.6.3: Philosophical Justification

This research adopted pragmatism as a paradigm which is known to be very relevant for social research. This is because it is strongly linked to the Mixed-Method Research (MMR) that considers elements of positivism and interpretivism (Morgan, 2014). Empirically, a research undertaking is focused on what the researcher discovers from their experience as they interact with a social phenomenon and what they observe in it.

Empirical knowledge is therefore what a researcher obtains as an answer to a question about a social phenomenon that is being investigated and is derived from sense experiences, and demonstrable, objective facts (Kivunja and Kuyini, 2017). This meant that in social research, this kind of knowledge is generated from both a qualitative and quantitative study process, hence the relevance of the pragmatism paradigm. It was envisaged that the mixed research method would therefore cover all elements that describe the nature of indigenous knowledge practices and how they form farmers' perceptions and attitudes towards other new climate change approaches that were introduced.

1.7: Scope of the study

This study was carried out in Kajiado West, Kajiado Central and Loitokitok Sub-counties of Kajiado County, Kenya, and data collected between February and March 2020. A systematic review of outcomes from mixed-method studies covering a period between from 2000 to 2024 was done for purposes of capturing any long-term trends in IK practices that are relevant to climate change adaptation. Current national and county government as well as international treaty policy documents that guide CC adaptation implementation guides. The study's principal respondents were the household heads or representatives.

The study also targeted representatives of national and county governments within relevant departments and parastatals under ministries such as agriculture, environment and natural resources, devolution, water and irrigation. Non-State Actors (NSA) such as NGOs and research organizations that have been involved in drought and food insecurity emergency responses as well as community's senior elders and opinion leaders as key informants.

The secondary data covered the period from the year 1999 to 2019. More specifically, the Famine Early Warning Systems Network (FEWS NET) (2019) bulletin on drought situation shows that there has been a persistent deterioration of drought effects in ASAL counties of Kenya (including Kajiado County) in the period 2014-2019, which was the main period of analysis in this research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, studies that have been carried out so far covering the concepts of food security vulnerabilities that are related to the effects of climate variability as a disaster risk, in regard to slow uptake of new mitigating agricultural technologies by farmers are comprehensively discussed. The discussions are guided towards identification of knowledge gaps within these studies with the aim of solving them with empirical research findings. The chapter therefore followed thematic areas that are stated in the study objectives. The conceptual models of the study are also discussed.

2.2 Nature of Indigenous Knowledge Practices among Farmers

Indigenous knowledge (IK) can be referred to as a collection of orally communicated and transferred knowledge that progressively changes from generation to generation in a society over time, with the main aim of entrenching attitudes and perceptions among the members about guaranteeing survival and development (Jacob *et al*., 2004: Moore and Nesterova, 2020). It is a system that embodies a way of knowing by the resident community for purposes of utilizing the immediate natural resources within an ecosystem to ensure sustainable livelihoods are obtained.

The agricultural practices that are applied by the members of a given community and which are based on the IK, may be so entrenched to such extent that adoption of other scientific-oriented technologies proving impossible or too slow. Most of the poor rural farmers that practice IK in their activities are mainly considered to be doing so on small-scale, but with aggregate large contribution to food security solutions in their respective areas (Ncoyini *et al*., 2022). Notably, the food production from these small-scale farmers has been capable of supporting up to 80% of food needs of most rural communities in underdeveloped countries (Donatti *et al*., 2018; Hlophe-Ginindza and Mpandeli, 2020). However it is these farmers who don't have sufficient CC adaptation information, always bearing the heaviest brunt of the adverse impacts of CC.

Indigenous knowledge systems have been proven to be supportive of the prevailing environmental conditions, ensuring that the farming activities are tailored to suit the existing ecosystem (Macusi *et al*., 2023; Mendoza *et al*, 2022; Yazdanpanah *et al.*, 2021). This has a big role towards achieving ecological resilience among communities in most of the rural agricultural environments. In many communities that actively practice IK in their farming have their institutional memory of predicting weather used in carrying out specific agricultural activities in specific seasons (Audefroy and S´anchez., 2017; Bekuma *et al*., 2023).

Even with the above highlighted benefits of IK CC adaptation practices, it is documented that such communities still have food security vulnerabilities emanating from CC hazards. The farming among the indigenous communities depend on the traditional rainfall patterns that have significantly been disrupted by the CC phenomenon (Bjornlund *et al*., 2022; FAO *et al.*, 2015; Mbuli *et al.,* 2021), unlike the case with the developed agricultural communities in western Europe and North America. It can be concluded that the adverse impacts of CC can not be mitigated against using IK adaptation systems in exclusion of other knowledge systems. This study examined certain characteristic factors that embody the IK among several local communities which may influence the adoption of alternative scientific climate change farming strategies.

2.2.1 Geographical and Ecological factors

Most authors on IK, are in concurrence that the term is associated with a particular place (Aryal *et al*., 2018; Jessen *et al*., 2021; Kom *et al*., 2024; Ning *et al*., 2007; Tanyanyiwa, 2019; Tatira, 2000). This assertion is buttressed by general consensus among scientists on which Studley (1998) avers that this knowledge “is linked to a specific place, culture or society; is dynamic in nature; belongs to groups of people who live in close contact with natural systems and contrasts with "modern" or western formal scientific knowledge.” The geographical and ecological characteristics of a particular location in which the farmer community carry out their agricultural activities define the environmental conditions that influence the application of the indigenous knowledge.

Diverse climatic and geological characteristics existing in different geographical locations determine how different communities utilize dissimilar sets of approaches in addressing disaster risks (Dube, 2018; Kom *et al*, 2022; Ogundiran, 2019). An area where there is prevalent arid and semi-arid climatic conditions with black cotton soils may have resident communities using a particular customary approach in mitigating extended droughts different from the community that resides in an area that has an agriculturally favorable precipitation intensity, variability and annual amounts.

Similarly different ecological zones have their respective resident communities utilizing traditional (i.e IK) environmental management practices unique to the existing natural resources such as forests, rivers, hills/mountains and lakes among others. Studies show that local farmers are prone to developing CC adaptation resilience from their long-term interactions with the natural environment (Chen and Cheng, 2020).

The socio-cognitive progression within which farming-oriented climate change adaptation occurs, tends to take place in a localized socio-ecological environment. Moreover, it is argued by Mitter *et al.* (2019) that farm and regional characteristics can also significantly modify the way a farmer will appraise the climate change related risks, hence seek to apply the knowledge that is "locally" understood in response to the adverse effects of climate change.

2.2.2: Climate change patterns in Kajiado County

The research depended on secondary data to draw conclusions on climate patterns within the county over a period of 30 years. This study took into cognizance that the analysis of the rainfall and temperature patterns was very imperative so as to establish the need for CC adaptation. However, since several similar research works in the same study location such as analysis of precipitation and temperature trend for Kajiado over the 30 year period (Othoo, 2025); comparative analysis of rainfall trends in different sub-counties in Kajiado from 1970 to 2013 (Bobadoye *et al*, 2014), among other studies, this area was covered with the support of secondary data.

The studies show a trend depicting a steady rise of temperatures and decrease in amounts of precipitation over a period of 30 years in Kajiado County. As shown in Figure 2.1 overleaf the linear readings of temperatures intersected between 2013 and 2014 thereafter showing increase in temperature levels as rainfall amounts continue to decrease.

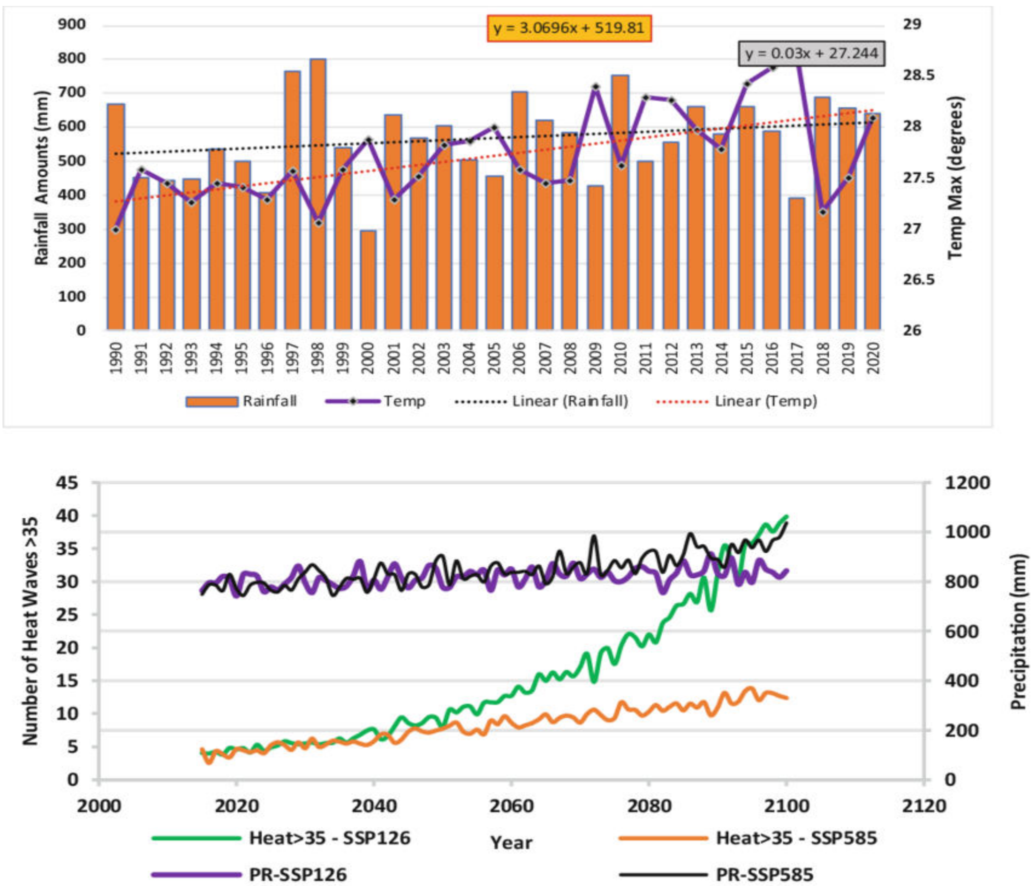

Figure 2.1: Observed Precipitation and Temperature Trend for Kajiado over the 30 Year Period (Source: Othoo, 2025)

With resultant longer periods of drought, these climate trends have occasioned risks to pastoralism which is considered as the main agricultural livelihood activity within Kajiado County. Additionaly, as posited by Dorji *et al*.(2024), differences in application of IK per geographical region is determined by these climatic conditions.

2.2.3: Socio-cultural Contexts and Transferability of Indigenous Knowledge in a Community

IK consist of both the content and context of intricate knowledge systems that encompasses technical expertise as well as social, economic, philosophical, learning and governance systems (Tanyanyiwa & Chikwanha, 2011). At the global scene; indigenous knowledge systems especially on agriculture, are only recognized to be existent and operative in poor, developing countries among local traditional communities.

In a book written from collection of papers prepared in conjunction with an UNCTAD expert meeting, Twarog and Kapoor (2004) point out that indigenous knowledge (which they also refer to as Traditional Knowledge) has a social capital value for poor communities whose food security and livelihood systems are vulnerable. Even in well-capital-intensive agricultural economies in America and Europe, indigenous knowledge systems are only known to exist among the rural natives who run small-scale farming (McIsaac and Edwards, 1994).

Globally, instances of traditional healing practices that include diagnosis, that are developed locally by communities to cure, control or prevent human or livestock diseases which are common among natives have been noted (Asefa *et al*., 2022; Mathias, 1994). However, there are no empirically sound studies that this researcher has come across which confirm that such desirable indigenous knowledge practices may have contributed to the slow uptake of modern conventional agriculture adaptive technologies among local farmers. The evidence map as illustrated by Petzold *et al* (2020) give an indication that

IK practices are more concentrated in rural subtropics and drylands. The knowledge system is mainly a source of planning, behavioural approaches and farming practices adopted towards CC adaptation.

In Africa and particularly the Sub-Saharan region, the indigenous knowledge systems are utilized among majority of rural communities in response to climate variability. However, most studies only focus on their importance as adaptive response mechanisms while highlighting the need of incorporating or integrating them into modern adaptive technologies for more effectiveness in sustainable agricultural productivity (Ajani *et al*., 2013; MacAllister *et al*., 2023; Manei *et al*., 2016; Masinde and Bagula, 2011; Shingirai, 2018; Songok *et al*., 2011; Theodory, 2016; Zurba *et al*., 2022). Most of these studies underscore the significant role that indigenous knowledge practices have played in helping rural farmers adapt to the adverse effects of climate change within Sub-Saharan Africa. The gap that this study intended to bridge is that there was need of delving into ascertaining whether farmers' adherence to the indigenous agricultural practices has worked at cross purposes with adoption of modern innovative agricultural technologies.

A point to note is that there has been a clear dichotomy between indigenous knowledge on one hand, and what is considered as conventional, scientific oriented knowledge on the other. In fact, indigenous knowledge is being seen as a hindrance to the implementation of scientific modern knowledge in many rural-based agricultural settings (Nygren, 1999; Theodory, 2016). Caution must be applied in generalizing this fact, as some studies show that indigenous knowledge actually can be utilized for empirical purposes in climate change research. In their study using a Participatory Appraisal Approach, on what the locals experience versus the actual measurements of climate variables within the dry forest region of Ecuador, Kieslinger *et al*., (2019) report that actually, "local knowledge could make a major contribution to selecting representative climate datasets, estimating local impacts of climate change, and developing adaptation policies."

In Africa, a study in Uganda also illustrates through its findings that there certain botanical changes of plants and animal behaviour that the local farmers use to predict rainfall patterns. These include shading off of tree leaves and restlessness of animals among other changes (Nyakaisiki *et al*., 2019). Since indigenous knowledge mainly incorporates a collection or a body of beliefs, practices, and information that keep on evolving by adaptive progressions and learnt from one generation to another "about the relationship of living beings (including humans) with one another and with their environment" (Berkes et al. 2000), its adoption and practice by a given community is fairly dynamic. On the other hand, western knowledge is mainly created within an analytical and reductionist methodological environment, favoring objectivity and quantitative considerations and is based on an academic and literate transmission (Ijatuyi *et al*., 2025; Jessen *et al*., 2021; Mazzocchi, 2006).

Although there are clear epistemological differences between Indigenous knowledge and the scientific knowledge, the former has been internationally recognized as key in sustainable natural resource management especially in rural settings. There is even an

Article 8 of the Convention on Biological Diversity recommends to the international community to "…respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity…." (United Nations, 1992).

Regrettably however, the proponents of scientific knowledge have always had difficulties in embracing IK, arguing that it is more localized to a geographical location and focused on beliefs and traditions of specific communities (Fletcher *et al*., 2021; Mazzocchi, 2006; Theodory, 2016). This is not withstanding that some of the indigenous knowledge is used in medical cures both for humans and livestock; concepts that can be utilized across societal and geographical boundaries. Additionally, Indigenous knowledge, just like scientific knowledge is dynamic and keeps on evolving and is a product of some external influences (Moore, 1996; Briggs *et al.,* 2007). Many actors such as agricultural extension workers, non-governmental organizations (NGOs), and farmers from the neighboring communities have over time influenced changes in IK. The indigenous communities, after careful evaluation of external knowledge and confirming that that knowledge resonates well with their own socio-cultural tenets and beliefs, they will incorporate such knowledge into their indigenous knowledge (Theodory, 2016). That follows the argument that the local farmers can easily identify with the process of planning those strategies.

In the case of Kajiado County the recorded high level of illiteracy among pastoralists also hinders access to information, speed of recovery from climatic shocks, and constraints options for livelihood diversification. This observation is also justified by the fact that indigenous farmers also tend to have and hold onto their own traditional perspectives about climate change. A study by Chepkoech *et al.* (2018) revealed that farmers' perceptions on higher temperatures, decreased rainfall, late onset and early cessation of rain, erratic rainfall patterns and frequent dry spells increase the incidences of droughts and floods. The indigenous farmers have a perception about the changing weather conditions but not necessarily adapting to them (weather conditions).

2.2.4: Sources of Acquiring Indigenous Knowledge

The global conversations by the researchers on knowledge systems, including indigenous knowledge, has been at the center efforts of designing strategic plans and policies geared towards responding to the negative effects of climate change. In fact the global organizations such as the IPCC mandated with addressing impacts of climate change have organized summits that have brought together international state actors with intentions of soliciting sets of response approaches from both scientific and indigenous knowledge systems. As Petzold *et al.* (2020) posit in their study on Indigenous *knowledge on climate change adaptation: a global evidence map of academic literature,* "The necessity to consider different knowledge systems in climate change research has been established in the fifth assessment report (AR5) of the Intergovernmental Panel on Climate Change (IPCC)."

Since the IK can be referred to as a collections of the culturally acquired awareness, skills and philosophies that are developed by communities which share long histories of interaction with their natural surroundings, the sources are most likely be from social networks including family, community elders, social groups and religious institutions among others. These kinds of sources of information and ways of knowing, generate very distinctive diversities of culture which have helped different communities to acquire resilience to natural phenomena, including effects of climate change (UNESCO, 2017).

These uniquely diverse sets of knowledge that characterize each community that share the socio-cultural and environmental attributes are consequently differently distributed globally (Petzold *et al*., 2020). In developed countries of Western Europe and North America, the knowledge on response to effects of climate change is acquired from research institutions and are broadly scientific oriented (Mitter *et al*., 2014). In these countries, these locally developed knowledge systems are "recognized as resources for understanding, monitoring and managing biodiversity." (UNESCO, 2019).

In a more local setting, indigenous knowledge among the Maasai is accumulated through observation and real-life experiences. Significantly, it is observed that indigenous knowledge structures and practices are utilized in treatments and care of humans and animals (Abebe, 2019; Jacob et al., 2004; Nkatha, 2020; Owfi and Barani, 2019) and for management of foliage, soils and rangelands (Maru et al., 2020; Wanjohi *et al*., 2020).

The purpose of this study is to attempt to identify the areas of disconnect between the indigenous knowledge and scientific (western) knowledge hence influencing the uptake of the conventional climate change adaptation strategies by the native farmers in Kajiado

County. The aspects to be examined is to confirm whether the slow uptake is as a result of lack of effective mechanisms of deliberately integrating indigenous knowledge into the more scientific strategies of climate change adaptation strategies.

This line of query emanates from some of the early scientific knowledge theorists' stance who advanced arguments that indigenous knowledge was a hindrance to development because it is devoid of analytical scrutiny, doesn't have a well-defined database for referencing and that it is simply primitive (Agrawal, 1995). The proponents of indigenous knowledge systems aver that those who have ignored its conservation importance have been influenced by factors such as colonialism, capitalism and modernization in total disregard to the core values held by traditional communities in their relationship with their natural environment (Masemula, 2013). In addition, studies indicate that efforts to enhance adaptive capacity through recognition and integration of indigenous knowledge into the conventional adaptive strategies are ineffective because little documentation of their application through official channels exists (Dekens, 2007). Many rural communities continue to utilize their own indigenous knowledge in managing their farms despite of the fact that they are exposed to climate change related hazards.

In Kenya, and more specifically, Kajiado County, a recent and relevant study carried out in the county on the indigenous knowledge practices being utilized by farmers to cope with and adapt to adverse climate change impacts reported that 98% of the respondents still apply IK in managing their farms (Manei *et al*., 2016). The farmers interviewed in that study argue that these practices are more reliable, accurate, familiar and cheaper. The traditional farming practices according to this study included agro forestry, irrigation, planting of appropriate crop varieties, preservation of pastures, application of organic and inorganic fertilizers and soil and water conservation (Manei *et al*., 2016). The agro-pastoralists that are a huge majority of the people in Kajiado County also practice migration and traditional control of pests and diseases in adapting to climate change effects.

In spite of what is viewed by the local farmers as convenient basis on why they depend on indigenous knowledge practices rather than modern technologies in managing effects of climate variability, persistent decrease in agricultural productivity as a result of drought emergencies continue unabated (CIAT, 2018; Chepkoech et al., 2018; Nunow et al., 2019; Ombogo, 2013). As argued by Meijer *et al*. (2015), many communities that depend on agriculture as a source of livelihood have over the years learned traditional means of combating effects of climate variabilities and hence more often are reluctant to adapt to new technology. There is a point of departure when integrating the two mechanisms: indigenous knowledge practices and the more scientific climate change adaptive strategies thereby slowing the uptake of the latter. A clear framework within which such integration can be processed in a participatory manner (Mercer *et al*., 2010) seems to be lacking according to the available literature. Although programmes such as National Adaptation Programmes of Action (NAPA) exists within the country, the implementation process lack an enabling environment including the political will and sound governance practices to ensure compliance by stakeholders.

2.3 Effect of Indigenous Knowledge Practices on Uptake of CCAS

A review of the existing theories and models that explain the nature of the uptake of agricultural innovations reveal the critical role that the intrinsic and extrinsic factors play, particularly the attributes of the targeted adopter and the external environment within the course of decision making (Meijer *et al.*, 2015). On the other hand, adaptation to climate change effects can be explained in terms of efforts that can be applied by communities at the local level, national, regional, continental and global level mainly in response towards addressing vulnerabilities occasioned by resultant compromised agricultural productivity as well as taking advantage of opportunities arising from the phenomenon (Kumar, 2014).

Climate change effects have been related to increased levels of global warming which adversely bring about among other things, especially extended periods of drought a climatic condition that exercabate reduced yields in crop agriculture (Dhanush *et al*, 2014). More specifically, climate change impacts have, according to the very recent study by the Climate Risk Profile on Kajiado County, continued unabated with persistent crop failures and livestock deaths due to biting extended droughts (CIAT, 2018).

In their study on “The Extent of Adopting Climate Smart Agriculture Technologies in Addressing Household Food Security in Makueni County, Kenya”, Nyale *et al*. (2019) found that although farmers were willing to adopt new agriculture technologies, cultural factors slowed this adoption. It was therefore imperative that the impact of these intrinsic factors (knowledge, attitudes and perceptions) be empirically examined to establish if they affect the uptake of the CCAS. In addition to that particular study, this study is aimed at examining specific IK practice parameters that influenced the uptake.

2.3.1 Farmers' Attitudes, Knowledge and Perception

The human actions and behaviour are normally predicted by knowledge, attitudes and perceptions (Crano and Prislin, 2006). Knowledge being an aspect of possession of information concerning a scenario or a phenomenon, will likely shape a person's decision to act in a certain way (Schrader and Lawless, 2004). For example, a farmer who possesses knowledge on climate smart agriculture strategy like sprinkle agriculture on horticulture is likely to be willing to demonstrate that knowledge.

Attitude is the intrinsic aspect of a person's behavioral concept which Allport (1967) and LaPiere (1967) define in a behavioral sense, "as a mental and neural state of readiness conditioned by stimuli directing an individual's response to all objects with which it is related". It has also a cognitive perspective in which Thurstone (1967) associates attitude with subjective decisions because they are viewed as the sum or aggregate of all feelings and dispositions toward a particular concept, idea, or action.

Most psychologist researchers hold the view that an attitude embodies an evaluative integration of cognitions and affects experience in relation to an object, idea, practice or concept (Crano and Prislin, 2006). It therefore follows that attitudes constitute evaluative judgments that characterize a mixture of cognitive/affective reactions which then inform how individuals prioritize actions thereby mould implications for persistence, resistance, and attitude-behavior consistency (Holland *et al*., 2002 Petty *et al*., 2004). This concept illustrates why community's view on a particular practice that has been innovatively developed to solve a problem may be less desirable as compared to a traditional practice. Attitude is therefore an aspect that may influence the farmers' uptake of new agricultural innovations meant to adapt to challenges of climate change.

Perception is an all-encompassing concept that even affect the knowledge and attitudes of individuals concerning an issue because based on the theory of planned behaviour (TPB) perceptions could lead to intentions to adapt as determinants of attitude were significant (Jellason *et al*., 2019). Any human action emanates from a well-defined behavioral characteristic which can be unknowingly influenced by knowledge that is incidentally activated in memory during social perception (Ferguson and Bargh, 2004). In spite of the importance of farmers' perceptions in the implementation of climate change adaptation practices, considering all relevant literature review only a few studies have applied the theory to climate change adaptation (Jellason *et al*., 2019; Lin, 2013; Masud *et al*. 2016), with almost no application in the context of Kenya and in particular, Kajiado County.

The available studies in Africa related to effects of climate change on agriculture have mostly focused on the mitigative practices and significantly ignored the attitudes and perceptions of the adopters of these practices; the farmers concerning the risk at hand (Jellason et al., 2019). Hardaker et al. (2004) correctly posits that climate change presents a significant risk to agricultural communities because there are obvious uncertainties concerning crop and livestock performance. This means that risk perception is considered significant in decision-making because as both Maye *et al*. (2012) and Hardaker *et al*.,

(2015) opines, “Decisions need to anticipate all possible consequences so as to tackle them holistically.”

Therefore, the most holistic approach in enhancing the uptake of climate change adaptation strategies especially among subsistence farming communities, requires efforts to be directed at improving the determinants of behavioral intentions; an area that has not been well researched in Africa and more specifically in Kenya. This kind of focus particularly on the poorly perceiving groups in hardest hit ASAL areas of Kenya such as Kajiado county could lead to better decisions to adapt to climate change and provide more targeted extension support in the future. (Jellason *et al.*, 2019).

2.3.2 Concepts of Climate Change Adaptation Strategies (CCAS)

Climate change is a global phenomenon that has been attributed to human activities that actually alter the natural balance of carbon gases in the atmosphere. This alteration is caused by such activities as burning of fossil fuels, deforestation and other related activities that release what is commonly called greenhouse gases (GHG) in the atmosphere (ISDR, 2008). This description fits with the definition by United Nation (1992) through the United Nations Framework Convention on Climate Change (UNFCCC) which states that climate change is a situation that emanates from “directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods”.

The conceptualization of climate change in this study is grounded within the context of disaster risk reduction, by analyzing its effects on sustainable agricultural productivity. In aggregate terms, the period between 1998 and 2017 experienced 1.2 million deaths and nearly direct economic losses of US$ 3 trillion with agricultural sector that supports 2.5 billion people bearing the biggest brunt due to climate change related hazards (FAO, 2019). One of the ways in which climate change has been associated with reduction in agricultural productivity is its connection to drought. Drought is a serious climatic natural hazard that has a slow onset attributes, but which eventually causes extreme and adverse consequences on the survival of populations.

These consequences of drought which emanates from the eco-hydrological and socioeconomic impacts, as succinctly stated by Mukherjee *et al* (2018), include, "increased risk of wildfire, water scarcity, loss of crops and livestock, increased food prices, migration, and indirect health effects." There is an apparent connection between climate change-induced warming and the acceleration of hydrological dynamics in the sense that it increases heat energy available for evapotranspiration (ET) as well as decreasing the water holding capacity of the atmosphere (Trenberth, 2011).

Climate change therefore has a very high probability to bear greatest impact on agricultural production and food security in poor counties in which communities largely depend on the environment for their livelihoods. This is especially true in drylands of Africa, where up to 250 million people will be exposed to water stresses by 2020 (IPCC, 2007).

There are measures that have been undertaken to reduce these huge impacts especially in developing nations whose populations are vulnerable because they hugely depend on agriculture for livelihoods. For example, FAO has strategically followed up on the 2015 Sendai Framework for Disaster Risk Reduction (SFDRR), the Paris Agreement and the 2030 Sustainable Development Agenda to implement programmes that alleviate adverse effects of climate change on agriculture (FAO, 2019). One of the key policy undertakings by FAO that are targeting sustainable agriculture to mitigate climate change effects is that the countries should ensure that there is a paradigm shift from reactive disaster response perspective to a more proactive approach in which disaster prevention is critically considered as envisaged in the agreement of SFDRR.

2.4 Existing Conventional Agricultural Adaptation Strategies and Services

The term adaptation in the context of disaster risk reduction refers to ability by the community in changing their ecological, social, or economic systems so as to reduce the impacts of disruptive climate variabilities (European Commission, Undated; UNFCCC, 2019). Relevant to this study, the term is defined as an acquisition of capacity by the Kajiado County farmers to effectively respond to adverse effects of climate change and capitalize on the advantages brought about by expected or actual climate variability that may alter their (farmers) economic, environmental or social systems.

Adaptation is a critical element in a multi-dimensional effort to ensure a sustainable response to adverse effects of climate change on communities. It facilitates effective means of protecting people, their livelihoods and their environments. It is from the foregoing that the United Nations Framework Convention on Climate Change -

UNFCCC (2019) advises that "adaptation action should follow a country-driven, gender-responsive, participatory and fully transparent approach, considering vulnerable groups, communities and ecosystems, and should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions" (UNFCCC, 2019).

Key in the above statement is the fact that for adaptation efforts to be sustainable and effective, the process of developing and designing them ought to be based on scientific evidence, participatory, gender-driven and as integrative as possible. The study will therefore examine the existing strategies to determine whether they meet these crucial criteria. Current literature that cover the policy frameworks of implementing climate change related mitigation/adaptation regulations and recommendations from relevant national/county government institutions and other non-governmental implementation partners was deliberately reviewed.

Key among the relevant documents that formed part of this study's secondary data was the Mitigation Technical Analysis Report (MTAR) which provides the evidence base for the prioritized climate change mitigation actions in the five-year National Climate Change Action Plan (NCCAP) 2018-2022 (GOK, 2018). Some of the key strategies spelt out in the plan within the agricultural sector include the promotion of indigenous knowledge on crops, modifying food habits and creating awareness on climate change impacts on the agriculture value chain. Apart from these plans being largely futuristic and based on certain critical assumptions, their implementation on ground cannot be quantified as the data reveals in latter sections of this chapter. For instance, the issue of sources of funding for the implementation of these plans has been cited severally in the report. In addition, the plan does not explicitly indicate the linkages between the technical stakeholders and key IK local informants

Adaptation strategies that can be employed by farmers include changing agricultural production processes and practices as well as existing structures so as to "moderate potential damages or to benefit from opportunities associated with climate change". Such plans also comprise of aptitudes of the farmers to effectively anticipate and estimate the negative impacts of climate change in addition to being able to efficiently respond and minimize these adverse effects (UNFCCC, 2019). Adaptation actions have been proved to significantly reduce emergency response costs and save lives if well planned (European Commission, Undated).

Globally, the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 followed by adoption by its member states of the Paris Agreement in 2015, has been the deliberate attempt by the international players to enhance the adaptation efforts in the wake of adverse effects of climate change (UNFCCC, 2019; Wiseman, 2016). Imperative to note is that the UN's Sustainable Development Goal No. 13.1 is to "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries", a goal whose indicators can only be achieved through multi-dimensional and multi-sectoral approaches (Ritchie *et al*., 2018).

The approaches towards implementing impact-led adaptation programs within communities are geared towards moderating the adverse effects of climate change. These efforts are hazard-focused rather than vulnerability focused (Theodory, 2016). Programs that are aimed at decreasing greenhouse gases in manufacturing and agricultural activities as well as conservation initiatives that limit destruction of forests include mitigation measures towards achieving this objective (Ozor and Nnaji, 2011).

Although the negative effects of climate change have been felt globally, the least developed countries (LDC) have borne their biggest brunt. A special attention has been directed towards these countries with the aim of establishing national adaptation programmes of action (NAPAs) and national adaptation plans (NAPs); structures within which the sustainable development goal 13:1 can be attained through policy making (Wiseman, 2016).

Studies show that subsistence farmers who form the bulk of agricultural production in the developing world, largely depend on rain and hence they are very much vulnerable to impacts of environmental degradation and climate variabilities because they don't have adequate economic resources to enable them access alternative livelihoods (Meijer *et al*., 2015; Slingo et al. 2005). FAO (2010) puts it more grimly that "per capita food output has declined in sub-Saharan Africa and the region has the highest proportion of undernourished people in the world, estimated to be 30% of the total population or 239 million people in 2010." To mitigate these adverse trends, there is need for the capacity enhancement for the subsistence farmers and a shift from the traditional agricultural practices to more advanced climate smart agriculture that can increase productivity while ensuring sustainable agriculture (Chengula, 2018).

Notably, the initial adaptive strategies to effects of climate change were mainly either autonomous or planned (Jellason *et al*., 2019). Whereas autonomous strategies include diversification, irrigation, change in planting date, crop and livestock insurance and using tolerant varieties of crops which are location-specific (Dang *et al*. 2014), the planned strategies are more policy oriented and include investment in infrastructure to facilitate supplies and marketing , subsidies to cushion farmers, research on drought resistant varieties, innovation and tax regimes (Bryant et al., 2000). However, in spite of all these innovative strategies, the adoption rates by subsistence farmers in Africa have remained persistently low (Ndjeunga and Bantilan, 2005).

The most relevant study that assessed the existing climate change adaptation Strategies in Kajiado county (Bobadoye *et al*., 2016), indicate that "adaptation and coping strategies adopted by Maasai pastoralist are autonomous and are unlikely to build resilience of pastoralist livelihoods and ecosystems to cope with the projected magnitude and scale of climate change in the 21st Century". The existing modern conventional strategies include early warning system, water harvesting, rapid infrastructural development, encouraging table banking and cooperative societies, building and equipping schools, migration, livestock diversification and child education. This scenario presents a grim reality that without a significant level of implementing these conventional technologies, the local farmers are unlikely to sustain optimal agricultural productivity (Chengula, 2018).

The slow uptake of climate change adaptation strategies has been a major concern to the disaster risk reduction experts. Perhaps the most accurate and relevant assertion is that the biggest proportion of previous studies on climate change adaptive strategies have ignored knowledge, attitudes and perception of risk as a key determinant of adaptation to environmental shocks and stresses (Stehr and Storch 1995;Weber 1997); rather, they rely on resource considerations alone (Deressa *et al*., 2011; Jellason *et al*., 2019; Jones and Boyd, 2011). Perceptions and attitudes of farmers towards new farming technologies can be affected by several factors including what they (farmers) consider as knowledge and the social characteristics of the people disseminating that knowledge. Such factors can therefore determine as to whether the farmers will uptake this "body of knowledge".

The study also delved into examining role of local/community based institutions in regard to facilitating awareness of the existing CCAS among farmers in Kajiado County. As posited by Makate (2020) studies show that locally-based community owned organizations are critical in improving levels of interactions between the local farmers and the formal scientifically oriented institutions. It was assumed that the IK in Kajiado County is institutionalized through and traditional local orgnanisational entities that are under the stewardships of community elders. These local institutions directly influence individual farmer's social expectations, their behavior and interactions (Agrawal, 2010;

Ostrom, 1990). The capacity of these institutions therefore would determine the level of farmers' uptake of CCAS.

2.5 Integration of Indigenous Knowledge with Conventional Climate Change Adaptation Strategies

Available literature indicates that indigenous knowledge, just like the scientific-oriented adaptation technologies, plays an important role in generating significant adaptive responses to disaster preparedness at local level (Dekens, 2007). In spite of the fact that indigenous knowledge contrasts with western science in several aspects, they can be applied in a complimentary manner so as to address any inherent weaknesses of either set of knowledge (Shizha, 2011; Tanyanyiwa, 2019). However, although the use of indigenous knowledge alongside scientific knowledge is increasingly advocated, there is as yet no clearly developed framework demonstrating how the two may be integrated to reduce community vulnerability to environmental hazards.

As Wiseman (2016) correctly posits, "Through the NAPA process, LDCs have identified urgent needs and prioritized projects, using existing information and consultations at the grassroots level". While the undertakings by the NAPA projects seem to target the local communities that are vulnerable to climate change, these programmes do not clearly demonstrate how they engage with the local people (farmers) concerning the integration of indigenous knowledge practices into the adaptation strategies. In addition, among the two objectives of NAPs (UNFCCC, 2018), inclusion of indigenous knowledge practices in climate change adaptation strategies is manifestly missing.

Review of the existing relevant literature by this researcher show that there is no documented evidence in Kajiado County on how indigenous knowledge conservation strategies have been enlisted to complement these largely conventional efforts. This study therefore seeks to confirm whether this may be the underlying reason for the slow uptake of the conventional (scientific-based) climate change adaptation strategies.

2.6 Conceptual Framework

This section illustrates the theoretical underpinnings of the research in ensuring that there is disaster management perspective of getting a solution in the farmers' uptake of the climate change adaptive strategies in Kajiado County, Kenya. This study employed two theories and two models to illustrate how the identified variables under investigation relate to each other. The two theories are The Situated Learning Theory (SLT) developed by Lave and Wengner (1991) and the Theory of Planned Behaviour (TPB) by Ajzen (1991); while the theoretical models being the Afrikology Framework of Integration of Knowledge and the Model of Private Proactive Adaptation to Climate Change (MPPACC).

The theories suggested for this study aided the researcher in identifying relevant independent and dependent variables in regard to the stated research objectives. They were therefore very key in the development of the conceptual framework model, thereby forming a firm basis of on which associations between variables were confirmed and consequently being able to draw accurate conclusions and coming up with sound recommendations.

2.6.1 The Situated Learning Theory (SLT)

Considering that the indigenous knowledge is an epistemological body of facts and beliefs that are acquired by members of a community through a social-oriented mechanism from one generation to another, its acquisition by the succeeding generation is through an elaborate learning process. This study therefore used an instructional learning theory that is most relevant to exploring how indigenous knowledge can be so entrenched in a particular society. The Situated learning theory (SLT) forwarded by Lave & Wengner (1991), is based on the assumption that a learning process takes place among social acquaintances, in an environment of constant and ongoing interaction within contextual experience (Vygotsky, 1978; Theodory, 2016). Henning (2008) further posits that this kind of learning interactions occur in a social relation environment, within a cultural context, specific artefacts, and physical dimensions of the learning setting. This theory was relevant for this study in the sense that it provided a framework within which an understanding of the learning processes among the local communities and how the indigenous knowledge was created and learnt.

2.6.2. Theory of Planned Behavior (TPB)

This study was also based on the Theory of Planned Behavior (TPB) (Ajzen, 1991). This theory deals with the aspect of the perceived behavioral control, which predicts the behavioral intention in the decision-making process subsequently leading to the performance itself (Ajzen, 1991; Meijer *et al*, 2015).

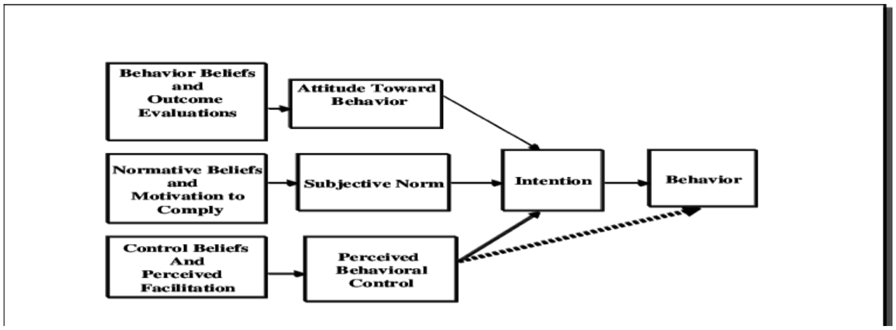

Figure 2.2: Theory of Planned Behaviour (Source: Ajzen, 1991)

At the center of this theory is the attitude formation that controls the behavior and eventually favors the uptake of the climate change adaptation strategies by the farmers in Kajiado County. Figure 2.2 above illustrates the process in which the desired behavior is achieved using several socially constructed influences. Indigenous knowledge practices are a product of socially learned processes a factor that can lead to a desired behavior which may exercabate vulnerability conditions towards climate change related hazards.

Najafi *et al*. (2017) succinctly points out that disaster preparedness requires a thorough understanding of the factors that influence performance or non-performance of disaster preparedness behaviors (DPB), and hence in their study findings note that intentions by members of the exposed communities to adopt the Disaster Preparedness Behaviour (DPB) is associated with the person's perceptions emanating from the predicted attitudes, subjective norms, and perceived behavioral control with respect to DPB. The same study also shows that there is a strong relationship between performing DPB on one hand and intentions and perceptions of control assessed in the prepared people on the other.

In disaster management, one of the key elements that is effective and long lasting in the reduction of disaster risk is the level of community-based preparedness. The unpredictable nature of climate change has had adverse effects on traditional rain-dependent agricultural productivity. Disaster preparedness strategy that will mitigate the effects of increasing drought in Kajiado County therefore requires a thorough understanding of the factors that influence performance or non-performance of disaster preparedness behaviors (Bradley, 2010).

Indigenous knowledge practices exhibited by the farmers in Kajiado County were therefore analyzed based on the fact that they are psychological processes. As Dwyer *et al.* (2007) posit in their report on understanding and influencing positive behavior change in farmers and land managers, the patterns of behavior change studies in the agricultural field have mostly focused their work on attitudinal theories. Similarly, this particular study sought to determine if the attitudes of farmers towards new farming practices and technologies may have affected the uptake of the new concepts of agricultural production.

In the context of the uptake of climate change adaptation innovative practices, this theory illustrates that the attitudes and perceptions of the farmers will only be modified positively if the social environment is set to in such a way that behaviour, normative and control beliefs are taken into consideration so that the intended behavior is acceptable.

2.6.3. Afrikology: Theoretical Framework for Integration of IK and Scientific Knowledge

Afrikology was used in this study as a theoretical framework for the study on the integration of indigenous knowledge systems scientific or modern knowledge. This is a philosophy of knowledge that was advanced by Nabudere (2010) and which demystified the notion that only scientific knowledge accounts for all knowledge. He argued that epistemology has its source at the cradle of humankind; Africa. He therefore advanced a holistic philosophy of knowledge creation which “makes it possible to interface scientific knowledge with other forms of knowledge”.

To illustrate this theoretical framework, this study adopted the Alaskan knowledge integration model that was developed by Barnhardt and Kawagley (2005) which succinctly elucidate on the unique parameters of indigenous knowledge as compared to those for the western scientific knowledge, as well as pointing out the areas of similarities, differences and linkages. This model therefore, draws its relevance to this study to the extent that opportunities for integrating the two domains of knowledge are areas of similarities, this model categorizes the parameters into three key clearly identifiable. Figure 2.3 below shows the elements of this model. Considering groups; the organizing principles, habits of mind, skills and procedures and finally, the knowledge. The study envisaged these categories to be the entry points of formulating an integration structure, and hence seeking to establish whether this kind framework exists.

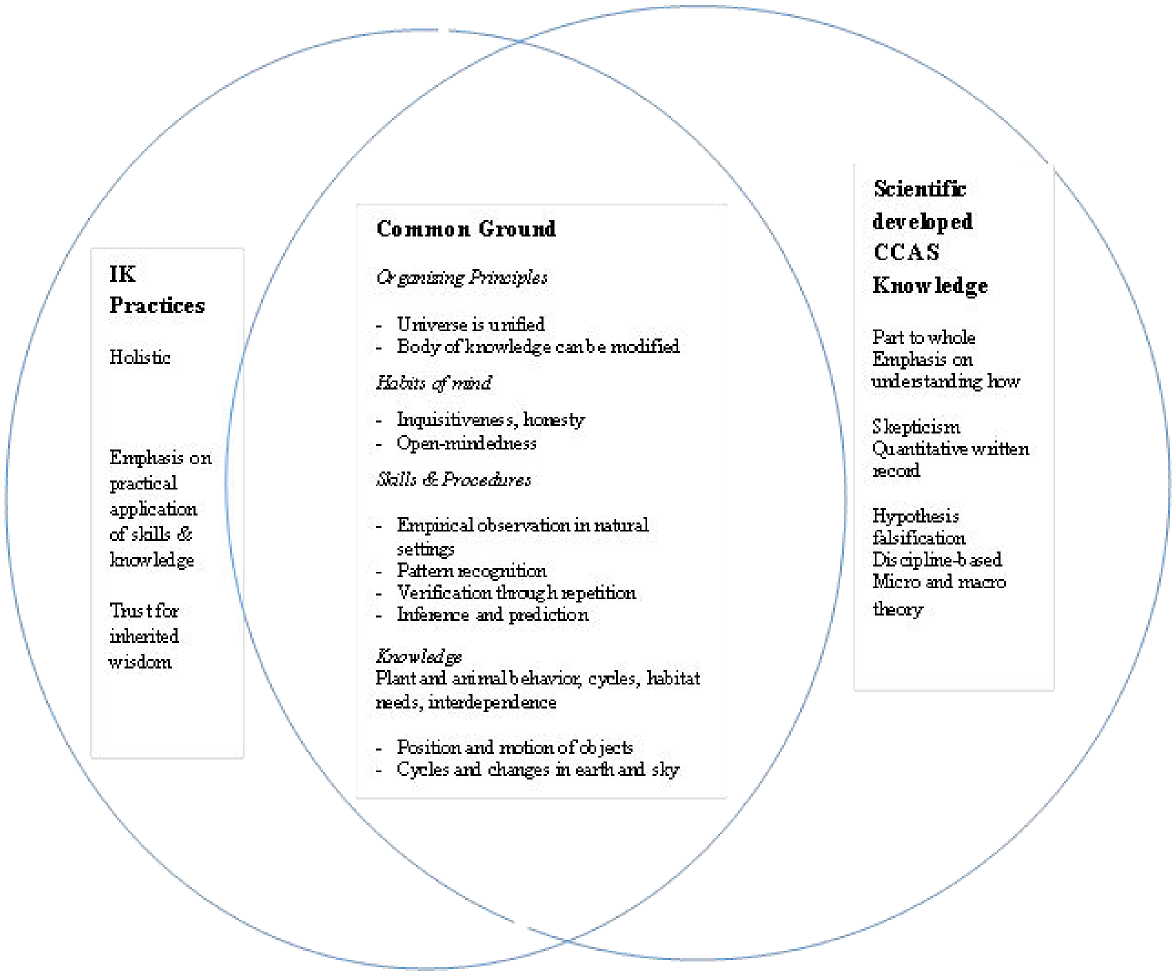

Figure 2.3: Indigenous and Western Knowledge Integration Framework (Barnhardt & Kawagley, 2005)

The examination of indigenous knowledge vis-à-vis conventional science-based concepts that have been utilized in community's adaptation to climate change related hazards in Kajiado County can be relevantly done through the prism of Afrikology theoretical framework. In disaster risk reduction initiatives, the appreciation of the need to understand the natural science has to be complimented with the understanding of socio-economic and cultural factors that guide a community's ways and means survival in a given environment (Wisner *et al.*, 2004; Mercer *et al.*, 2010). Whereas the science-oriented efforts are focused on the natural reality of occurrence of hazard events, IK can be used to describe socio-cultural characteristics that may define a community's vulnerability based on their risk perception and response strategies to such events.

The understanding of both epistemological sources; the IK and scientific knowledge concerning disaster risks will create an accurate awareness and an appropriate framework of addressing vulnerability factors in a given community. The United Nations International Strategy for Disaster Reduction (UNISDR) (2004), has underscored this fact by stating that disaster risk reduction is "the systematic development and application of policies, strategies and practices to minimize vulnerabilities, hazards and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development." This definition reinforces the need to incorporate both indigenous and scientific knowledge in helping communities exposed to climate change induced hazards to develop effective adaptive capacities. Afrikology theoretical framework will therefore help in examining and understanding of the levels of integration of IK into the conventional climate change adaptation strategies and confirm whether those levels determine the rate of uptake of the latter among farmers in Kajiado County.

2.6.4. Model of Private Proactive Adaptation to Climate Change

This model which is diagrammatically illustrated in Figure 2.4 shown below and which was first developed by Grothmann (2005) is used to assess climate change characteristics as they relate to other proximal factors that influences individual farmer's cognition enabling him/her willing to adopt the CCAS.

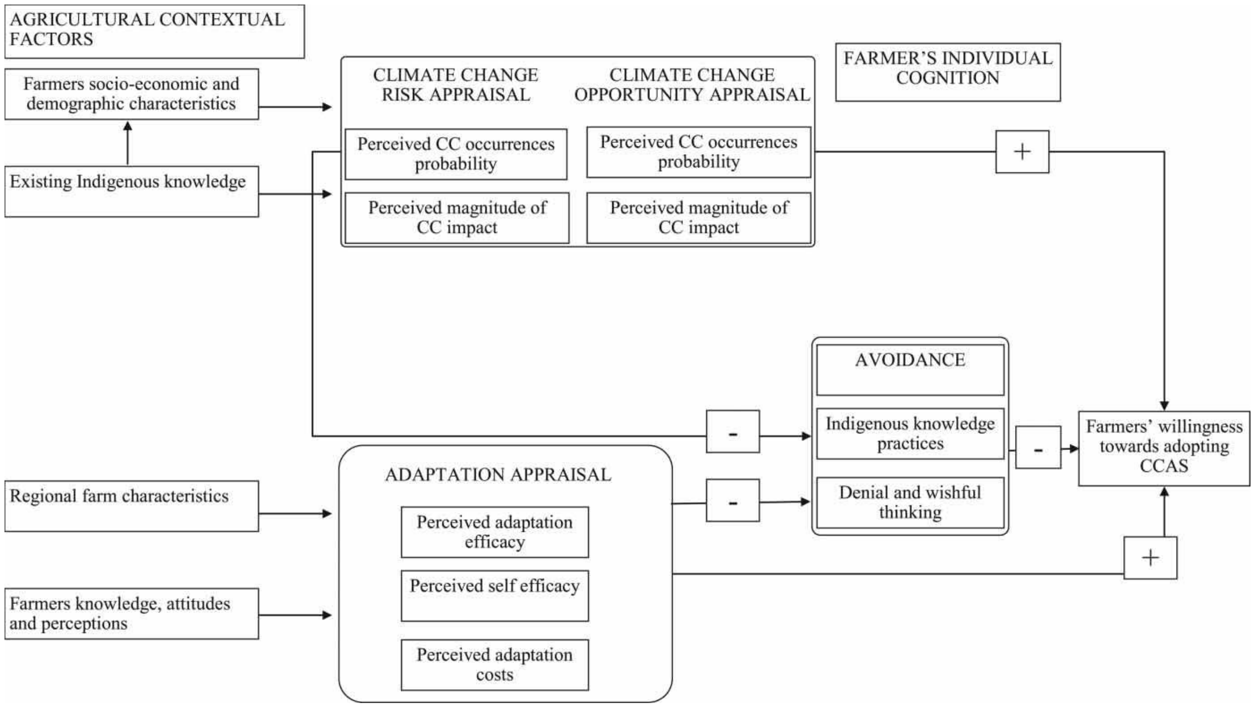

Figure 2.4: Model of Private Proactive Adaptation to Climate Change (Source: Grothmann, 2005)

The agricultural contextual factors which consist of farmers' socio-economic, demographic and regional farm characteristics, existing indigenous knowledge as well as the farmer's knowledge, attitudes and perceptions all play a part in their climate change risks, opportunities and adaptation appraisals. The key components that were examined to assess the likelihood of the farmers to adapt to CCAS included their perceived adaptation efficacy, perceived self-efficacy, and perceived cost efficacy (Grothmann & Patt, 2005; Hailegiorgis *et al*., 2018).

Socio-demographic and economic characteristics such as age, sex, household size, level of education, poverty indices and sources of income were considered as key in determining the perceived adaptation efficacy - a farmer's evaluated effectiveness of his/her adaptation measures to avert climate change risks. In regard to perceived self-efficacy, the farmer's ability to effectively carry out climate change impact responses were assessed using this model by estimating their level of experiences in handling such interventions in the past through the process of learning. It is here that the learned IK over a period of time played a role in the farmers' way of responding to CC effects in Kajiado County. Since this model is so explicit in distinguishing between intention and actual behavioral adaptation, this study adopted it so as to bring out clearly the predictor variables that influence the willingness of the farmers in Kajiado County to adopt the CCAS.

2.6.5 Conceptual Framework Model

In this section the researcher articulated his understanding of the key variables in this study in view of the phenomenon under investigation. It is therefore a representation of the roadmap on how the study was be implemented. The model illustrates the relationship between variables in that the changes in independent variables moderate the dependent variables.

Based on the research title of this study, the dependent variable is the uptake of the climate change adaptation strategies among farmers, while the independent variable is the indigenous knowledge practice parameters within which farmers in Kajiado County carry out their agricultural activities. The IK practice variables were the ones that were observed to determine their effect on the uptake of CCAS. The dependent variables demonstrate the indicators that are a consequence of the positive behaviour change by farmers, hence their willingness to uptake conventional climate change adaptation technologies. Figure 2.5 is the conceptual framework model that illustrated how the variables identified in this study related with each other

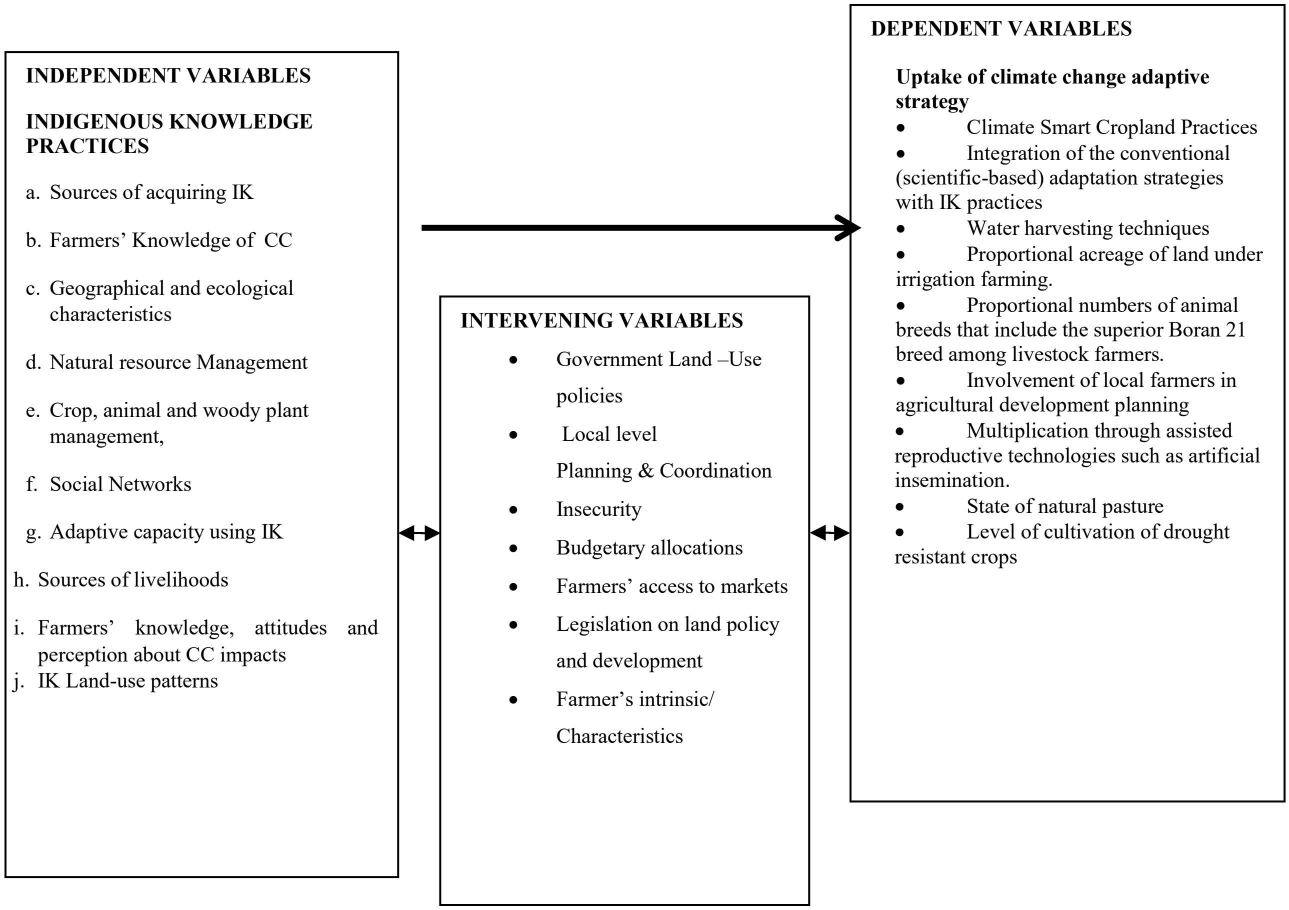

Figure 2.5: Conceptual Framework Model (Source: Author, 2021)

The independent variables explain the characteristics of the farmer based on their IK, that are likely able to influence the decision-making process towards adopting of new farming technologies. For instance, in reference to the theoretical models that guided this study, the social environment in which a farmer operates in terms of networks is likely going to influence his/her decision if group perception favors behaviour change.

It was envisaged that when the change agents produce and present credible messages that focus on socially and culturally acceptable norms, the uptake of these strategies would be ensured as indicated by increased acreage of land under irrigation farming, increased number of animal breeds that include the superior Boran 21 breed among other indicators of uptake of climate change adaptive strategies. Studies show that the behavior change is achieavable in a process that takes time while engaging the target populations with persuasive information that demonstrate benefits (Doran *et al*., 2022; Dwyer *et al.,* 2007).

As shown in this model, a variable such as selection and training of extension agents depended on a participatory local level coordination structure to ensure that the right individuals that will be trusted and accepted by community farmers are enlisted. Similarly, in the context of addressing issues of climate change on agricultural productivity in Kajiado County, factors such as appreciating and acknowledging the role of agriculture or farming styles of the local farmers as undertaken under IK practices as well as targeting collective responses from them (farmers) by the change agents induced positive attitude concerning the recommended strategies.

Examining farmers in relation to their risk perception of the climate change related hazards was one of the key independent variables so as to understand the social construct of their (hazards) impacts within the Kajiado County communities. The level of understanding of these risks informed on how the community prioritized and managed them. This is important because, based on the types of livelihoods undertaken by members of the community, farmers would prioritize response to those climate risks that threaten their livelihoods (Ahmed *et al*., 2021; Granderson, 2014; Guo *et al*., 2022; Theodory, 2016).

Independent variable parameters that exist within the operational space of farming activities in Kajiado County and which are largely characterized by the indigenous knowledge systems have both worked and failed in building CC adaptive capacity. For instance, the sources of acquiring IK in adapting to CC have made the pastoralist farmers to easily be proficient on adaptation practices leading the community to be reasonably resilient. However, the IK including the knowledge about CC, natural resource managementas well as crop/plant and animal management becomes so entrenched in a skewed/biased manner among the members of the community to the danger of exclusion of other knowledge systems that can equally be helpful in adapting to CC phenomenon.

Variables such as social networks and sources of livelihoods have created adaptive capacity in terms of ensuring the passing on of critical information of both mitigation and preparedness in the face of CC related hazards. This is because IK is passed on from one generation to another among close social acquintances, ensuring trust and compliance in the knowledge disseminated in addition to carrying on of those farming activities that can only be supported by the prevailing geo-ecological conditions. However, practices such as nomadism has increasingly encounter challenges because of the changing land tenure policies and the shrinking of the large tracks of land that support this type of livestock farming.

On the other hand, the dependent variables are scientifically tested and may apply among a wide variety of farming communities that are faced with CC phenomenon. These approaches are however considered prescriptive and often not developed in a participatory environment. In a space where IK is more entrenched among farmers, the study sought to determine if the uptake of the scientifically developed strategies was negatively influenced.

There are however, some factors on which the independent variables depend for them to significantly cause a change in the dependent variables. These are called intervening variables. In other words, the intervening variables affect the dependent variables while they are affected by the independent variables. For instance, in this study, the indigenous knowledge practices by the farmers as an independent variable may determine the type of land use patterns – an intervening variable. The land use pattern may in turn determine the acreage of land under irrigation farming which is the dependent variable.

2.7 Philosophical Stance

This section covered the study paradigm that was chosen by the researcher and the justification for the research methodology. These were standpoints that influenced the way in which the researcher thought about the research process in his/her quest of creating knowledge in answering research question or solving a problem (Zefeiti and Mohamad, 2015).

2.7.1 Methodological approach

Having adopted the pragmatist philosophical stance, this study opted not to focus on the two extremes of methodological study approaches; the quantitative or qualitative research. Rather, a consideration of using both approaches depending on the subjectivity and objectivity aspects of matters under investigation sufficed. In an analytical view of the Saunders' research onion, the most appropriate methodological approach for this research was found to be the mixed method (Saunders, 2009). The intrinsic factors such as knowledge, attitudes and perceptions of the farmers as well as the extrinsic matters like the packaging and information dissemination methods can be quite complex, and may be at the center of the slow uptake of the climate change adaptation strategies in Kajiado County. This phenomenon therefore generates research questions for interrogation empirically (Kivunja and Kuyini, 2017; Saunders, 2009).

Johnson *et al*. (2007) opines that mixed method research approach is an amalgamation of ideas from both qualitative and quantitative research. It supports the idea of triangulation, applying "multiple operationalism, in which several techniques are utilized as part of a validation process that ensures that the explained variance is the result of the underlying phenomenon or trait and not of the method (e.g., quantitative or qualitative)". Similar research findings from more than one method (Drost, 2011) in this study enhanced and strengthened the content validity of the research methodology that was applied.

For instance, while Knowledge, Attitude and Perception (KAP) survey was used to collect quantitative data from respondents, a Key Informant Interviews (KII) was used to obtain subjective views from experts or authorities concerning the prevailing social phenomena or problem. The results from both methods mirrored each other, in which case then, the content validity was ensured. On the foregoing therefore, descriptive survey, key informant interviews and focus group discussions were strategies that were used in data collection. This methodology ensured that data collected brought out real picture of the social phenomena.

2.8 Chapter Summary of Knowledge Gaps

In spite of what is viewed by the local farmers as convenient basis on why they depend on indigenous knowledge practices rather than modern technologies in managing effects of climate variability, persistent decrease in agricultural productivity as a result of drought emergencies continued unabated (CIAT, 2018; Chepkoech *et al*., 2018; Nunow *et al*., 2019; Ombogo, 2013). As argued by Meijer *et al*. (2015), many communities that depend on agriculture as a source of livelihood have over the years learned traditional means of combating effects of climate variabilities and hence more often are reluctant to adapt to new technology. However a nexus between the adoption of new farming technologies by local farmers on one hand and the nature of IK practices in terms of their geographical and socio-demographic cultural characteristics on the other, is manifestly lacking among the studies analyzed herein.

In spite of the importance of farmers' perceptions in the implementation of climate change adaptation practices, considering all relevant literature review only a few studies have applied the theory to climate change adaptation (Jellason *et al*., 2019; Lin, 2013; Masud *et al*. 2016), with almost no application in the context of Kenya and in particular, Kajiado County. Additionally, relevant literature that was reviewed showed that IK practiced by local farmers in relation to their socio-demographic profiles as well as the peoples' knowledge attitudes and perceptions slowed their uptake of new farming technologies (Dhanush *et al*, 2014; Meijer *et al*., 2015; Nyale *et al*., 2019). However, theirs were generalized views, a justification to carry out an empirical study to ascertain which specific IK dimensions had significant effect on the uptake of these technologies. Moreover, the adverse effects of climate change on the farmers' livelihood present a different viewpoint on which farmers could base their adoption decision-making in regard to CCAS.

Most of the literature reviewed, especially based on the Intergovernmental Panel on Climate Change forums have suggested CCAS that can be implemented especially in poor countries that are unequally but also more severely affected by the effects of climate change (IPCC, 2020). However, a follow-up system to oversee these implementation programs are not very clear, a gap that this study sought to ascertain if such mechanisms exist and if they are effective. Programs that are aimed at decreasing greenhouse gases in manufacturing and agricultural activities as well as conservation initiatives that limit destruction of forests are mitigation measures towards achieving this objective (Ozor and Nnaji, 2011). However, there is no documented evidence in Kajiado County how indigenous knowledge conservation strategies have been enlisted to complement these largely conventional science-oriented efforts.

Therefore, the most holistic approach in enhancing the uptake of climate change adaptation strategies especially among subsistence farming communities, requires efforts to be directed at improving the determinants of behavioral intentions; an area that has not been well researched in Africa and more specifically in Kenya. This kind of focus particularly on the poorly perceiving groups in hardest hit ASAL areas of Kenya such as Kajiado County could lead to better decisions to adapt to climate change and provide more targeted extension support in the future. (Jellason *et al*., 2019). The approaches towards implementing impact-led adaptation programs within communities are geared towards moderating the adverse effects of climate change. These efforts are hazard-focused rather than vulnerability focused (Theodory, 2016). Finally, the available literature indicates that for adaptation efforts to be sustainable and effective, the process of developing and designing them must be based on scientific evidence, participatory, gender-driven and as integrative as possible. The study will therefore examine the existing strategies to determine whether they meet these crucial criteria.

There is also a point of departure when integrating the two mechanisms: indigenous knowledge practices and the more scientific climate change adaptive strategies thereby slowing the uptake of the latter. A clear framework within which such integration can be processed in a participatory manner (Mercer *et al*., 2010) seems to be lacking according to the available literature.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter illustrates the framework within which this study was conducted. In this respect therefore, the chapter presents the research designs, outlining how both primary and secondary data were obtained, processed, analyzed and presented. The chapter illustrates the rationale behind the choice of the study location as well as other significant methodological issues of reliability and validity, assumptions, limitations and ethical considerations.

3.2 Study Area

This study was conducted within Kajiado County which is among the 47 Counties in Kenya. The County is located between Longitudes 36^0 5’ and 37^0 5’ East and between Latitudes 1^0 0’ and 3^0 0’ South, covering an approximated area of 21,900.9 square kilometers. Demarcated according to the 2019 Kenya population census administration units, Kajiado County consists of 6 sub-counties namely; Kajiado Central, Kajiado West, Kajiado North, Loitokitok, Isinya and Mashuuru (GOK, 2019). Bordering the Capital City of Kenya, Nairobi on the north, the County also neighbors Machakos, Makueni, Narok, Taita Taveta and Kiambu Counties. The County’s physical features are characterized by beautiful plains, valleys, volcanic hills, scarce vegetation in low altitude areas which increases with altitude and rain. The rainfall pattern in the county is erratic and the rains are infrequent, causing dry spells which subject the inhabitants and their livestock to water scarcity. Kajiado County is located in the southern part of Kenya as shown in Figure 3.1 overleaf.

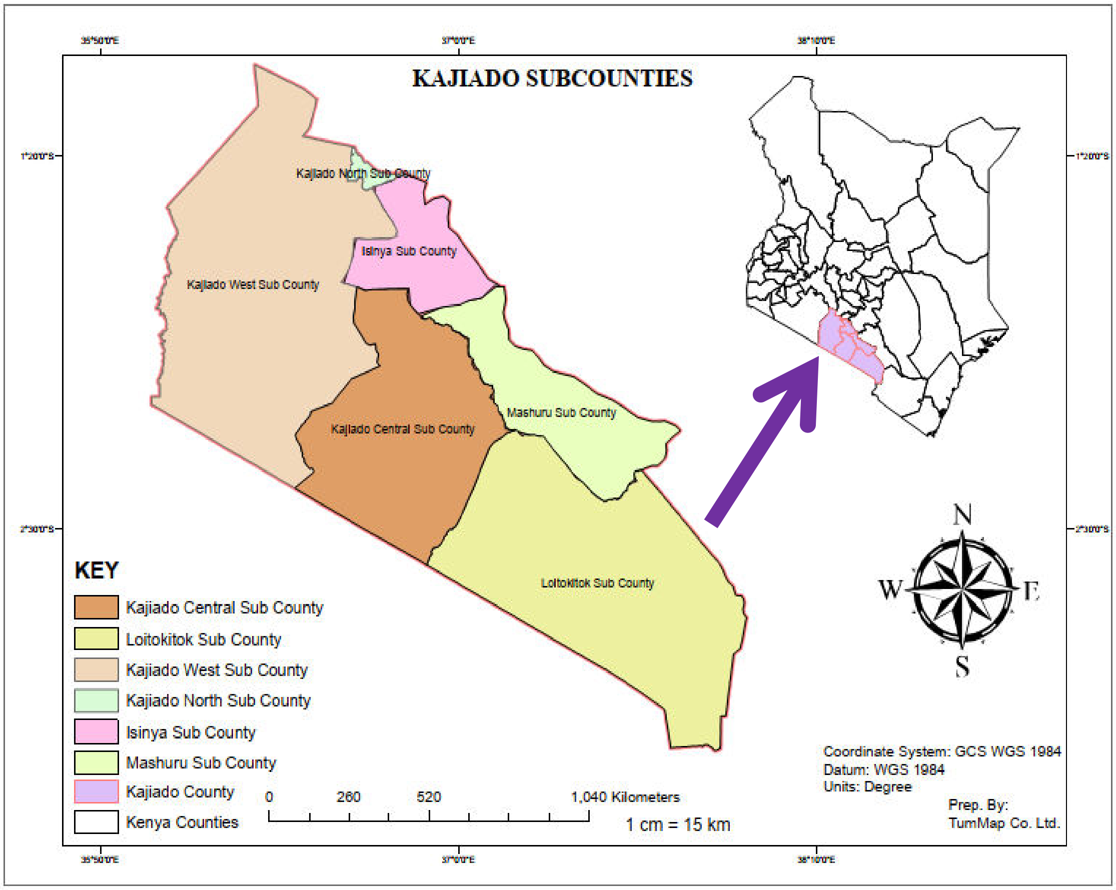

Figure 3. 1: Location of Kajiado County Showing the Study Sites (Source: Researcher, 2022)

Agricultural activities that mainly include horticulture, food crop farming, livestock production, dairy, beef production, hides and skins and poultry farming are the main exploits for livelihoods, economic growth and development. Having a forest cover of approximately 6,866.88 HA, conservation activities are common with people being encouraged to engage in tree farming (County Government of Kajiado, 2019).

The Kajiado agriculture profile that was prepared by the International Center for Tropical Agriculture (CIAT) shows that its agriculture sector has encountered persistent climatic challenges, especially, drought (CIAT, 2018). This has led to massive crop failure and livestock losses and has subsequently occasioned severe food shortages for years. For instance, CIAT (2018) reports that in 2009 "crop failure in the county reported was at more than 90%, while livestock losses were in excess of 70% in most areas within the county". A case in point in Kenya, the Research-based bodies such as Kenya Meteorological Department (KMD), National Drought Management Authority (NDMA) and the Ministry of Agriculture and Livestock and Fisheries (MoALF) have findings that are key in establishing climate change challenges to agricultural production in Kajiado County (CIAT, 2018).

The choice of Kajiado County was informed by the fact that it is located within the ASAL region. Ecological conditions of these areas are rife with dwindling crop yields and increasing livestock deaths courtesy of climate change phenomenon (CIAT, 2018; FEWS NET, 2019). The IPCC sixth assessment report with insights for African countries cites such regions to bear the heaviest brunt of climate change with characteristic increases in temperature levels and diminishing amounts of precipitation (Trisos *et al*., 2021). Majority farmers in Kajiado County are pastoralists who have practiced nomadism, a livestock farming that thrives under traditional tenets of indigenous knowledge. Such IK practices are so entrenched among local farmers because they define how management of natural resources particularly land is done; to the extent that any efforts of introducing foreign practices triggering conflicts in the past (Karamesouti *et al*., 2018).

This study was therefore focused on investigating aspects of existing indigenous knowledge practices among Kajiado County farmers being used to mitigate effects of climate change in terms of how they influence the uptake of other contemporary or modern agricultural technologies. In spite of what is viewed by the local farmers as convenient basis on why they depend on indigenous knowledge practices rather than modern technologies in managing effects of climate variability, persistent decrease in agricultural productivity as a result of drought emergencies continue unabated (CIAT, 2018; Chepkoech *et al*., 2018; Nunow *et al*., 2019; Ombogo, 2013). The above facts therefore formed the rationale of choosing Kajiado County as the study area for this research.

3.3: Research Design

This is a plan or a framework that illustrates the procedure on how credible data were collected for purposes of ensuring that the research questions are answered as accurately as possible. As Durrheim (2004) posits, a research design is a strategic basis on which the study is actualized and hence offers a connection between the research questions and the implementation of the exercise. This study adopted a mixed methods research approach in which both qualitative and quantitative methods were used, highlighting and examining the subjectivity and objectivity aspects of matters under investigation. This research method allowed the researchers to manipulate multiple designs in a single study in the quest of addressing the research problem (Creswell, 2012). The study therefore adopted a correlation, descriptive, cross-sectional survey and evaluation research designs in line with their relevance to the research specific objectives as summarized in Table 3.2 below.

. Table 3. 1: Summary of Research Designs as per Research Objectives

Objective	Variables/ Measurable indicators	Research Design
Assess the determinants of farmers' indigenous knowledge practices influencing the uptake of climate change adaptation strategies in Kajiado County, Kenya.	▪ Existence of socio-demographic characteristics that determine IK practices ▪ Existent geographical and socio-cultural characteristics of the IK ▪ Awareness of climate change impacts on agricultural productivity ▪ Existence of indigenous knowledge practices for mitigating adverse climate change effects	Descriptive, Cross-sectional, Correlation dsigns
Determine the effect of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya.	▪ Awareness of climate change adaptation strategies; farmer's familiarity with the adaptation practices, Farmer's Knowledge of risks. ▪ Increase/decrease in agricultural production ▪ Personal responsibility/self-efficacy in applying new adaptive strategies	Descriptive, cross-sectional Correlational design
Evaluate the effectiveness of existing climate change adaptation agricultural technologies on sustainable agriculture in Kajiado county, Kenya.	▪ Existing socioeconomic characteristics. ▪ Existence of social network	Correlational design
Examine the strategies for enhancing the integration of indigenous knowledge practices and the conventional agricultural technologies employed in Kajiado County, Kenya.	▪ Existence of climate change adaptation agricultural technology service providers and their services. ▪ Existence of institutional and technological barriers ▪ Inclusion of IK practices in conventional climate change adaptation strategies ▪ Involvement of local farmers in agricultural development planning ▪ Communication barriers	Correlational and Evaluation designs

(Source: Researcher, 2019)

The mixed method approach also according to Johnson *et al*. (2007) supports the idea of triangulation; applying "multiple operationalism, in which several techniques are utilized as part of a validation process that ensures that the explained variance is the result of the underlying phenomenon or trait and not of the method (e.g., quantitative or qualitative)". Similar research findings from more than one method enhance and strengthen the content validity of the research methodology applied (Dawadi *et al*., 2021; Drost, 2011).

3.4: Study population

According to the just concluded 2019 Kenya Population and Housing Census: Volume I report, total population of the Kajiado County stands at 1,107,296 with estimated 316,179 households and an approximate 3.5 average number of people per household. Covering an area of 21,871.1 Km^2 with a population density of 51, Kajiado County is considered largely sparsely populated except for the urban centers (GOK, 2019). Table 3.1 indicates the average number of people per household.

Table 3. 2: Population, Number of Households and Average Household Size by Sub-County in Kajiado County

Study population units/ Sub counties	Population	No. of Households	Average Household size
Kajiado	**1,107, 296**	**316,179**	**3.5**
Kajiado North	304,404	101,378	3.0
Kajiado Central	159,520	37,238	4.3
Loitokitok	190,174	47,058	4.0
Kajiado West	181,622	42,774	4.2
Isinya	207,715	71,579	2.9
Mashuuru	63,861	16,152	4.0

(Source: Kenya National Bureau of Statistics, KNBS, 2019)

The population distribution in Kajiado County is summarized in Table 3.1 above showing both population and household's sizes per sub-county as per the latest 2019 Kenya Population and Housing Census (GOK, 2019).

3.5 Sampling strategy

The study focused on collecting responses from the representatives of households as principal respondents. The selection criteria were based on the household's major occupation or livelihood activity being farming (crop, livestock or both). The primary sampling units were sub-counties, sub-locations or villages in a multi-stage sampling process, as per the 2019 national census data. In stage 1, three sub-counties were purposively sampled namely Kajiado West, Kajiado Central and Loitokitok Sub-counties as shown in Table 3.3.

The determination of the sample sizes in each sub-location was arrived at through proportionate sampling. The choice of Loitokitok is informed by the fact that it is the region with much of the crop farming that is rain-fed. On the other hand, Kajiado West is largely arid and semi-arid with pastoralism being the major livelihood activity. Kajiado Central has a bit of crop farming but extensively inhabited by pastoralists who live in large semi-arid areas that constitute the sub-county (County Government of Kajiado, 2019).

From the published statistics , the three sampled Kajiado Sub-Counties had an estimated 127,070 total number of households in 2019 (KNBS, 2019) as shown in Table 3.3. This is indicative that the sampling frame has a population of more than 100,000. Therefore, the researcher used the Cochran's (1977) formula for purposes of arriving at an appropriate sample size for continuous and categorical variables. The anticipated response rate in this study was pegged at 75%, hence the calculation to determine the sample size was:

$$n^{\circ} = \frac{Z^2 pq}{e^2}$$

Where; n^0 = the anticipated sample size from a population that is more than 100,000

Z = Value for alpha level of .025 in each tail (i.e. 1.96)

p = (estimated) proportion of the population which has the attribute in question (estimate of variance)

e = the desired level of precision (i.e. the margin of error).

Considering that the researcher will use a confidence level of 95% with a sampling error of 5%, the desired sample size for the households is;

$$\frac{(1.96)^2 * (0.5) * (0.5)}{(0.05)^2} = 384$$

The second phase involved determining 6 study locations which were the sub-location administration units from a total of 92 sub-locations in the three purposively sampled sub-counties. These sub-locations comprised of 41 in Kajiado West, 36 in Kajiado Central and 15 in Loitokitok. Due to the expansiveness, remoteness and distances between households, the subcounties had to be further sub-devided purposively with help of local authorities (as indicated in the limitations sections). Thirdly, these sub-counties were then sub-divided into two areas: the northern and the southern regions.

The subdivision was done by determining that the the two regions ended up with approximately same number of households and not the numbers of sub-locations. For Kajiado West, random sampling was done to choose one Sub-location from among the 17 sub-locations in the North and another one from the 24 Sub-locations from the Southern part of the Sub-county. Kipeto and Emukutan sub-locations from the north and south respectively were then randomly picked. Oloyiankalani and Olepolos were picked from the 22 sub-locations in the north and 14 sub-locations from the south respectively. For Loitokitok, Imbirikani in the north and Kimana Sub-locations in the south were picked from a group of 7 and 8 sub-locations respectively. As shown in Table 3.3, the sample size for each sub-location was determined by its proportionate number of households to the total number of households in the three sampled sub-counties. This was then multiplied by the sample size figure of 384.

Table 3.3: Sample Sizes per Sub-location

Sub-County	No. of S.C. households	Sub-Locations	No. of S.L. HH	Sample
Kajiado West	**42,774**	Emukutan	7,294	66
		Kipeto	4,973	45
Kajiado Central	**37,238**	Olepolos	6,853	62
		Oloyiankalani/Ilsilale	7,626	69
Loitokitok	**47,058**	Imbirikani	7,516	68
		Kimana	8,179	74
Totals	**127,070**		**42,441**	**384**

(Source: Researcher, 2019)

The exercise was completed with 382 respondents participating as Kipeto returned 44 and Kimana 73, the figure representing a response rate of 99.5%. This particular figure is the one that has been used in the calculations done within the findings.

Representatives of key stakeholders in the sector of food security, climate change, meteorology, livelihoods and agriculture were also purposively sampled to obtain the key data. Key informant in-depth interviews were conducted on purposively selected representatives of relevant national and county government ministries including the Ministry of Environment and Mineral Resources, National Drought Management Authority (NDMA), Water Resources Management Authority (WARMA) and the Ministry of Agriculture and Livestock and Fisheries (MoALF).

Local administrators including chiefs and assistant chiefs, non-governmental organizations, government and private research institutions such as Kenya Agricultural & Livestock Research Organization (KALRO), Kenya Meteorological Department (KMD), Kenya Forestry Research Institute (KEFRI) and Famine Early Warning Systems Network (FEWSNET) were also interviewed. In some instances, the snowball sampling technique was employed in cases where more information was required.

The study also conducted 3 (three) Focus Group Discussion forums involving specific homogenous groups in the community from which qualitative data was obtained. The groups were the village elders, the women and the youths (both male and female). Table 3.4 overleaf, illustrates the sampling methods that were used to determine the sample sizes in terms of number of households for each purposively sampled sub-counties. The *n* number in the analysis was 382 because two questionnaires could not be administered. The sample size for each sub-county was determined by the proportional number households in that sub-county in relation to the total number of households in the three sub-counties.

Table 3. 4 : Summary of Sampling Methods and sample size for the Study population

Sub counties	Sampling method.	No. of Households (KNBS)	Sample Size
Kajiado West	Multi-stage Random, Simple random and Proportionate	42,774	110
Kajiado Central	Multi-stage Random, Simple random and Proportionate	37, 238	131
Loitokitok	Multi-stage Random, Simple random and Proportionate	47,058	141
TOTALS		**127,070**	**382**

(Source: Researcher, 2019)

3.6 Data Collection

The determination of data collection instruments illustrated the data types that were utilized in this study. Both quantitative and qualitative data were required for purposes of obtaining the desired information in Kajiado County. As discussed below under validity and reliability of data collection instruments, the semi-structured questionnaire was a key tool that was used among the households' representatives. The other instruments were key-informant interview guides, Focus Group Discussion guides and observation checklists.

3.6.1 Questionnaires

As indicated in the conceptual framework model, this tool was used to gather data concerning the farmers' socio-cultural and economic characteristics, sources of livelihoods, knowledge and practice of conventional climate change adaptation strategies, climate change risk perceptions and their existing indigenous knowledge practices in response to climate change. The data collection exercise was done using the locally recruited research assistants who had good command of local dialects, and were able to translate accurately the questions to respondents who could not understand English. They subsequently recorded the responses in English in the questionnaires. The questionnaire was designed with a section that would be used to capture attitudinal responses indicative on a 5-point Likert scale from strongly agree to strongly disagree (see Appendix I).

3.6.2 Key informant interview

There were two categories of interview guides that were used in collecting data from the purposively selected informants as summarized in Table 3.5 overleaf. The first category was meant for collecting data from local leaders, village elders and religious leaders in the community. This guide was also used to form the agenda of formal interactions during focus group discussions (Appendix II).

The second category was for purposes of capturing technical aspects and policy related issues that touch on perceptions on climate change, existing vulnerability- and impact-led climate change adaptation strategies, indigenous knowledge and practices on climate change adaptation, challenges of uptake of conventional climate change adaptation strategies among local farmers, challenges of indigenous knowledge in climate change adaptation and challenges of integrating indigenous knowledge into the existing conventional climate change adaptation strategies (Appendix III).

Table 3. 5 : Summary of Key Informants

SECTOR	Departments	Sampling frame	Sample size	Details of KII	Selected
Agriculture	Livestock & veterinary, Fisheries & Aquaculture, Agriculture,KALRO, Irrigation, Kenya Climate Smart Agriculture Project(KCSAP), Agricultural Sector Development Support Program II (ASDS P II)	58	9	Agricultural extension officers	3
				KALRO	1
				Livestock	1
				KCSAP	2*
				Fisheries	1
				ASDSP	1*
Water, Environment, Natural Resources and Climate change	Forestry, Wildlife and Tourism, Kenya Meteorological Department, Climate Change, Water Resources Management	51	6	Wildlife	1
				Forestry	1
				K-SEED Project	1*
				Climate Change Unit (CCU)	1*
				Officer in-charge; County Climate Change Action Plan (CCAP)	1*
				Kenya Meteorological Department	1
Provincial administration	County Commissioners Office(CCO), Chiefs/sub-chiefs	96	4	Officer in CCO	1
				Emukutan	1
				Isilale	1
				Imbirikani	1
NGOs Running CC related Humanitarian Programs	Kenya Red cross Society (community development, disaster preparedness, and water and sanitation)			"Sowing Change"	1
	Action Aid International			Local Rights Program (LRP)	1
	World Vision International			Water, Sanitation, and Hygiene (WASH)	1

*Sampled using Snowball technique

(Source: Researcher, 2020)

3.6.3 Focus Group Discussions

The main aim of Focus group discussion was to obtain an in-depth understanding of socio-cultural issues that characterize a community concerning how the members handle problems. It therefore focused on capturing qualitative data. As Berkes (2004) avers, there is a connection linking people's perceptions and attitudes to their socio-cultural situation in such a manner that it influenced decision making about the surrounding natural resources "since most people derive their notions, mental constructions and interpretations from their immediate surrounding and develop these from experiential knowledge".

This tool was therefore used by means of bringing together individuals that shared unique social characteristics and under an environment in which the group members had utmost liberty to give their views on the phenomenon under examination. Each group consisted of 8 members and sitting arrangements were deliberately circular with all members given equal chance to contribute.

The interviewers who were mainly the selected research assistants; but in the presence of the main researcher, they took notes of the omissions that were occasioned from the other data collection instruments and from other discussant groups. The discussant groups were clustered under, youths, women, selected small scale farmers and pastoralists (mainly elders).

3.6.4 Observation and Photography Checklist

The study also employed the use observation on farming activities so as to collect information in purposively selected sites in Kajiado County concerning climate change adaptation practices based on the specific diverse study themes. The study particularly focused on activities in specific consideration of existing ecological zones, noting and documenting prevailing livelihood activities as well as taking photographs for ease of reference.

Therefore, for primary data collection exercise, Table 3.5 summarizes the study population units including sampling methods, sample sizes and data collection instruments. It is important to note that although the calculated sample size was 384, the returned responses were 382 as indicated in the table. All the three FGDs that were conducted; two in Kajiado West and one in Loitokitok Sub-counties, comprised of 8 participants. In Loitokitok the FGD was made up of the women farmers while the two in Kajiado West had village elders/leaders and youths participants respectively.

Table 3. 6: Summary of population units, sampling methods, sample sizes and data collection instruments.

Study Population Units	Sampling method.	Sample Size	Data Collection Instrument	Appendix Number
Household heads	Multi-stage Random, Simple random and Proportionate	**382**	Household Questionnaires	**1**
Government department representatives	Purposive, Convenient and snowballing	15	Key informant interview guide	III
Non-State/Governmental actors	Purposive	4	Key informant interview guide	**III**
Focus Group Discussions	Quota	8	FGD Guide	IV
Observation checklist	Purposive	3 sites/sub-counties	Visual Observation checklist and photography	VI

(Source: Researcher, 2019)

3.6.5: Secondary Data

A search in research journals, academic articles, research websites and books for relevant data was comprehensively conducted with the aim of identification of gaps that informed the research problem herein stated. Secondary data were also used for extrapolation and triangulation of results.

3.7 Data Analysis and Presentation Techniques

Table 3.6 below summarizes the methods that were used for data analysis as per each specific objective.

Table 3. 7: Summary of Methods of Data Analysis as per Specific Objectives

Objective	Variables/ Measurable indicators	Research Design	Methods of Data Analysis
Assess the determinants of farmers' indigenous knowledge practices influencing the uptake of climate change adaptation strategies in Kajiado County, Kenya..	▪ Farmers' socio-demographic and economic characteristics ▪ Geographic and ecological factors ▪ Awareness of climate change adaptation strategies; farmer's familiarity with the adaptation practices, Farmer's Knowledge of risks. ▪ Management of natural resources, livestock and crops ▪ Existing IK oriented CC response mechanisms (nomadism, other IK practices) ▪ Levels of CCAS implemented (irrigation, new breeds of cattle, AI, pastures, Water resource management)	Descriptive Correlational and Cross-sectional designs	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation and Chi-square
Determine the effect of farmers' indigenous knowledge practices on the uptake of climate change adaptation strategies in Kajiado County, Kenya.	▪ Awareness of climate change impacts on agricultural productivity ▪ Existence of indigenous knowledge practices for mitigating adverse climate change effects	Descriptive, cross-sectional Correlational design	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation and Chi-square
Evaluate the effectiveness of existing climate change adaptation agricultural technologies on sustainable agriculture in Kajiado county, Kenya.	• Farmers' level of CCAS awareness, • farmers' perceptions and attitudes on CCAS, • local CC adaptive capacity	Correlational design	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation and Chi-square
Examine the strategies for enhancing the integration of indigenous knowledge practices and the conventional agricultural technologies employed in Kajiado County, Kenya.	▪ Existence of climate change adaptation agricultural technology service providers and their services. ▪ Existence of institutional and technological barriers • Communication barriers	Correlational and Evaluation designs.	Descriptive statistical analysis, Qualitative analysis, Likert scale, Spearman rank order correlation and Chi-square

(Source: Author, 2019)

This study mainly queried the uptake of climate change adaptation strategies by local farmers as being influenced by indigenous knowledge practices, the latter being the independent variable and the former, the dependent variable. Both quantitative and the qualitative data collected were coded and classified according to themes and posted into the Statistical Package for Social Sciences (SPSS) software version 20 for purposes of interpretation and analyses. Accordingly, descriptive statistical analyses were conducted focusing on bivariate relationships using frequencies, percentages, modes, means, median, variances and standard deviation. For purposes of generalizing results and confirming significance of relationships between variables, inferential statistical analyses were carried out using chi-square tests and Spearman rank order correlation.

3.8 Validity and Reliability of the Research Instruments

3.8.1 Validity

This researcher appreciates the importance of ensuring the validity of data collection instruments based on the fact that the research findings were meant to reflect true knowledge created about the phenomena that were under investigation in addition to confirming that the results are only attributable to the independent variable and not any other factors (Kivunja and Kuyini, 2017). Towards achieving this, the items that needed responses in questionnaires and interview guides as well as observation checklists were aligned to the specific objectives. This is what is referred to as internal validity and which was very key in this study for empirically demonstrating that adherence to indigenous knowledge practice influences the level of uptake of the conventional climate change adaptation strategies.

An attempt was coherently made to address the influence of the intervening variables during the interpretation of the results. Secondly, determination of the sample size was carefully calculated so as to eliminate any possibility of sampling inadequacy. Thirdly, upon designing of the instruments, expert advice especially from the supervisors was sought for scrutiny and confirmation that the instruments were able to measure what they were intended to measure.

3.8.2 Reliability

This researcher considered a methodology that was utilized in similar studies that revealed consistency or repeatability of measurement (Kirk & Miller, 1986; Mugenda and Mugenda, 1999). Using the instrument triangulation technique which compares results with previous similar studies, the researcher ensured that the reliability criterion was met. Since the survey questionnaire was broadly used as the main primary data collection instrument, several items within were subjected to a standard procedure of using the Cronbach's coefficient on the SPSS software to determine its reliability. On the scale of 0 to 1, an alpha (α) value of above 0.70 considered as an acceptable level of reliability (Taber, 2018).

The questionnaire was however pre-tested through a pilot survey to authenticate its validity and reliability in Narok County which has similar socio-cultural, climatic and ecological characteristics, but not among the selected areas for this study. The test and retest exercise was conducted 6 days apart using 38 questionnaires which were 10% of the total number of intended respondents in Ntulele and Sosian Sub-locations within the

Mosiro Ward of Narok East Sub-county. The households in these two sub-locations were randomly picked and data collected. This data was then analyzed using SPSS to establish the Pearson Correlation coefficients of most of the sections which posted $\alpha > 0.797$, a measure that confirmed that the questionnaire met test retest reliability that signified consistency as shown in Table 3.8 below.

Table 3. 8: Reliability Test Results from Pilot Survey

Group	Alpha (α) value
Socio-demographics characteristics	0.94
Economic Characteristics	0.79
Land and crop agricultural activities	0.86
Livestock agricultural activities	1
Knowledge about extreme weather	0.86
How information on IK is received	0.85
Sources of receiving weather extreme event information	0.87
Knowledge on CC	0.92
Knowledge about CCAS	1
Challenges of applying CCAS	0.83

This figure demonstrated the best fit through the data of variables that were intended to be collected for of objectives this study.

3.9 Ethical Considerations

This section deals with ethical issues that were considered while carrying out this study. These considerations were based on how the researcher views his own values and those of the research participants in terms of behavior, thereby making decision on what is right or wrong in the process of conducting a research (Finnis, 1980). This study was subjected to scrutiny for purposes of approval by the faculty and School of Graduate Studies of the Masinde Muliro University of Science and Technology. Subsequently, a permit was duly obtained from the National Council of Science and Technology (NACOSTI). Similarly, permits were secured from Kajiado County Government and the County commissioner as well as the county department of Education.

In addition, necessary consents were pursued in the course of obtaining of both secondary data by duly recognizing the sources through citations and primary data by ensuring that respondents' strict confidence were observed. The identities of the respondents were concealed and their willingness to participate was at their discretion without influence or coercion. The information that was collected from the participants was treated with utmost confidentiality. The objectivity of primary data collection was ensured with all the sensitivity put into consideration so as to avoid or minimize risk or harm, whether physical, psychological, legal, social, economic or other prejudices (ARC, 2018).

3.10 Limitations and Delimitations

i. Assigning accurate meanings to key terminologies and concepts on indigenous knowledge practices and climate change adaptation strategies proved to be a challenge in primary data collection exercise. This was addressed by recruiting members of community who had good command of English language and local dialects as research assistants.
ii. The county is quite expansive with some villages very remote and sparsely populated which hindered accessibility. The researcher involved the local

leadership in identifying the locations of households in a way that facilitated ease of access to the most deserving of the households ensuring accurate representation.

iii. Due to the expansiveness of the county, there were challenges in ensuring a wider coverage in data collection to allow for replicability of the study findings. In order to handle this challenge the researcher carefully sampled to cover most zones in the county.

iv. The data collected from the officers in the relevant ministries such as agriculture and environment had challenges of bias based on issues of conflict of interest emanating from defense of effectiveness of their work. This challenge was addressed on the basis of the assurance of anonymity to the respondents.

3.11 Assumptions

i. This researcher assumed that the sample randomly selected from representatives/heads of households doing farming in Kajiado County were sufficiently representative of the entire farming population in the county and that it reflects a homogenous tendency.

ii. It was anticipated that at least 75% response rate would be achieved. Approximately 99% response rate was realized.

iii. Further, it was also assumed that both the purposively selected key informants and accessible randomly selected participants gave honest and accurate responses without undue influence or coercion.

iv. It was assumed that the researcher would be able to access all key stakeholders that play key roles in the implementation of climate change adaptation strategies and that they would be willing to participate

CHAPTER FOUR

DETERMINANTS OF INDIGENOUS KNOWLEDGE PRACTICES INFLUENCING UPTAKE OF CLIMATE CHANGE ADAPTATION STRATEGIES AMONG HOUSEHOLDS IN KAJIADO COUNTY, KENYA

4.1: Introduction

This chapter presents study results from both the qualitative and quantitative data obtained from household questionnaires on specific objective one. The focus of discussions of the findings are on the nature of indigenous knowledge practices in terms of how they are adhered to depending on the farmers' socio-demographic characteristics such as age, sex, level of education size of the household, geographical locations, land ownership and type of livelihoods. The chapter also discusses the findings in regards to the farmers' understanding of climate change risks and their subsequent attitudes and perceptions on CCAS. The discussion also highlights key findings established through triangulation with results from secondary sources in relevant research published journals, key policy documents as well as primary data from FGDs, key informants and observations.

4.2: Households' Socio-demographic Characteristics and Uptake of CCAS

Results for households' socio-demographic characteristics summarized in Table 4.1 show that the majority of the respondents were drawn from Loitokitok Sub-county (141; 37%); while 232 of the respondents were males, approximating 61%. The household heads between ages 35-49 years were the majority age bracket category, totaling 132 (35%), while households with between 4-7 members constituted highest number of the respondents (198; 52%). A majority of the household heads interviewed, numbering 144 (38%) were illiterate, whereas 269 (70%) of the total number stated that they owned land. The collection of data and analysis of the socio-demographic characteristics of the farmers was informed by the supposition that these factors would determine how an individual perceived IK as an effective approach of CC adaptation and by extension influence their CCAS uptake. The study therefore sought, for instance, between farmers who were older and those who were younger, to establish who were more likely to adhere to practicing IK in their adaptation to CC effects than the other. Equally, it was imperative to know if this devide existed between the male and female farmers, those with bigger or smaller household sizes, those that were rich or poor, those that were educated or the illiterate and those that owned land versus those who did not.

Table 4.1: Summary of the Socio-demographic Characteristics of the Households Heads

Characteristics	Categories	Frequency	Percent
Sub County	Kajiado West	110	28.8
	Kajiado Central	131	34.3
	Loitokitok	141	36.9
Sex of the respondents	Males	232	60.7
	Females	150	39.3
Age group of the respondents	18-24	30	7.9
	25-34	66	17.3
	35-49	132	34.6
	50-64	114	29.8
	65-86	40	10.5
Household size	1-3	58	15.2
	4-7	198	51.8
	8-11	84	22.0
	Over 11	42	11.0
Education level of the respondents	Illiterate	144	37.7
	Adult education	15	3.9
	Primary education	86	22.5
	Secondary education	106	27.7
	College	31	8.1
Land ownership (Do you own land?)	Yes	269	70.4
	No	113	29.6

(Field data, 2020)

Discriptively therefore, the results from this study indicate as shown in Table 4.2 below that a demographic factor , such as the age would influence a farmers willingness to adapt or not to adapt to CCAS (CI = 99%, X2 = 20.866, $p < .01$). However, the findings revealed clearly that the level of education was the demographic factor with the most significant relationship with the farmers' CCAS uptake (CI = 99%, X2 = 72.177, $p < .01$). This meant that the level of education of a farmer most likely determined his willingness to adapt to CCAS.

Table 4.2: The relationship between Demographic information and level of uptake of modern agricultural practices index score

Farmer's Demographic characteristics	No uptake of modern agricultural practices (n=178)	Uptake of modern agricultural practices (n=204)	X^2	p-value
Sub County				
Kajiado West	14.1	14.7	3.914	0.141
Kajiado Central	13.6	20.7		
Loitokitok	18.8	18.1		
Sex of the respondents				
Male	28.8	31.9	0.158	0.691
Female	17.8	21.5		
Age group of the respondents				
18-24	6.0	1.8	20.866	0.000***
25-34	9.2	8.1		
35-49	11.8	22.8		
50-64	14.9	14.9		
65-86	4.7	5.8		
Household size				
1 – 3 members	9.2	6.0	10.1	0.018**
4 – 7 members	22.3	29.6		
8 -11 members	8.6	13.4		
11 and above	6.5	4.5		
Household farm in hectares recorded (n=269)				
Below 5 hectares	21.2	23.8	21.367	0.001***
5 - 9 hectares	1.9	7.1		
10 - 19 hectares	1.1	3.7		
20 - 49 hectares	4.1	9.3		
51 - 100 hectares	8.6	5.9		
Over 100 hectares	2.6	10.8		
Education level of the respondents				
Illiterate	25.4	12.3	72.177	0.000***
Adult education	2.6	1.3		
Primary education	11.3	11.3		

Secondary education	7.3	20.4
College plus	0.0	8.1

(Field data, 2020)

In the MPPAC model (Figure 2.3) that was used in this study, these socio-demographic and economic characteristics were the contextual factors that were able to predict adaptation intentions of farmers in Kajiado County. Interestingly, sex did not show a significant relation with the uptake of new agricultural technologies. However, as the findings further reveal in this study, the more rural and traditional Kajiado county farming communities have their decision-making processes influenced by these socio-demographic factors.

The socio-economic variables that were analysed all showed significant associations with the uptake of CCAS as shown in Table 4.3 below.

Table 4.3: Socio-economic Characteristics of a Farmer and their Uptake of CCAS.

Farmer's Socio-economic Characteristics	No uptake of modern agricultural practices (n=178)	Uptake of modern agricultural practices (n=204)	X^2	p-value
Household average monthly income				
<3,000	19.4	2.6	21.367	0.001***
3,000 - <10,000	14.9	14.4		
10,000 - <20,000	6.0	14.7		
20,000 - <30,000	4.2	8.1		
>30,000	2.1	13.6		
PPI				
Poorest	4.5	1.0	19.141	0.000***
Poor	18.6	17.8		
Medium	23.0	31.2		
High	0.5	3.4		
Land ownership (Do you own land?), yes	27.7	42.7	18.9	0.000***
Type of land ownership? (n=269)				
Private	19.7	46.1	27.078	0.000***
Communal	13.8	10.0		
Public	4.1	0.7		
Leased	1.9	3.7		

Livestock and agricultural products and produce	34.8	31.7	17.621	0.001***
Employment salary	2.1	8.6		
Remittances	2.1	4.5		
Other sources of income	7.6	8.6		

Field Data 2020

For instance, level of income (CI = 99%, $X^2 = 98.322$, $p < .01$) showed a very significant relationship with a farmer's uptake of CCAS. The other economic factors such as land ownership (CI = 99%, $X^2 = 18.9$, $p < .01$), type of livelihood activity /source of income (CI = 99%, X2 = 21.367, $p < .01$) also showed moderate significant associations with the uptake.

Socio-demographic profiles have been proved to considerably influence the uptake of new agricultural technologies by farmers that operate within traditional rural settings (Badu *et al*., 2018; Melesse, 2018; Sunny *et al.,* 2018). This section will therefore give an account of summary of respondents' socio-demographics as shown in Table 4.6 below as discussions cascade into how each socio-demographic characteristic as an independent variable, relates to the household perception concerning uptake of climate change adaptation strategies; summarized in Table 4:2.

Demographic characteristics such as sex, age bracket, education level, marital status and sources of livelihoods can significantly influence the decision-making aspects of response to climate change impacts, subsequently determining the nature of adaptation process (Burton, 2014; Hardaker *et al*., 2015; Maye *et al*., 2012). Although these studies tend to concur with the research findings on the role that these socio-demographic factors play towards adaptation of modern technologies, this study goes further to manifest an association between specific characteristics that are mainly unique to the Maasai community of the Kajiado County in Kenya in so far as CCAs are concerned.

One of the fairly recent studies that was conducted in a more urban agricultural setting in Bangladesh, came up with results showing some of these factors such as gender, land ownership and secondary income to be insignificant in regards to adoption of scientific technologies (Sunny *et al*. 2018). Nevertheless, the findings of this study shows a different view in that the stated three socio-demographic characteristics influence adoption decision-making tendencies as illustrated by inferential statistical analysis results shown in Table 4.2. Individual characteristics shall be separately discussed in the subsequent sections based on the descriptive information in graphs and statistical analysis test results in tables. The table illustrates the significance and direction of relationship of the individual socio-demographic characteristic and uptake of a particular CCAS.

4.3.1: Gender Distribution and Climate Change Adaptation Strategies.

The findings on gender indicate that this variable is a major factor in terms of household decision-making process on livelihood sources. Figure 4.1 is a graph illustrating gender distribution of the household heads that were interviewed, indicating that the majority were males at 60.7% while females were 39.3%. It's clear that male were majority of the respondents but the presence of over a third of female indicates that climate change adaptation strategies are not limited to specific gender in Kajiado County.

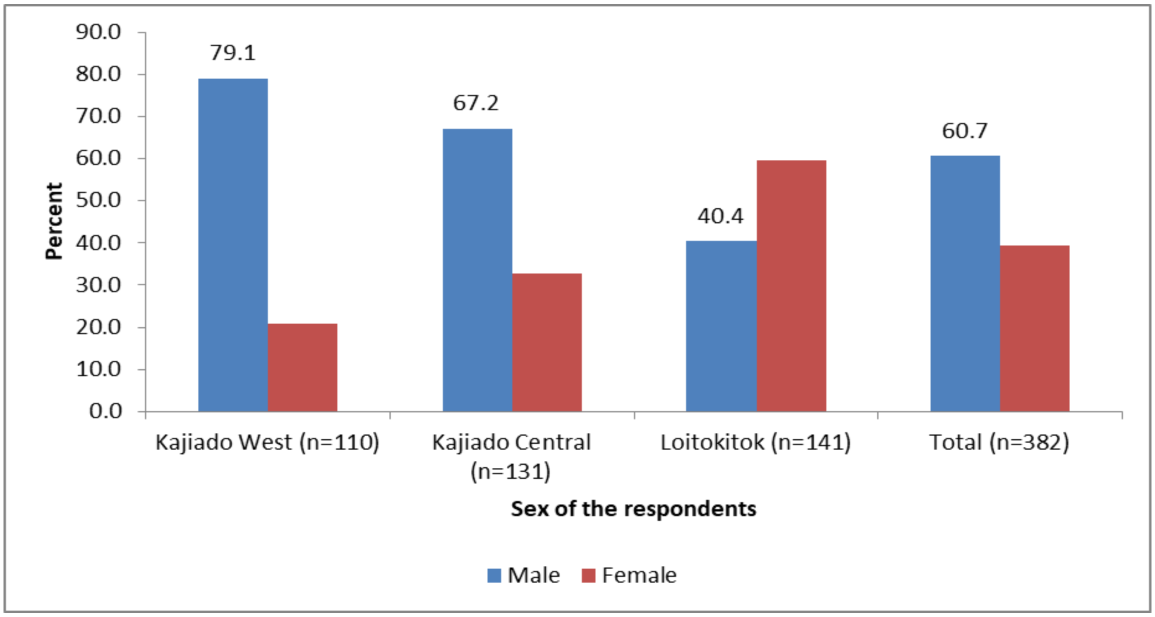

Figure 4.1: Gender Distribution of the Respondents (Field Data, 2020)

The findings in this study, while not showing a wide margin between males and females among the respondents as household heads, presented a fairly balanced gender composition (Figure4.1). This is regardless of the fact that in this community, ownership of main household livelihood assets, especially land and livestock, is controlled by men as is the case with other traditional African communities (Igwe *et al*., 2019).

This was more apparent during interviews with female respondents who clearly stated that decision on the livelihood assets was absolutely the responsibility of the husband or the key male relative responsible in the case of a widow being the household head. Further analysis using Spearman Rank Correlation to establish association between the gender of a farmer and his/her CCAS uptake, Table 4.4 shows that male farmers were less likely to increase acreage of land under irrigation farming(r= -0.160) and were also unlikely to increase numbers of animal breeds that include the superior breeds (r= -

0.102). It was also found that males were less likely to practice artificial insemination for livestock(R= -0.154) and to fence off including reseeding natural pasture(R=-0.161).

Table 4.4: Bivariate Analysis of Gender of a farmer and Uptake of CCAS

Variable	Pearson Coefficient correlation (*r*)	Sig. (2-tailed)
Proportion of land placed under irrigation farming	-0.160	.000**
Proportional numbers of animal breeds that include superior breed among livestock farmers.	-0.102	.041*
Involvement in agricultural development planning at village, ward or constituency committees	0.038	.458
Practicing artificial insemination for livestock.	-0.154	.001**
Management of natural pasture	-0.161	.000**
Pasture establishment by using more than one grass species to spread the risks.	-0.143	.005**
Cultivation of drought resistant crops	0.008	.869
Water resource management practices (e.g. water harvesting)	0.072	.162

Field Data, 2020

Gender roles within a household set-up clearly defined who among the members would be available to do farming activities. It was observed in this study from women in one of the FGDs that, they are the ones who mainly work in the farms. One of them stated:

> *"Sisi wanawake ndio tunafanya kazi shambani. Wazee wetu wamezoea kupeleka mifugo malishoni mbali. Watoto wetu siku hizi wanaenda shuleni, na wale walimaliza shule wameenda mjini kutafuta vibarua" (*it is we women who work on farms. Our husbands focus on taking livestock for grazing in far places. Our children go to school, while those that are through with school, migrate to urban areas to look for employment).

The above explanation gives credence to the insignificant role that the household size may play in the decision of households adopting to adaptation strategies that address effects of climate change among the communities in Kajiado County.

The concept of climate change adaptation is supported mainly so as to reduce food security challenges that communities face as a result of climate variability. This study therefore sought to evaluate the role of gender in the decision-making process about the farming practices since there are differentiated risks that women, men, girls and boys are exposed to including ensuring active equal involvement of women and men (Lewis *et al*., 2018).

Another aspect was on power relationship between a husband and wife in regard to key decision-making authority. Although the custodianship of indigenous knowledge farming practices in most of the African traditional settings is collectively exercised among the older members of the society both men and women (Barigye and Siraje, 2019), this study found that among the Maasai community, this knowledge is mainly exercised at the goodwill of men. One of the focus group participants among the eight selected women commented on this that:-

> "*Mila zetu mambo ya umiliki wa shamba na mifugo ni uamuzi wa wazee wetu. Kama wamama tuna fanya vile wameamua. Kwa mfano, ile kitu tutapanda kwa shamba mwaka huu na ni wapi, kiasi gani, ama mifugo wale wa kupeleka sokoni kuuzwa, yote ni uamuzi wa wanaume.*" (Our customs and traditions concerning what should be done on the land as well as our cattle is mainly decided by our husbands or male elders. As women we are mainly mandated to implement the decisions already made. For example, whatever is going to be planted on the land in one given season, size of the land to be utilized, which animals to be sold are all decisions that are made by the man of the house – my husband).

In terms of the index score on the uptake of CCAS, gender does not seem to have an influence among the farmers in Kajiado County as shown in Table 4.2. However, individual analysis of CCAS variables reveals that, gender is an issue on decisions to do with adopting the rearing of superior breeds of cattle and the better management of pastures. The inferential statistics on a Pearson Chi-square test at CI of 95%, show the significance of gender as $p < 0.05$ indicating its association with the perception on climate change adaptation strategies.

This study tends to agree with other studies, notably by Belay *et al*. (2017) on smallholder farmers' adaptation to climate change and determinants of their adaptation decisions in the Central Rift Valley of Ethiopia, Igwe *et al.* (2019) on the influence of farmer demographic characteristics on environmental behaviour and Lawson *et al*. (2019) on dealing with climate change in semi-arid Ghana. These studies focused on understanding intersectional perceptions and adaptation strategies of women farmers; all who concur that gender issues can actively influence adaptation to agricultural strategies on climate change.

The issue of uptake of new adaptation farming strategies is characterized by decision-making domains that mainly hinge on socio-cultural issues such as power relations and control over livelihood assets within a household setting that is headed by a husband (man) and wife (woman) (Basdew *et al*., 2017; Burton, 2014; Mathibela *et al*., 2015; Melesse, 2018; Singh and Sahoo, 2019). In spite of the fact that women are more environmentally oriented, more prone to adapt to new government conservation farming methods and more likely to embrace government policies (Burton, 2014), this study showed that they are at a disadvantage in decision-making. It is however important to take note of a case study done in rural Bangladesh by Sunny *et al.* (2018) whose findings revealed that there was no significant association between gender and adoption of new farming technologies. As had been asserted by one of the discussants in the quoted verbatim above, power relations between genders within the dominant *Maasai* farmers in Kajiado County favours men , hence granting them major decision-making authority. This may likely not be the case among the farmers community in rural Bangladesh.

4.3.2: Households Average Age and Uptake of Climate Change Adaptation Strategies

It was important in this study to determine the age of the respondents for purposes of establishing their perceptions on new climate change oriented farming technology in view of the prevailing indigenous knowledge practices. The categorization of the ages was informed on the assumption that people belonging to different age groups may have dissimilar socio-cultural and economic experiences. Individuals also develop different tastes and preferences as well as behavior as they grow older. These reasons can influence different responses from people that fall in different age groups.

In the study, the most dominant age group among the farmers who participated was 35–49 years that accounted for 34.6% (132), while the age group of 18–24 years had the least number of respondents at 7.9% (30) as shown in Figure 4.2. Although the age group 18–34 years would be considered as the youth doing farming, it was assumed in this study to categorize this group further to classify 18–24 years as the youths who are engaged in institutions of learning hence doing farming on a part-time basis. Subsequently, those youths in the 25–34 years were those that were through with schooling and expected to be engaged in farming fully. Age has a bearing on the acceptance and use of the different practices and hence is perceived differently based on the age group.

The ages in years were therefore categorized into five groups; 18-24, 25-34, 35-49, 50-64 and 65-86. The findings show that the age group of 35-49 years taking the biggest proportion at 34.6%, while the age group of 18-24 having the least number of respondents at 7.9 %. It was assumed that farmers that can possess decision-making authority within a household are those with a minimum of 18 years of age. The elderly, for example, are more biased in favour of IK as compared to the educated youth who easily embrace technology. As will be discussed later in regard to education levels, these results show that the younger generation in the community and who are well informed by having been more exposed academically are not keen on agriculture as an occupation

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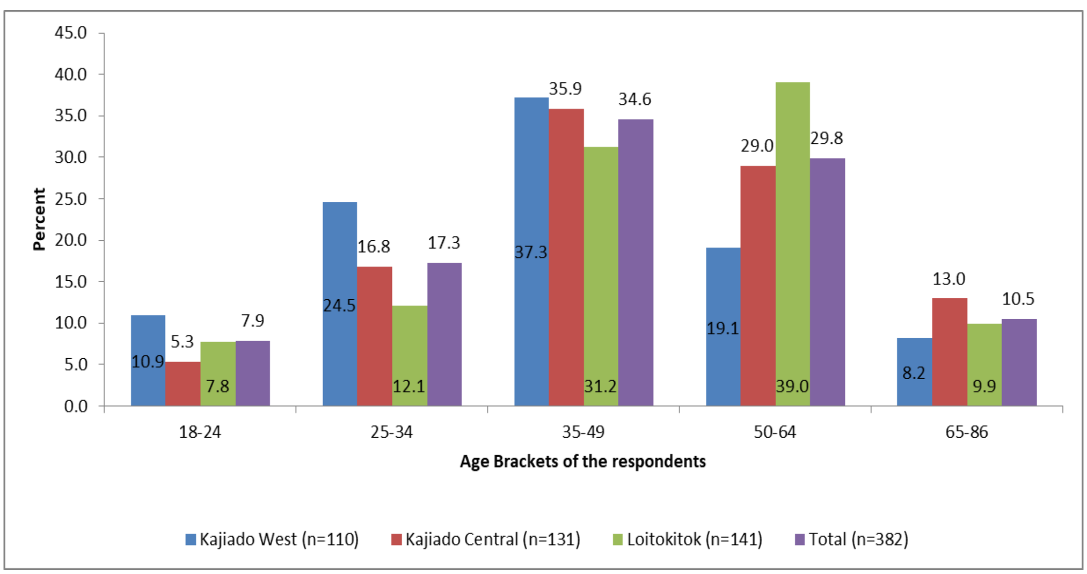

Figure 4.2: Age Distribution of the Respondents (Field data, 2020)

Farmers beyond the age of 86 years were considered too old and mainly dependent on their stronger descendants to make major decisions. To this extent, this study found that the younger respondents (18-24) posted a favorable response as to whether modern climate change adaptation strategies were more effective as compared to IKP at CI = 95% with results showing a Pearson Chi-Square of $X^2 = 20.866$ $p < .000$ as shown in Table 4.2. The age distribution of the respondents was therefore significant in determining the understanding of effects of climate change and adoption of the CCAS. These study findings affirm the fact that age variance is likely to influence decision-making towards adapting to new climate change oriented agricultural technologies. The findings further revealed that the older farmers are more conservative and hence reluctant in adopting modern climate-smart agriculture. As shown in Table 4.5 below, age was found to have an inverse relationship with the uptake of most of the CCAS. .

Table 4.5: Bivariate Analysis of Age of a Famer and Uptake of CCAS

Variable	**Pearson Coefficient correlation (r)**	**Sig. (2-tailed)**
Proportion of land placed under irrigation farming	-.161	.002
Proportional numbers of animal breeds that include superior breed among livestock farmers.	-.337	.000
Involvement in agricultural development planning at village, ward or constituency committees	.008	.871
Practicing artificial insemination for livestock.	-.218	.000
Management of natural pasture	-.095	.063
Pasture establishment by using more than one grass species to spread the risks.	-.168	.002
Cultivation of drought resistant crops	.021	.685
Water resource management practices (e.g. water harvesting)	-.143	.005

Field Data, 2020

The older farmers were less likely to increase their land to be under irrigation R= -0.161; unlikely to increase their herds with superior breeds (R= -0.337); probably not willing to do artificial insemination for their livestock (R = -0.218) and also not likely to fence off and reseed their pastures (R = -0.095). It can therefore be concluded that while the younger farmers favoured the CCAS over the IK practices, the older farmers preferred IK practices and would reject CCAS. Some of the distinctive factors that came up during the study and which are considered to contribute to the negative association between age and adoption of modern agricultural practices are that the older farmers' are always skeptical about the resultant benefits, due to their low understanding and beliefs in favor of indigenous knowledge farming practices.

These findings concur with the previous studies linking socio-demographic factors to adaptive tendencies on farming options which were done by Burton (2014). Age differences of particular household heads within a society have, according to several studies, determined behavioral tendencies towards adoption of new agricultural technologies (Melesse, 2018). For instance, the younger farmers that may have gone to school may be more willing than the older, more conservative folks to uptake more advanced farming technology, based on their exposure to modern technologies. The understanding about the influence of age variations among farmers in decision-making processes is critical in planning and designing more sustainable agricultural and environmental initiatives (Igwe *et al*., 2019; Sunny *et al*., 2018; Uddin *et al*., 2014).

Although these findings indicate similarities with results of other related studies (Abubakar *et al*., 2019; Igwe *et al*., 2019; Worku, 2019), the distinctive feature of age distribution as a socio-demographic characteristic in Kajiado County, shows marked differences on how this factor affects communities that largely depend on crop agriculture in Loitokitok as compared with that dominated with livestock rearing in Kajiado West (Table 4.1).

4.3.3 Household Size and Uptake of Climate Change Adaptation Strategies

Household size as a socio-demographic variable on uptake of CCAS was examined by asking the respondents how many people lived in one homestead. The responses were grouped into four categories; 1 – 3, 4 – 7, 8 -11 and those with 11 and above people. As shown in Figure 4.3 below, the majority of the respondents were those with 4-7 people with an aggregate proportion of 51.8 % while those with over 11 people being the least at 11%.

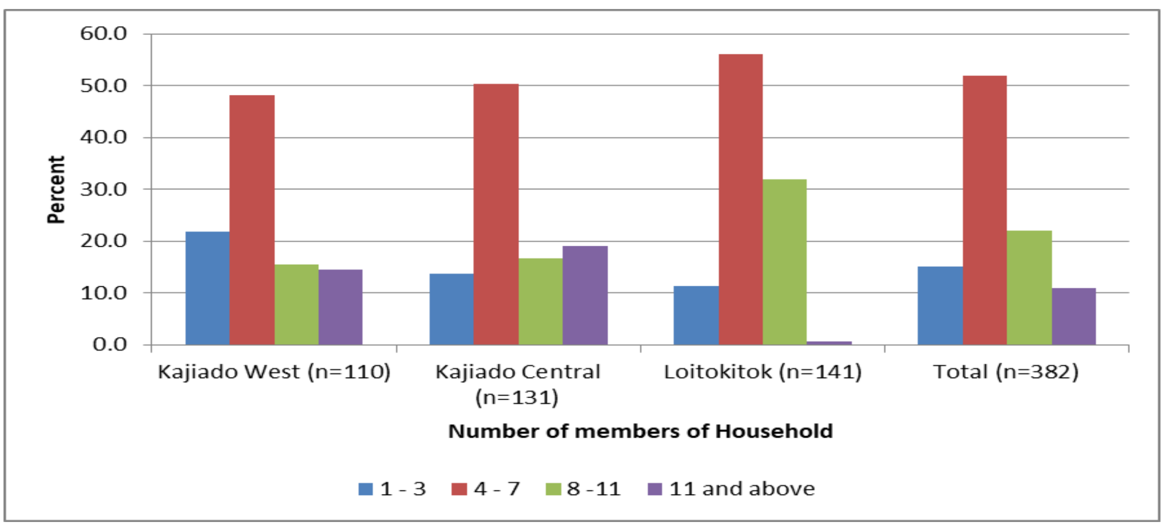

Figure 4.3: Household sizes of the Respondents (Field data, 2020)

Correlation analysis results in Table 4.6 shows that the bigger the size of a household, the less likely would the farmer be willing to increase acreage of land under irrigation farming (R= -0.113). Similarly, larger households would not go for rearing superior breeds of cattle (R= -0.187) and would also less likely fence off or reseed their pasture lands. Larger households were also less likely to involve themselves.

These findings are indicative of the importance of the household size in terms of handling the effects of climate change using indigenous knowledge practices. In other words, the more the number of members, the more the household would be equipped to handle certain key roles of combating the impacts. For instance, nomadism can easily be practiced by larger households who may allow men and younger men to go to longer distances in search for water and pastures during serious droughts as had been postulated by one of FGD woman member quoted earlier.

Table 4.6: Bivariate Analysis of Household Size of a Farmer and Uptake of CCAS

Variable	**Pearson Coefficient correlation (*r*)**	**Sig. (2-tailed)**
Proportion of land placed under irrigation farming	-0.160	.000**
Proportional numbers of animal breeds that include superior breed among livestock farmers.	-0.102	.041*
Involvement in agricultural development planning at village, ward or constituency committees	0.038	.458
Practicing artificial insemination for livestock.	-0.154	.001**
Management of natural pasture	-0.161	.000**
Pasture establishment by using more than one grass species to spread the risks.	-0.143	.005**
Cultivation of drought resistant crops	0.008	.869
Water resource management practices (e.g. water harvesting)	0.072	.162

Field Data, 2020

This is in disagreement with other similar studies that have sought to determine the influence of household size on decision-making towards adopting new agricultural technologies. For instance, Thuo *et al*., (2014) reports on the effects of social network factors on information acquisition and adoption of improved groundnut varieties, focusing on farmers both in Kenya and Ugandans respectively. They aver that among other factors, household sizes influence adoption of farming techniques' choices among Ugandan farmers, but not Kenyan farmers. Likewise, Abubakar *et al.* (2019) studying on issues that would improve the adoption of better rice farming practices in Nigeria, have their finding showing significance of the association between household size and the adoption. They argue among other explanations, and just like Singh and Sahoo (2019), that a bigger household size would guarantee adequate labor needed for farm work and vice versa.

The variance of this study with other studies can only be explained by taking note of the main farming culture among the dominant Maasai farming community in Kajiado County. The main livelihood here is nomadic pastoralism; a culture that is not only heavily biased in favour of IK but also very labour intensive, requiring more household members to support it.

The importance of household size as a measure of labor in carrying out farming activities at a household level can therefore not be over emphasized. The findings supports an argument that indigenous knowledge related farming practices being highly labor intensive (Altieri *et al*., 2012; File and Nhamo, 2023), are easier facilitated by larger household sizes which have more individuals available to ease the constraints on either the grazing work or on the overworked women in the farms. Larger families are therefore likely to find it easier carrying out IK oriented agricultural activities.

4.3.4: Level of Education and Uptake of Climate Change Adaptation Strategies

The household heads were asked to state their education background, for purposes of establishing if the education levels have influence on farmer's decision on adopting new agricultural technologies. The results of this study in Figure 4.4 show that the majority of the respondents were illiterate at 38% while the farmers that have attended adult education represented the least numbers. It is important to note that those who had received some form of basic education i.e. primary and secondary school were approximately 50%.

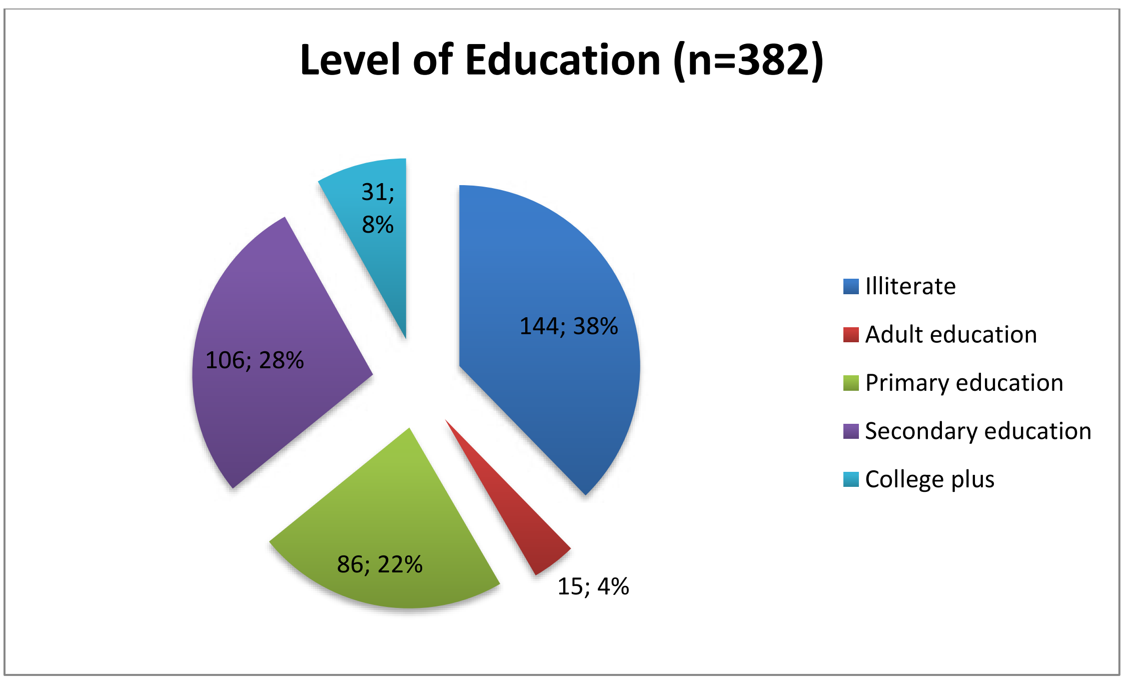

Figure 4.4: Level of Education of Household Heads
Source: Field data, 2020

The study further found that the southern region of Loitokitok Sub-county which receives more annual rain and engages more in crop agriculture, has higher literacy levels than the drier Kajiado West and Kajiado Central Sub-counties. The southern region, based on the main livelihood activity that is largely sedentary-oriented is therefore more food secure, hence creating opportunities for children to attend school as compared to the other two mainly arid sub-counties.

Chi-square analysis revealed that there is a significant association (CI = 99%, X^2 = 72.177, $p < .01$) between the level of education of a farmer and his/her willingness to adopt the new CCAS farming technologies as shown in Table 4.2. Further analysis had shown in Table 4.7 below that there is a significant positive coefficient correlation between the level of education and uptake of all CCAS. Conversely, the study shows a significant negative correlation between the level of education and use of indigenous knowledge practices in response to adverse effects of climate change on the farmers' agricultural productivity. These results show that the higher the level of education of a farmer, the more likely will he/she increase acreage of land under irrigation farming (R=0.284), increase numbers of animal breeds that include the superior breed among livestock farmers(R=0.196) and more willing to be involved in agricultural development planning at village, ward or constituency committees.

Table 4.7: Bivariate Analysis of Level of Education of a Farmer and Uptake of CCAS

Variable	**Pearson Coefficient correlation (*r*)**	**Sig. (2-tailed)**
Proportion of land placed under irrigation farming	.284	.000**
Proportional numbers of animal breeds that include superior breed among livestock farmers.	.196	.000**
Involvement in agricultural development planning at village, ward or constituency committees	.074	.147
Practicing artificial insemination for livestock.	.172	.001**
Management of natural pasture	.355	.000**
Pasture establishment by using more than one grass species to spread the risks.	.048	.347
Cultivation of drought resistant crops	.125	.015*
Water resource management practices (e.g. water harvesting)	.458	,000**

Field Data, 2020

In analyzing the association between the level of education of an interviewed farmer and their uptake of CCAS, individual CCAS variables had different strength of associations as shown in Table 4.5. The results show that there is marked significant positive correlation between level of education and uptake of climate change adaptation strategies such as placing land under irrigation farming(CI = 99%, r = . 284 , $p < .01$) , willingness to rear animal breeds that include superior breed among livestock farmers(CI = 99%, r = .196 , $p < .01$), practicing artificial insemination for livestock (CI = 99%, r = .172 , $p < .01$), applying modern management of natural pasture(CI = 99%, r = .355 , $p < .01$), cultivation of drought resistant crops(CI = 95%, r = .125 , $p < .05$) and engaging in Water resource management practices (CI = 99%, r = .458 , $p < .01$).

It was however, illustrative that the strengths of associations were low to moderate considering that r =1 is indicative of the strongest association and only the management of water resources variable scored r =.458. Notably, the willingness of the farmers to be involved in agricultural development planning and technical aspects of utilizing different types of grass species in pasture management did not have any significant relation with the level of education of a farmer.

More succinctly therefore, these results indicate that the higher the education of a farmer, the more likely that farmer will easily internalize and adopt new agricultural innovations and vice versa. On the other hand, the lower the level of education of a farmer the more likely that farmer being sufficiently conservative continues to apply indigenous knowledge practices.

It has been established by studies on factors that determine the level of farmers' adopting to new agricultural innovations (Nyale *et al*., 2019; Sunny *et al*., 2018; Worku, 2019) that education is a socio-demographic characteristic that may influence decision-making and tendency towards new agricultural practices. In concurrence with this finding, this study further identified a unique factor that is based on ecological features and geographical location.

Education plays a very important role in creating awareness and enhancing understanding about complex issues to such an extent that it can shape an individual farmer's attitude and perception about new agricultural technologies (Burton, 2014; Howley *et al*., 2012). By extension, this assertion helps affirm the fact that education can shape farmers' environmental behavior. Bivariate analysis on Pearson Coefficient correlation on collected data reveals statistically significant correlation between level of education and several dependent variables that characterize climate change adaptation strategies.

Conversely, a similar test was done but instead of the CCAS, the IK related CC response mechanisms were tested to determine their preferences. Remarkably, when a bivariate correlation test was done on the farmer's level of education with what they would revert to in response to climate change impacts, the results showed a significant negative coefficient (CI =99, r -.382, p<.01) as shown in Table 4.8 below

Table 4.8: Bivariate Analysis on Level of Education and Farmers' Response Mechanisms to Effects of CC

Variable	Pearson Coefficient correlation (r)	Sig. (2-tailed)
Resign to our fate and do nothing	-.088	.85
Appeal to government for help through local administration	.103	.044*
Wait for Humanitarian assistance from NGOs, civil societies etc.	.205	.000**
Use traditional IK to survive	-.302	.000**
Seek help within social networks; relatives, clan, neighbors	.121	.018*
Migration	-.175	.001**

(Field data, 2020)

Nomadism, which is an IK practice characterized with migration (CI =99, r -.175, p < .01) is another common climate change response indigenous knowledge mechanisms that also indicate an inverse correlation with the level of education as shown in Table 4.6 above. It is important to note that key response mechanisms that promote modern CCAS such as appeal for government and/or humanitarian intervention are positively statistically significant to level of education. This means that the higher the level of education, the more likely a farmer will decide to seek government or humanitarian assistance. As an overall conclusion, this is interpreted to mean that the higher the level of education, the less likely individual farmer will be willing to utilize indigenous knowledge in response to climate variability and vice versa. The role of extension services to educate farmers and promote new technologies would therefore be a more effective approach to enhance CCAS uptake.

Notably, a study done in Mizoram, Northeast India (Singh and Sahoo, 2019) about the socio-economic and demographic influences on farmers' decision-making concerning farm management techniques found an inverse association between level of education and application of modern fertilizers. However, this cannot be taken at the face value as it was revealed that the more learned farmers avoided applying excess fertilizers for purposes of sustaining the soil potency.

However in a study conducted in Niger State of Nigeria among farmers in adopted villages, Abubakar *et al.* (2019) found no statistical significant correlation between level of education of the farmers and their rate of adoption of new farming innovations. The reasons behind this kind of an outcome is beyond the scope of this study, but the variations of education levels among the members of this community could be very insignificant.

4.3.5: Land Ownership and Uptake of Climate Change Adaptation Strategies

As part of the study enquiries to establish the nature of land ownership in Kajiado County and how it influences farm management practices, the respondents were asked whether they own the land on which they live and farm. This county's land is categorized as community land, private land or public land with registration classified as either leasehold or freehold ownership. Land ownership according to the definition in the 2018-2022 Kajiado County Integrated Development plan, is legal possession of legal title deed of which it is reported that 95% of the rural farmers have the legal documents. The responses were therefore categorized into "yes" and "no" answers. From the data collected, the majority of the households in the county standing at 70.4% own land as shown by the pie chart, Figure 4.6 below.

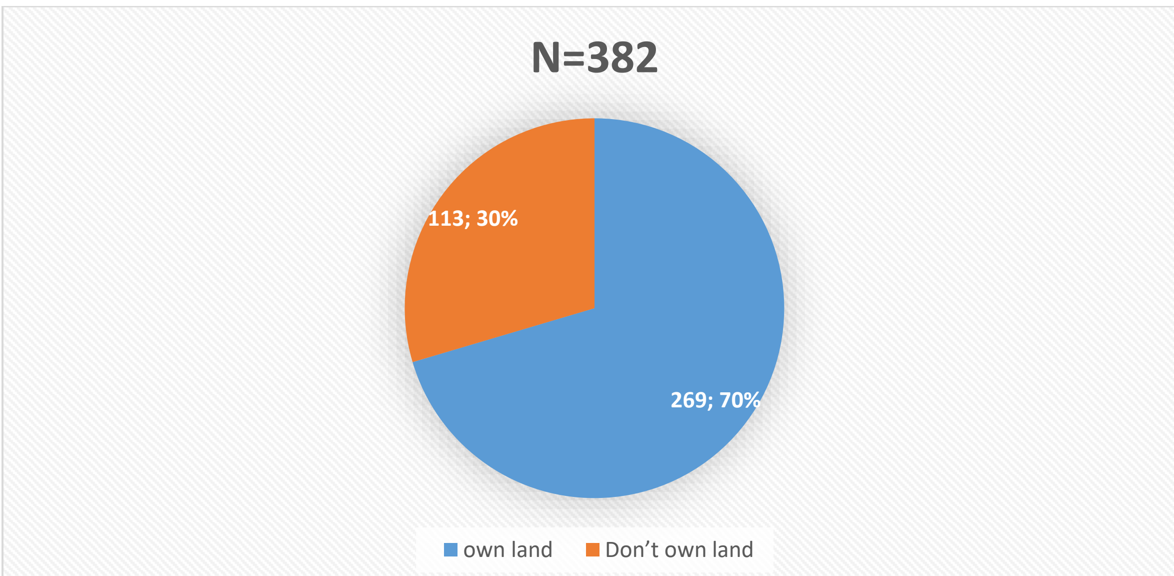

Figure 4.5: Land Ownership among HH Respondents (Field Data, 2020)

From the statistical analysis, the results show that land ownership is significantly associated with use of indigenous knowledge practices in response to climate change and variability. Further analysis inferentially to establish the association between IK-oriented CC response mechanisms and CCAS was done. To relate this to the land ownership, a bivariate correlation analysis was done; results being illustrated in Table 4.9 below.

The analyzed IK oriented practices including nomadic migration and the farmers' tendency of just ignoring the CC adverse effects (doing nothing) tend to have significant positive association with the independent variable of land ownership. The findings show that IK practices are more adhered to by the farmers who own land, who would respond to CC challenges such as drought by migrating (CI =99, r =.162, $p < .01$) or other indigenous knowledge oriented responses (CI =99, r = .149, $p < .01$).

Table 4.9: Bivariate Correlation Analysis of Land Ownership and Farmer's CC Adaptation Preference

Variable	Coefficient	Sig. (2-tailed)
Indigenous Knowledge		
Use of Indigenous Knowledge response mechanisms	.149	.003**
Migration	.162	.002**
Climate Change Adaptation strategies		
Irrigation farming	-.092	.073
Rearing superior livestock breeds	-.198	.000**
Farmers' involvement in the agricultural development planning	-.039	.453
Use of Artificial Insemination	-.101	.049*
Pasture Management	-.144	.005**
Planting Drought resistant crops	-.084	.100
Water Resource Management	-.208	.000**

Field Data, 2020

As shown in Table 4.9, the respondents' view on the uptake of the climate change adaptation strategies, using bivariate correlations, the findings revealed a significant negative association in dependent CCAS variables with the management of water resources showing the strongest inverse association (CI =99, r = -.208, $p < .01$). This implies that a farmer who owns land would be more reluctant in adopting new farming technologies in response to the climate change adverse impacts. Notably, the variables that could be predicted by landownership were mainly oriented to livestock farming practices, while those that were related to crop cultivation had no significant associations.

These results indicate that the farmers who own land in Kajiado County would be inclined more on reverting to more traditional methods of dealing with weather related hazards such as droughts, floods or storms. The migration tendencies among pastoralists are more supported more in the semi-arid areas of Kajiado West and Kajiado Central owing to the fact that farmers in these areas own large tracts of land. For example, as shown in Figure 4.6 overleaf, the majority of farmers with over 100 hectares of land reside in Kajiado West, where nomadic pastoralism is heavily practiced. Consequently, movement of farmers from place to place in search of pasture and water, covering long distances, without encroaching into farms owned by other farmers or areas owned by other communities is feasible.

The findings therefore highlight the dynamics of land-use variables that determine food security especially in nomadic pastoralists' dryland areas such as Kajiado West and Kajiado Central Sub-counties. The availability of land as a livelihood resource supports the nomadic pastoralism and slows down the uptake of alternative technologies suggested in the CCAS.

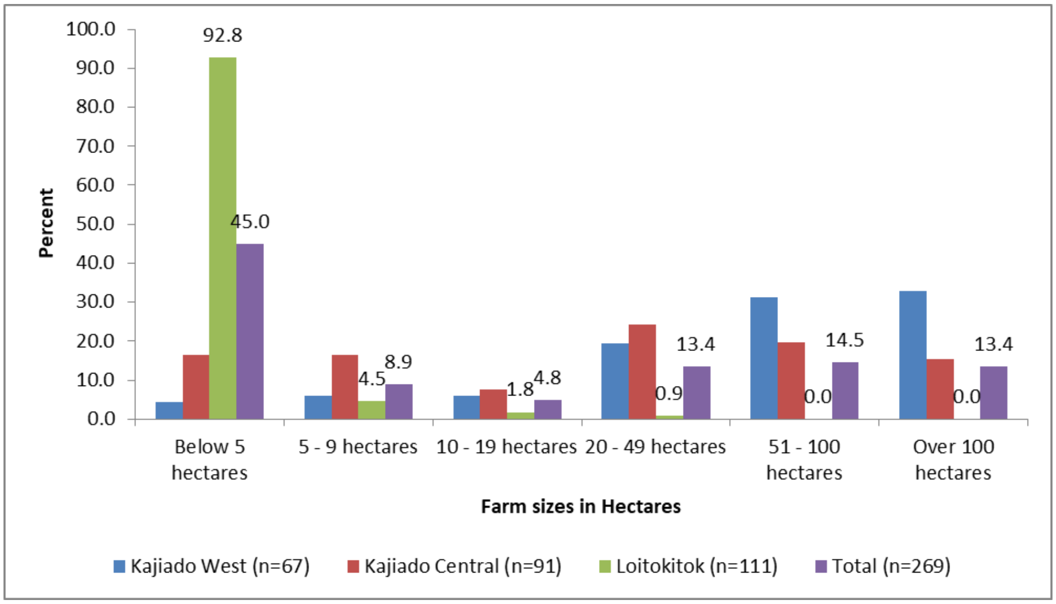

Figure 4.6: Household's Farm Size in Hectares (Field data, 2020)

On their review of the studies on predictors of farmers adaptive tendencies towards climate change response mechanisms, Dang *et al.,* (2019) report that "Farmers' adaptive decisions were affected by the institutional arrangements about land as well as land ownership in Benin." In some communities that are patriarchal, women who are the main workers in the farms, have no decision-making powers to adapt to new farming technologies because they don't own land. The rights to sell, transfer, or use is absolutely at the discretion of men (Tsige *et al*., 2020). This argument is similar to a response from one of the women in the FGD who said:

> "*Serikali ilituma watu wao kutuhamashisha kupanda miti ambayo inasaidia kuvuta mvua, lakini wengine wa wanaume wakakataa na kung'oa hiyo miti wakisema shamba si ya wamama*". (The government officials came here and sensitized us to plant trees so as to attract rain, some of our men refused and uprooted the trees, saying the land doesn't belong to women).

General responses from the women were that even when the farm work has been done by the women, the men appear at the time of the harvest and take decision in regard to what should be sold for income earning and what should be preserved for household subsistence needs.

4.3.6: Household Farm Size and Uptake of Climate Change Adaptation Strategies

This study sought to determine the influence of the household's farm size on the farmer's willingness to adopting climate change agricultural technologies. The responses were grouped categorically into six; those with land under 5 Hectares, 5-9, 10-19, 20-49, 50-100 and those with over 100 hectares. The farm sizes according to those who responded in the affirmative to the question as to whether they own land and who were 269 in number, are illustrated in Table 4.10 overleaf.

As shown in Table 4.10 below, the majority of the respondents had land below 5 hectare at 45.8% yet those with land between 10 and 19 hectares represented only 4.8%.

Table 4.10: Households's Farm Sizes

	Kajiado West (n=67)	Kajiado Central (n=91)	Loitokitok (n=111)	Total (n=269)
Below 5 hectares	4.5	16.5	92.8	45.0
5 - 9 hectares	6.0	16.5	4.5	8.9
10 - 19 hectares	6.0	7.7	1.8	4.8
20 - 49 hectares	19.4	24.2	0.9	13.4
51 - 100 hectares	31.3	19.8	0.0	14.5
Over 100 hectares	32.8	15.4	0.0	13.4

(Field data, 2020)

Although majority of those who owned land were those with farms of between less than 1 to 5 hectares (45%), and were found in more wet areas of Loitokitok where crop farming is most common, the farmers with bigger lands (51 Hectares – 100 Hectares) were found in the more arid areas of Kajiado West where livestock pastoralism was the most common form of agriculture. Farmers who owned land of between 51 and 100 hectares were those who resided in more arid areas of Kajiado West (31.3%) and Kajiado Central (19.8%), while none of the respondent farmers from Loitokitok owned more than 50 hectares.

More specifically, the households with smallest farm sizes are found in Loitokitok Sub-county, which receives the highest amount of annual rain, and has its community largely engaged in crop agriculture. On the other hand, Kajiado West Sub-county which is the most arid, with farmers mainly engaged in pastoralism, has very large farm sizes as shown in Table 4.8 above. Descriptive statistical analysis shown in Table 4.4 had indicated that the farm size as an independent variable and indigenous knowledge oriented variables have a significant positive association. For instance, the respondents with bigger farm sizes were more likely to revert to indigenous knowledge practices in response to adverse effects of climate change. On the other hand, those with smaller farms would seek help from the government and humanitarian agencies in search of alternative innovative ways of addressing the issues of drought or floods.

There was also an analysis to establish an association between the farm sizes owned by the respondent farmers as an independent variable that would predict what was considered in this study as the IK practice variables that denoted the farmers' traditional response mechanisms to the effects of CC such as drought or floods. The locally learned approaches include ignoring the adverse CC phenomenon and do nothing; applying IK practices (including planting of drought resistance crops, gathering of wild fruits/vegetables and reduction of number of meals), dependence on social networks for support and the main nomadic pastoralism practice of migration. The findings as shown in Table 4.11 below, indicate that among the "yes" respondents, the farmers that preferred migration accounted for 43%, resigning to fate 35%, using a number of IK practices 20% and those who resorted to get help from social networks (family, friends), 2% .

Table 4.11 below also shows the association between farm sizes and tendency to use IK practices to respond to CC effects, and indicates that migration, use of IK to survive and resigning to fate have significant associations in their decreasing order of the strength of significance, posting CI=99%, X^2 = 162.067, $p< .01$; CI = 99%, X^2 = 128.269, $p< .01$ and CI = 95%, X^2 = 87.151, $p< .05$ respectively.

Interpretively, migration is strongly associated with CC intervention measure among farmers with bigger sizes of farmlands, as one of the IK practice.

Table 4.11: Crosstabs between Farm Sizes and Application of IK Practices in Response to CC Effects

IK practice Variables	Yes	Percentage	Crosstab with land/farm size - Chi-square	*P* values
Resign to our fate and do nothing	184	35	87.151	.029*
Use traditional IK to survive	106	20	128.269	.000**
Seek help within social networks; relatives, clan, neighbors	10	2	56.521	.735
Migration	227	43	162.067	.000**

(Field data, 2020)

These findings imply that for the farmers who have bigger sizes of land, and who were found to be mainly residing in the more arid areas of Kajiado West and Kajiado Central (Figure 4.6), the most common response mechanisms that they would prefer to address adverse effects of CC would be more IK-oriented practices.

Conversely, statistics from the correlation analysis between farm sizes and farmers willingness on adopting new farming technologies as shown in Table 4.12 below, show a predictable trend in which the uptake of CCAS depend on farm sizes inversely for the farms that are mainly doing food crop cultivation indicating that these farmers would most likely agree to place their farms under irrigation (CI = 95%, $r = -.139$, $p < .05$) and also engage in raring superior breeds of cattle (CI = 99%, $r = -.180$, $p < .01$). This can be interpreted to mean that the farmers with smaller sizes of land can easily adopt CCAS in the variables stated as opposed with those farmers owning bigger farmlands.

It can also be further deduced that the needs of the pastoralist farmer with larger farmland in Kajiado West or Kajiado Central have always been addressed by him moving around in search of water and pasture, while those needs of the crop farmer in Loitokitok can be met through intensive utilization of the available smaller farmland to sustain his/her production. This therefore also means that the land owners of smaller farms in most of the southern part of the county (Loitokitok Sub-county) who are mainly food crop farmers readily adopt new agricultural innovations as shown by the inverse statistical significance as shown in Table 4.12 overleaf.

Table 4.12: Bivariate Correlation Analysis between Household Farm Sizes and Uptake of CCAS

Variable	Pearson Coefficient	Sig. (2-tailed)
Proportion of land placed under irrigation farming	-.139	.022*
Proportional numbers of animal breeds that include superior breed among livestock farmers.	-.180	.003**
Involvement in agricultural development planning at village, ward or constituency committees	.115	.060
Practicing artificial insemination for livestock.	.058	.348
Management of natural pasture	.256	.000**
Pasture establishment by using more than one grass species to spread the risks.	.196	.001**
Cultivation of drought resistant crops	-.005	.941
Water resource management practices (e.g. water harvesting)	.032	.599

(Field data, 2020)

On the other hand the same analysis indicated that CCAS-oriented management of natural pastures can easily be adopted by the farmers with larger farms as shown by their positive association (CI = 99%, $r = .256$, $p < .01$). Livestock farmers therefore depend on larger farm sizes that can facilitate pastoralism, which they manage mainly by utilizing indigenous knowledge practices such as sub-dividing grazing land into several portions, some of which are set aside, left for pasture replenishment, to be used for future grazing, a concept known as *Olopoleli.*

In conformity with what a study on the *Maasai* pastoralism resilience by Ameso *et al.* (2018) found, this concept addresses the dangers of overgrazing by indicating that during the dry seasons and in the wet seasons the grazing lands that had previously been in use should be enclosed and set aside to allow grass to grow.

Several studies that have examined factors that influence farmers' tendencies towards adoption of new farming practices (Dang *et al*., 2019; Howley et al., 2012; Ntshangase et al., 2018; Singh and Sahoo, 2019; Sunny *et al*., 2018; Tiruneh *et al*., 2015; Yaron et al., 1992), all of which concur with these findings that farm size can influence the innovation adopters' decision. However, the correlation, though significant, may be on either direction depending on demographic, ecological or socioeconomic factors. Whereas farm size was found to be significantly negatively associated with adoption of new farming technology in this study, similar to several studies (Howley *et al*, 2012; Ntshangase et al., 2018), other studies show a positive association (Worku, 2019; Singh and Sahoo, 2019). An assessment study carried out in Ghana about the level of uptake of adaptation strategies in the wake of climate change and variability actually showed both positive and negative associations (Sadiq *et al*., 2019).

The land use patterns in Kajiado County according to the County Integrated Development Plan (CIDP) 2018-2022 report perhaps explains the scenario about how farm size relates to the uptake of new climate change adaptation strategies. The report highlights the fact that Kajiado County is predominantly characterized with livestock farming in which the majority (*maasai* community) live on large tracts of land which support pastoralism as a livelihood activity (County Government of Kajiado, 2017). The main traditional response mechanism to drought, which threatens the availability of pasture and water, has always been nomadism (migration from village to village in search of water and pasture).

4.3.7: Household Monthly Income Levels and Uptake of CCAS

This factor, which was considered as an economic factor among farmers was examined to establish if it had any influence on a particular household preferring utilizing IK practices over CCAS. The classification of these levels as per the UN recommendations of income per capita (UN, 2011), but calculated monthly, was done. In this study the categorization was broken down into three; poor, middle and high income earning households.

Table 4.13: Households' Monthly Income Levels

Household average monthly income (KES)	No. of Households	Total (n=382) %	
<3,000	84	22.0	
3,000 - <10,000	112	29.3	
10,000 - <20,000	79	20.7	
20,000 - <30,000	47	12.3	
>30,000	60	15.7	
Descriptives			
			KES
Mean			28, 749
Median			10,000

Field Data, 2020

The poorest were pegged on those that earned below 50^{th} percentile, the middle income earners at the median, i.e between 50^{th} and 75^{th} percentile and the high income earners at above 75^{th} percentile. Specifically therefore, since the median was KES 10,000, the households that earned less were considered poor while those whose earnings were between KES 10,000 and those that earned KES 10,000 to 30,000 were considered to be the middle income earners. The households who earned more than KES 30,000 were classified as high income earners. Table 4.13 above shows the income levels of the participating respondents indicating that a majority of them, totaling 196 (51%), earned less than KES 10,000 a category that was considered as poor. Those who were rich household represented 16% among the respondent farmers.

As shown in Table 4.14, further analysis reveal that households with bigger monthly income are more likely to adapt to the suggested CCAS recommended techniques and reccommendations. For instance, farmers with higher income are likely to increase acreage of their land to be under irrigation farming (R=0.218) and would also likely increase numbers of animal breeds that include the superior breed among livestock farmers(R=0.145).

Table 4.14: Bivariate Correlation Analysis between Household Monthly Income and Uptake of CCAS

Variable	Pearson Coefficient	Sig. (2-tailed)
Proportion of land placed under irrigation farming	.218	.000
Proportional numbers of animal breeds that include superior breed among livestock farmers.	.145	.004
Involvement in agricultural development planning at village, ward or constituency committees	.028	.581
Practicing artificial insemination for livestock.	.250	.000
Management of natural pasture	.394	.000
Pasture establishment by using more than one grass species to spread the risks.	.199	.000
Cultivation of drought resistant crops	.075	.142
Water resource management practices (e.g. water harvesting)	.474	. .000

(Field Data, 2020)

The richer farmers are also likely to practice artificial insemination for livestock(R=0.250), fence off and reseeded natural pasture (R=0.394) and do more water resource management practices (e.g. water harvesting) (R=0.474). It can therefore be deduced that household income level is a key determinant in a farmer's preference to IK practices as compared to adapting to CCAS. For the farmers who had their larger income emanating from their agricultural activities may have perceived these new technologies as a means of increasing their productivity and subsequently raising their income levels. This argument is further confirmed by one of the Kajiado County Smart Agricultural extension officer who reported that:

> "Many questions arise from the established farmers who are doing agriculture for commercial purposes mainly asking us to do an undertaking that these approaches would ensure increased productivity, before they commit to adopt the same."

This assertion is supported by other studies (Atube *et al*., 2021; FAO, 2013; Mizik, 2021) which equally point out that economic benefits emanating from adaptations of CCAS would enhance uptake. In a review of Climate-Smart Agriculture among Small-Scale Farmers in Africa, Abegunde *et al*. (2019) avers that the concept is popular among farmers because it guarantees increased income levels. It can therefore be concluded that the dissemination of CCAS information to local farmers need to be packaged with a focus not just on resilence to negative impacts of CC but also on the economic benefits that a farmer would stand to gain.

The overall conclusion on socio-demographic and economic attributes of a farmer, otherwise reffered to internal factors, accurately shape their climate change adaptation behavior. These findings, in agreement with Capa-Mora *et al*. (2025) demonstrate that there are currently weak structures within which robust and relevant climate change adaptation knowledge bases can be created and be made available to the farmers in need. The next sections deal with socio-cultural dimensions that may have an impact on the farmers climate change adaptation decision-making.

4.4: Indigenous knowledge systems

From the study findings, the most devastating impact of CC phenomenon that is prevalent in most parts of Kajiado County is increasing trend of prolonged drought as shown in

Table 4.23 in a subsequent section. The dominant traditional way of responding to this impact among most farmers has been nomadism (migration) as shown in Table 4.15 below. The study shows that 95% and 82% of the farmers in Kajiado West and Kajiado Central respectively normally migrate with their livestock to other locations in search of water and pastures. This method of pastoralism is the most preferred because cattle, goats, sheep and donkeys are regarded as the most valued livelihood assets, perhaps even more than land. As per one of the elders who opined during the elders/key farmers FGD, nomadism is effectively facilitated by the availability of vast lands that are inhabited by few population numbers especially in Kajiado West and Kajiado Central. He stated:

> "*Sisi Mali yetu ni ng'ombe na mbuzi. Tukiona maisha yake inahatarishwa na kiangazi mingi, sisi tunahama nao, kutafuta mahali ingine pale iko maji na nyasi. Ardhi iko mingi ya kutembeza hii wanyama*". Our key assets are cows and goats. When we realize that their lives are threatened by prolonged drought, we migrate with them to places with water and pasture there is vast land enough for use to move around with these livestock.

However, only 10% of the farmers in Loitokitok Sub-county and who mainly engage in sedentary crop farming favour nomadism. It is important to note that this sub-county is located at the wet lower slopes of Mount Kilimanjaro, and receives regular rains to support this kind of farming. On the contrary , only 5%, 11% and 58% of the interviewed farmers in Kajiado West, Kajiado Central and Loitokitok sub-counties respectively would seek more scientific assistance from government, humanitarian organizations or research institutions when encountered with the adverse effects of CC.

Table 4.15: Farmers' Response Mechanisms to Climate Change Effects per Sub-County

Response mechanism to CC effects		Migration %		
		Yes	No	Totals
Sub-county	Kajiado West	95	5	100
	Kajiado Central	82	18	100
	Loitokitok	10	90	100
Response mechanism to CC effects		**Indigenous Knowledge practices %**		
		Yes	**No**	**Totals**
Sub-county	Kajiado West	53	47	100
	Kajiado Central	39	61	100
	Loitokitok	6	94	100
Response mechanism to CC effects		**Wait for Humanitarian assistance from NGOs, civil societies e.t.c. %**		
		Yes	**No**	**Totals**
Sub-county	Kajiado West	5	95	100
	Kajiado Central	11	89	100
	Loitokitok	58	42	100

Source: Field Data, 2020

Nomadism, being a culturally-developed approach of dealing with climate change impact such as drought, is more prevalent in Kajiado West, an area whose main agricultural activity is pastoralism. This livelihood depends on water and pasture which in turn is determined by rainfall patterns within the area. Having learned the weather patterns for many years using indigenous knowledge and thereby developed locally acquired adaptation strategies, the farmers would find it difficult to opt for new practices unkown and untried among them.

Indigenous knowledge system, within a local community setting, entails the local way of life of a given community which further determines how individuals, families or other community units conduct their social, political, economic and spiritual life (Tanyanyiwa and Chikwanha, 2011; Tanyanyiwa, 2019). Going by this description, indigenous knowledge shapes ways in which members of the community establish their livelihood systems, and especially, their food production systems (Mwangi, 2018). This chapter shall therefore discuss the nature of the indigenous-knowledge-oriented farming practices that may have an influence on uptake of CCAS.

4.5: Indigenous Knowledge Parameters Influencing Uptake of CCAS

The key features of indigenous knowledge that prevail as a way of life of a people in a given local community include the localization of the knowledge to a specific place; ownership of the knowledge by a community whose members are ethnically, culturally and historically closely connected as a society; the members of such a society are sharing a similar environmental or natural system; the knowledge is characteristically dynamic (Studley, 1998). This section therefore discusses these key parameters of indigenous knowledge as they shape the adoption intentions, perceptions and attitude towards new climate-change-oriented farming practices.

4.5.1. Geographical Location and Indigenous Knowledge

This study sought to establish if the geographical place, in terms of the prevailing climatic conditions are associated with the existing indigenous knowledge farming practices. When asked about what their likely response mechanisms would be in cases of adverse effects of climate change, 95%, 82% and 10% of the respondents in Kajiado West, Kajiado Central and Loitokitok respectively opted for migration in search for water and pastures (Table 4.15). These same variations in response were noted when they were asked about a combined indigenous knowledge practices as an option, with Kajiado West, Kajiado Central and Loitokitok posting 53%, 39% and 6% respectively. The results therefore confirm that; based on the regional variances of prevailing ecological and climatic conditions, communities tend to adopt to climate change effects differently.

Towards establishing these associations, the household respondents were asked to state their response mechanisms towards effects of climate change and data analyzed according to the responses obtained based on their locational sub-counties (Table 4.15). Kajiado County has varied temperature across different locations based on both altitude and seasons. Notable inter-annual rainfall variations have been experienced within Kajiado West and Kajiado Central in the years between 1970 and 2013 (County Government of Kajiado, 2017), indicative of significant climate change effects prevailing within these areas. Inferentially the study sought to determine the significance of the farmer's location and their CC response mechanisms.

The results show that all suggested CC response mechanisms are significantly associated with geographical, socio-cultural and ecological characteristics of location of a given farmer. As shown in Table 4.16, migration (nomadism) is the practice that is strongly associated with where a farmer is located (CI = 99%, $X^2 = 231.267$, $p< .01$); while seeking help from social networks is the least significant form of CC response mechanism associated with a farmer's location. Having considered the seeking for assistance from government, research institutions and NGOs by farmers as an approach that is related to the scientific CCAS option, it was also determined to be strongly associated with the farmer's location (CI = 99%, $X^2 = 231.267$, $p < .01$).

These results can be interpreted that to imply that the willingness of a farmer to adhere to their traditional IK practices on one hand or adopt new farming technology on the other towards addressing adverse effects of CC is strongly associated with the location in which they practice their farming activities. For instance, the unpredictability and inadequacy of rainfall in a given location in Kajiado West coupled with dominant high temperatures have occasioned local farmers to opt for adaptation strategies that are locally designed and indigenous in nature, as the results in Table 4.16 below show. Conversely, a farmer in Loitokitok who does agricultural activities that are heavily rain-dependent will be readily willing to adopt a scientific approach so as to utilize the smaller land resource that is available towards achieving optimal crop productivity that is sedentary.

Table 4.16: Crosstabs Showing Relationship between Farmer's Sub-county and Climate Change Response Mechanisms

Independent variable	**Dependent variable**	**Pearson Chi-Square**	**df**	**Asymp. Sig. (2-sided)**	**Significance**
Farmer's location of residence (Sub-county)	**Climate change response**				
	Resign to our fate and do nothing	79.467	2	.000**	Significant
	Appeal to government for help through local administration	9.887	2	.007**	Significant
	Wait for Humanitarian assistance from NGOs, civil societies etc.	111.514	2	.000**	Significant
	Use traditional IK to survive	66.604	2	.000**	Significant
	Seek help within social networks; relatives, clan, neighbors	6.908	2	.032	
	Migration	231.267	2	.000**	Significant

(Field Data, 2020)

The cooler temperatures and relatively heavy amounts of rainfall that is (and adequately predictable) experienced in Loitokitok Sub-county; which also has rich volcanic soils, has its farmers adopting to a largely sedentary form of agriculture which is mainly characterized with crop and dairy farming technologies. This can be demonstrated from the study findings that were earlier shown in Table 4.15, where 58% of the farmers in Loitokitok Sub-county would likely look up to expert assistance from NGOs, civil societies, research institutions among others, to address the effects of climate change as compared to only 5% of the respondents in more arid Kajiado West Sub-county.

These findings therefore reinforce the applicability and significance of the credence that, the socio-cognitive progression within which farming-oriented climate change adaptation occurs, tends to take place in a localized socio-ecological environment. Such an environment as Mitter *et al*. (2019) avers is characterized by "social and institutional support, cultural values and norms, regional characteristics, and climate-related trigger events". Kajiado West farmers who operate within an arid ecosystem and are pastoralists, are likely to respond to the effects of climate change differently from those farmers on the cooler and rainy slopes of Mount Kilimanjaro in Loitokitok Sub-county. As shown in Table 4.17 overleaf, the crosstab analyses to establish associations between locations (sub-counties) and application of indigenous knowledge practices, the Chi-square figures indicate significant associations between the two variables.

Notably, a significant relationship between farmers' locations and those farmers that will do nothing about the adverse climate change events as indicated by the finding (CI =

99%, X^2 = 79.467, *p*< .01) may likely have been as a result of the climate change being a new phenomenon that is evolving quite rapidly and which the traditional farmers are still grappling with to contain. The level of interactions between these farmers and the institutions/entities that have alternative responsive options, depend on their specific locations. One of the elders in the FGD meeting stated it as such:

> "*Hiyo maneno ya kuongezeka ya hali ya kiangazi, inabadilika kila mwaka. Kuna wale watu wanaishi karibu na town, wanasaidiwa na serikali kuuza ng'ombe yao, na mambo ingine, lakini sisi hapa, tukishindwa kuhama kutafuta malisho ama kutumia mbinu zetu za kiasili, tunakaa tu. Ng'ombe yetu mingi imekufa kwa sababu ya njaa na kiu*". (Those issues of increasing cases of droughts, keep varying every year. There are other livestock farmers who live near urban centers who get government assistance in selling their cattle and other help, but us here, if/when we fail to migrate in search of pastures or are unable to utilize our indigenous knowledge, we just stay, watching many of our cattle die of hunger and thirst).

Table 4.17: The Level of Uptake of CCAS Index Score by Sub-counties

CCAS Variables	**Sub counties**					
	Kajiado West (n=110)	**Kajiado Central (n=131)**	**Loitokitok (n=141)**	**Total**	**X^2**	**p-value**
Increased acreage of land under irrigation farming, yes	2.9	2.1	12.8	17.8	44.506	0.000***
Increased numbers of animal breeds that include the superior breed among livestock farmers, yes	2.1	3.4	13.6	19.1	45.924	0.000***
Involvement in agricultural development planning at village, ward or constituency committees, yes	0.5	1.6	4.7	6.8	13.234	0.001***
[1]Practicing artificial insemination for livestock, yes	0.5	1.0	0.8	2.4	0.447	0.800
[1]Fenced off and reseeded natural pasture, yes	10.5	12.0	2.1	24.6	43.236	0.000***
[1]Better pasture establishment by using more than one grass species to spread the risks, yes	6.5	3.7	2.4	12.6	15.665	0.000***
[1]Increased cultivation of drought resistant crops, yes	0.8	1.8	1.8	4.5	1.101	0.577
[1]Water resource management practices (e.g. water harvesting), yes	11.3	17.5	15.4	44.2	4.042	0.132
Other farming practices, yes	0.8	0.5	0.0	1.3	3.631	0.163
OVERRAL SCORE: LEVEL OF UPTAKE OF MODERN AGRICULTURAL PRACTICES						
MEAN	20.55	21.07	12.20	17.64	8.914	0.000***
Standard Deviation (SD)	23.22	20.35	14.30	19.70		
Level of uptake of modern agricultural practices						
% of Households with No uptake (0), %	14.1	13.6	18.8	46.6	3.914	0.141
% of Households with Uptake (1), %	14.7	20.7	18.1	53.4		

(Field data, 2020)

In terms of how a location's socio-ecological characteristics influence levels of farmers' uptake of the modern CCAS, Table 4.17 below show the level of uptake of modern agricultural practices index score by the study sub counties. These statistics indicate that level of farmers' uptake of irrigation farming with (CI = 99%, $X^2 = 44.506$, $p < .01$), rearing superior cattle breeds (CI = 99%, $X^2 = 45.924$, $p < .01$) and management of fenced off and reseeded natural pastures (CI = 99%, $X^2 = 43.236$, $p < .01$), all vary according to where a farmer practiced his/her farming activities. For instance, the index score for irrigation farming and rearing of superior breed were agricultural technologies easily adopted in Loitokitok Sub-county with index scores of 12.8 and 13.6 respectively as compared with Kajiado West Sub-county that had 2.9 and 2.1 respectively. It can also be concluded that the CCAS are readily acceptable among the crop farmers as compared with the livestock farmers.

This empirical analysis is based on the Situated Learning Theory (SLP) of Lave & Wengner, (1991) which not only appreciates the fact that IK is that knowledge which is acquired within a social interactive environment but also more importantly, within a physical dimension of the learning setting (Henning, 2008; Theodory, 2016). The contextual experience among the people in a given community, living in a geographical area that share unique environmental and climatic characteristics, creates a learning environment, which over time, generates knowledge for sustainable survival; similar to the case of Kajiado farming communities as results show. Since SLT emphasizes on continuous social and environmental interaction between the inhabitants of a physical geographical location and the natural system in which they exist, the individuals are inspired by specific contexts characteristic of that place (Lave, 1988).

4.5.2 Socio-cultural Contexts and Transferability of Indigenous Knowledge in a Community

The study findings show that the indigenous knowledge practices are easily transferable and readily adopted and trusted by majority of the dominant Maasai community that resides within the Kajiado County. To determine this fact, the farmers were asked to indicate what their main sources of information for their existing farming practices, with the study noting the number of "yes" responses on the provided options. As indicated in Table 4.18 below, the major source that the farmers in Kajiado County acquire information that they use in doing their farming activities is through personal experience (261, 68%) by way of learning within a socio-cultural environment. Farmers learn very little about agricultural information from churches or mosques with only 2% of the respondents affirming acquisition of knowledge from these religious entities.

Table 4.18: Sources of information on Indigenous Knowledge-based Farming Practices

Sources of IK	Yes Responses	Percentage (yes responses)
Personal experience	261	68
Parents/Family	146	38
Friends/Neighbors	61	16
Social groups	100	26
Church/mosques	9	2
Community gathering	20	5
Village leaders	120	31

(Field data, 2020)

From the four key sources of learning IK as shown by the above statistics, the farmers simply demonstrated that this knowledge is mainly acquired within a socio-cultural context. Moreover, some of these practices are done by the local farmers because as

Nkatha (2020) argues, some of the agricultural activities are carried out with cultural aspects in mind such as belief in supernatural beings that live in some of the forests and rivers and which must be respected, certain herbs that heal their livestock as well as certain rituals that appease the gods so as to ensure favorable climatic conditions.

Although more about the traditional environmental management practices will be discussed in Chapter 5, it is important to note that the cultural setting within *Maasai* community has proved to be a challenge for implementing agricultural policies developed by the government of Kenya, aimed at addressing adverse effects of climate change. For instance, during the in-depth interview with the Kajiado's Assistant County Director of the Kenya Climate Smart Agriculture (KCSAP), he noted that in remote rural areas of Kajiado County, there are elders who have a strong belief in traditional means of responding to extended droughts. He said:

> "These elders go to an extent of offering explanations as to the reasons for the prevailing harsh weather events, and that by offering some rituals, the conditions would relent. This is of course in addition to insisting that their traditional means of mitigation had worked for them before, and hence no need to introduce new farming technologies. The main challenge here is that, the farmers within the community place high levels of trust and respect to the opinions from these elders"

The above assertion implies that the transferability of agriculture-oriented indigenous knowledge among local farmers is faster and easier as compared to new technological knowledge because of the former being considered to be emanating from trusted sources and easily adaptable. The findings show that although much was learned through personal experience (68%), the same was mainly happening in a social environment in which family (38%) and social groups (26%) played a key role. This assertion is more illustrated inferentially by the index scores for sources of learning indigenous knowledge as they relate to the levels of uptake of CCAS as shown in Table 4.19 below.

The statistics in Table 4.19 indicate manifestly a clear association between where the farmers derive their farming knowledge concerning mitigating adverse weather conditions on one hand and their level of uptake of modern CCAS on the other. For instance, in cases where the local farmers obtained the agricultural-oriented IK from village elders, the net index score show an inverse association between that source of farming knowledge and the farmers' uptake of CCAS. The Chi-square (X^2) value of 47.176 and $p<.01$ indicate that the relation is statistically significant. It is also notable that the respondents who learnt IK practices from village elders would more likely reject uptake (difference of -14.2), while those who got the knowledge from social groups are more likely to have a high CCAS uptake.

Table 4.19: Relationship between the Sources of IK and Levels of Uptake of CCAS

Sources of IK	**Index score; Level of uptake of modern agricultural practices**					
	No uptake	Uptake	Difference	X^2	P-value	Significance
Personal experience	33.5	34.8	1.3	1.980	0.159	No
Parents/Family	16.2	22.0	5.8	1.621	0.203	No
Friends/Neighbours	3.7	12.3	8.6	16.311	0.000***	Yes
Social groups	6.3	19.9	13.6	27.796	0.000***	Yes
[5] Church/Mosques	1.3	1.0	-0.3	0.297	0.586	No
[5] Community gathering	2.9	2.4	-0.5	0.599	0.439	No
Village leaders	22.8	8.6	-14.2	47.176	0.000***	Yes
[5] Media	14.1	25.1	11.0	11.145	0.001***	Yes
[5] Extension staffs	0.5	3.7	3.2	7.802	0.005***	Yes
[5] NGOs	1.0	9.2	8.2	23.051	0.000***	Yes
Overall score: Sources of Indigenous knowledge						
Mean	8.54	15.49	6.9509	t=-4.657	0.000	Yes
SD	11.40	16.82				
Std. Error Mean	0.85	1.18				

(Field data, 2020)

The above findings are in consonant with the observed differences between the methods of farming (both arable and livestock) in regions near urban centers and those in the remote rural regions. The famers within urban regions are easily accessed by the government and NGO agricultural extension experts, in addition to being areas that demonstration farms are easily set up. One Kenya Red Cross field officer within the Loitokitok Sub-county went further to confirm credence of this observation. In an in-depth key informant interview, he explained that a drip irrigation project on a 20 acre farm was rolled out in 2014, to improve food security among *Maasai* pastoralists by doing maize farming in Kisanjani Location.

Although there were challenges of transforming the pastoralists towards adopting this climate change form of agriculture, especially as exhibited by how some of them drove their cattle into the maize farms during extreme droughts, somehow the harvest returns encouraged the farmers to embrace the climate-smart agriculture. The officer explained:

> "Our observation is that the farmers have a mindset that the major economic asset is livestock. Their perception about the survival of their cattle is extremely important and is hinged on ensuring that anywhere that they can access pasture for the cattle will be used for that purpose regardless of the consequences of overgrazing or destruction of crops. It's a mindset that has been entrenched through the knowledge generationally acquired and which is trusted".

Other similar studies, particularly on the importance of indigenous knowledge systems in addressing disaster risk reduction, have indicated that IKSs are easily transferable within communities that share same cultural contexts (Shaw *et al*., 2008; Tanyanyiwa, 2019). Since this knowledge is traditionally transferable over generations and is not documented, most of the respondents stated that the knowledge on agricultural practices is acquired through observations from the farming activities as carried out by the older members of the communities within a social context of family, clan and other social networks.

In contrast, the results show that forums that may draw participants from a multi-ethnic or multi-cultural spectrum such as churches/mosques (2%) and other community gatherings (5%) are considered to be the least likely sources of acquiring indigenous knowledge. In concurrence with other similar studies, these findings manifest indigenous knowledge system as being an epistemologically grounded concept that is embraced by indigenous communities believing that their experience in interacting with their environment defines the reality (Ansah and Siaw, 2017; Fre, 2018; King, 2010; Lwoga *et al*., 2016; Nkuba *et al*., 2020; Thapa *et al*., 2008).

The anticipated benefit of improving household levels of food security through engaging into this drip irrigation, helped develop adaptation self-efficacy towards mitigating adverse effects of climate change – particularly prolonged periods of drought for the crop farmers. According to the Model of Private Proactive Adaptation to Climate Change (MPPACC) developed by Grothmann and Patt, (2005), these farmers easily adapted to new climate smart agriculture because dissemination of information was easily facilitated by the demonstration farm; enhancing knowledge and subsequently shaping their perceptions and attitudes in favor of the CCAS. On the contrary, the major go-to option during the prolonged period of drought for the pastoralists, who are the majority group of farmers in Kajiado County, is migration (nomadism). Changing this nomadic way of life which has been acquired traditionally across the generations is extremely slow as indicated by these findings.

4.6: Household Knowledge, Perception and Attitudes towards Climate Change and Adaptation Strategies

The study sought to establish the level of knowledge among the farmers about CC and its effects on the agricultural productivity. Their perceptions with regard to impacts of CC and attitudes concerning the scientifically oriented CCAS were also analyzed. The results showed that only 31 respondents (8%) had no idea about CC as shown in Figure 4.7 below, indicating that although a significant number of farmers had some knowledge on CC and its effects, their perceptions and attitudes about ways of responding to the phenomenon largely favored the IK in ways that affected their uptake of CCAS.

4.6.1: Household Knowledge on Climate Change and Adaptation Strategies

To obtain the critical data on this aspect, the farmers were asked to state whether they know or had ever heard about climate change. On a 4 Likert scale responses (1- know a lot, 2- Know, 3- Know a little and 4- Don't know), the majority of the households responded that they know little about climate change phenomenon (62%) while 24% agreed that they know about the phenomenon as shown by the pie chart, Figure 4.7 below. Notably, 8% of the respondents had no idea about climate change.

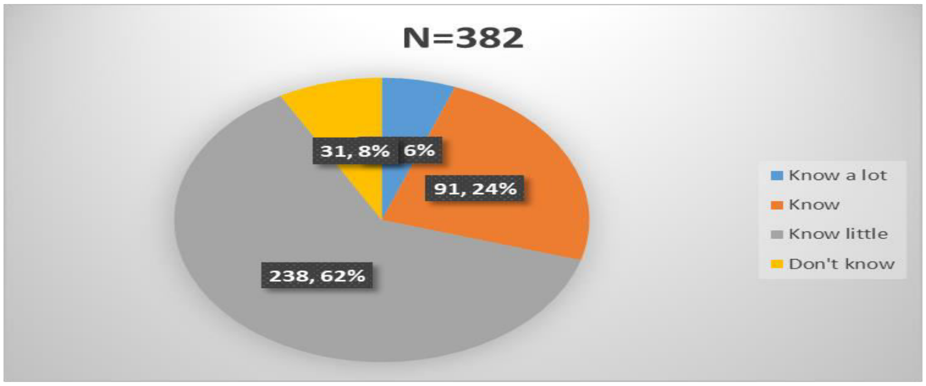

Figure 4.7: Knowledge about CCAS (Field data, 2020)

These findings having established that there is some knowledge about CC among the farmers, also sought to determine whether that awareness could influence them to make certain decisions in responding to the adverse impacts. The farmers' knowledge about climate change was further analyzed in evaluating as to whether they understood the causes of climate change; with the aim of determining any current detrimental farming practices which can be addressed as a way of limiting the impacts.

The household respondents were therefore asked to pick on options including environmental degradation, pollution, deforestation, modernization (industrial and urban expansion) responding in the affirmative at 66%, 69%, 78%, and 46% respectively. This shows a significant level of knowledge about causes of climate change. The above findings therefore were envisaged as an indication that the decisions by farmers in Kajiado County concerning the negative impacts of CC would automatically suffice.

Table 4.20: Farmer's Knowledge about CCAS and the Uptake

Independent variable	Climate change response/Dependent variable	Pearson Chi-Square	Df	Asymp. Sig. (2-sided)	Significance
Climate change awareness					
	Proportion acreage of land under irrigation farming.	1.522	2	.467	Insignificant
	Proportional numbers of animal breeds that include the superior breed among livestock farmers.	.496	2	.780	Insignificant
	Practicing artificial insemination for livestock.	3.322	2	.190	Insignificant
	Involvement in agricultural development planning at village, ward or constituency committees	6.394	2	.041*	Significant
	Fenced off and reseeded natural pasture	5.002	2	.082	Insignificant
	Type of pasture establishment by using more than one grass species to spread the risks	16.712	2	.000**	Significant
	Increased cultivation of drought resistant crops	2.242	2	.326	Insignificant
	Water resource management practices (e.g. water harvesting)	20.504	2	.000**	Significant
Awareness of causes of Climate change-Deforestation					
	Proportion acreage of land under irrigation farming.	4.077	1	.043*	Significant
	Proportional numbers of animal breeds that include the superior breed among livestock farmers.	10.236	1	.001**	Significant
	Practicing artificial insemination for livestock.	.611	1	.434	Insignificant
	Involvement in agricultural development planning at village, ward or constituency committees	9.788	1	.002**	Significant
	Fenced off and reseeded natural pasture	22.381	1	.000**	Significant
	Better pasture establishment by using more than one grass species to spread the risks	7.733	1	.005**	Significant
	Increased cultivation of drought resistant crops	2.627	1	.105	Insignificant
	Water resource management practices (e.g. water harvesting)	26.789	1	.000**	Significant

(Field data, 2020)

The Chi-Square results as shown in Table 4.20 above demonstrate some sort of dichotomy between the farmers' adaptation intentions in regard to those who are simply aware of climate change and those that have further knowledge; being conversant with the causes of climate change. For instance, there was no significance association between the responses of farmers who stated that they know about climate change and the willingness to rear livestock whose herd include the superior breed. However, the results show a significant association between those that claimed knowledge about deforestation being a cause of climate change (independent variable), and willingness to rear livestock whose herd include the superior breed (dependent variable).

This association is indicated by statistical measure of Pearson Chi-square of with a degree of freedom (df) of 1 with CI=99%. X^2 =10.236, $p < .01$. This findings show that a farmer's knowledge of the causes of climate change is likely to influence the intention of that farmer to adopt a risk reduction agricultural practice. This study outcome closely conforms to the findings by Ameso *et al.* (2018), who used Community Managed Disaster Risk Reduction Assessment (CMDRRA) and reported that the identification of natural hazards that *Maasais* encounter, facilitates their willingness towards reducing the risks associated with that hazard.

The human actions and behavior which demonstrate their decision-making tendencies, are normally predicted by knowledge, attitudes and perceptions (Crano and Prislin, 2006). One of the theoretical underpinning of this study was based on the theory of planned behavior (TBP), developed empirically, establishing that an intention to make a decision to behave towards a particular practice is influenced by knowledge, attitudes, subjective norms and perceptions (Ajzen, 1991). As Maleksaeidi and Keshavarz (2019) report in their findings, the theory confirms from the "findings reinforcing the available evidence regarding the significance of moral norm and knowledge in development of environmental intention”. Accordingly, a number of considerations about improving farmers' intention to preserve on-farm biodiversity are recommended”.

Knowledge of what the climate change phenomenon entails enhances the farmers’ risk perception and level of preparedness. Knowledge being an aspect of possession of information concerning a scenario or a phenomenon will likely shape a person’s decision to act in a certain way (Schrader and Lawless, 2004). The awareness of an individual farmer concerning a given new agricultural practice or innovation is significantly intertwined with the knowledge that individual has about that practice (Meijer *et al.*, 2015). In the process, the farmer will most likely make a decision to either adopt or reject the practice based on the information he/she has on the innovation.

These findings indicate that the large proportion of households had an idea about the phenomenon signifying the fact that there have been locally developed mechanisms of responding to negative effects on their farming activities. Using traditional pastoralism as the dominant food production system, most of the households in Kajiado County base their response to climate change effects on indigenous knowledge that has been generated over a period of time. This argument is bolstered by other similar studies whose findings revealed that there is definite evidence of pastoralism resilience to negative effects of climate change (Ameso *et al*., 2018).

This finding is critical because as Nguyen *et al.* (2019) on their study about knowledge for enhancing farmers’ mitigation and adaptation behaviour to climate change posit that

“Farmers' knowledge of climate change causes and effects doesn't affect their adaptation but direct their attitudes towards mitigation”, farmers perceptions on impacts of CC are key in adaptation. Their findings conforms with the results in this study as the Pearson Chi-square show a significant association between knowledge about climate change causes and adopting to new farming technologies variables indicating that farmers with this knowledge have not adopted some of the climate smart agricultural practices as shown in Table 5.18.

In conformity with what Najafi *et al*. (2017) reported on the Theory of Planned Behavior (TPB) as it relates to disaster preparedness, a clear understanding of the climate change generated risks by farmers seen in the prism of the prevailing mitigation measures, will inform on their intention to adapt to new agricultural practices. For example, a farmer who possesses knowledge on climate smart agriculture strategy like sprinkle agriculture on horticulture is likely to be willing to demonstrate that knowledge so as to benefit from its efficacy in alleviating climate change risks. This was especially demonstrated in areas where arable farming including some sprinkle irrigation was evident within Loitokitok Sub-county where the researcher visited as shown in Plate 1 at a local primary school.

Plate 4.1: Researcher in the Field Location
Source: Field data, 2020

This study also sought to determine if the local farmers did anything in response to the phenomenon, being knowledgeable about risks of climate change on their food production. On being asked what mechanisms they used to respond to climate change, the respondents gave varied responses, but the findings show that majority would opt for the traditional response mechanisms of either migrating (nomadism) or resign to their fate. For instance, those farmers who were asked whether they would opt for migration or resign to their fate the responses were 60% and 48% respectively as shown in Table 4.21

Table 4.21: Farmer's Responses to Adverse Effects of Climate Change

Options for Responding to Extended drought	Responses	
	Yes %	No %
Resign to our fate and do nothing	48	52
Appeal to government for help through local administration	10	90
Wait for Humanitarian assistance from NGOs, civil societies etc.	27	73
Use traditional IK to survive	28	72
Seek help within social networks; relatives, clan, neighbors	3	97
Migration	60	40

(Field data, 2020)

These responses also reveal that the farmers are not keen on seeking external help during these times of extended drought, showing that just a few households would either appeal to government for help through local administration or wait for humanitarian assistance from NGOs/civil societies (10 % and 27% respectively).

As will be argued later on the household perception on climate change in the subsequent section below, the understanding of the trends of climate change is mainly based on the realization that there have been increased cases of extended droughts. The farmers, who are mainly pastoralists, focus on how they can respond to these increasing trends of drought. Their affirmative responses therefore point on their mitigation mechanisms in search of pastures and water (59%) and other indigenous knowledge practices (27%). Among other indigenous knowledge practices include planting specific indigenous cereal, fruits and vegetable species that are drought resistant.

The farmers also prefer using animal manure as organic fertilizers as they claimed that "modern" fertilizers are killing the soil. Other traditional climate change mitigation practices include sub-division of pasture lands and utilizing rotational grazing as well as burning of medicinal herbs, producing smoke that would either drive away or kill harmful insects. In conclusion therefore, in spite of the knowledge of CC effects among the farmers in Kajiado County on their agricultural activities, they still preferred their traditional response mechanisms, mainly migration to sustain their productivity.

4.6.2: Household Risk Perception on Climate Change and Adaptation Strategies

Apart from respondents agreeing that there have been increased cases of extended drought over the last 10 years (85%), their perceptions about other specific indicators of CC is quite low as shown in Table 4.22 below.

Table 4.22: Farmer's Climate Change Risk Perceptions

Climate Change indicators	Responses	Frequencies	Percentages
Increased cases of extended drought	Yes	324	84.8
	No	58	15.2
Increased pest invasions on crops	Yes	160	41.9
	No	222	58.1
Increased Cases of very high temperatures	Yes	135	35.3
	No	247	64.7
Increased Cases of very low temperatures	Yes	11	2.9
	No	371	97.1
Increased cases of storms	Yes	15	3.9
	No	367	96.1
Increased cases of floods	Yes	185	48.4
	No	197	51.6

(Field data, 2020)

The above results also show that the farmers, being residents of an ecological region largely characterized with arid and semi-arid conditions had not noticed any increases of storms with only about 4% of them affirming to this; nor observed any notable reduction of temperatures having only 3% of them agreeing. In a nutshell, taking into the consideration that the main adverse effect of CC that would affect their key agricultural activity of pastoralism is drought, the farmers in Kajiado County perceive that the major threat to their survival is the trend of increasing cases of extended droughts that deplete water and pastures for their cattle. A further inferential statistical analysis showed that an increasing number of cases of extended droughts as a CC indicator has an association with the farmers' decisions on whether to uptake or not to uptake the CCAS as shown by the index scores in Table 4.23 below.

Table 4.23: Relationship between CC Indicators and the Level of Uptake of Modern Agricultural Practices among Farmers

CC indicators	Index score; level of uptake of modern agricultural practices			Results		
	No uptake	**Uptake of**	**Difference**	**X^2**	**P-vale**	**Sigificance?**
[1]Very heavy rain, yes (%)	43.5	39.0	-4.5	26.869	0.000***	Yes
[1]Storm, yes (%)	1.0	2.9	1.9	2.492	0.114	No
[1]Drought, yes (%)	42.9	41.9	-1.0	13.861	0.000***	Yes
[1]Pest invasion on crops, yes (%)	17.3	24.6	7.3	3.163	0.075*	Yes
[1]Very high temperatures, yes (%)	10.5	24.9	14.4	24.155	0.000***	Yes
Wild fires, yes (%)	0.5	0.5	0.0	0.019	0.891	No
Floods, yes (%)	33.5	14.9	-18.6	73.581	0.000***	Yes
Landslides, yes (%)	0.8	0.8	0.0	0.028	0.866	No
Thunder, yes (%)	1.8	4.5	2.7	3.127	0.077*	Yes
Very low temperatures, yes (%)	1.3	1.6	0.3	0.006	0.939	No
Overall score climate change; Extreme events						
Mean	49.44	49.90	0.464	t= -0.181	0.856	No
SD	19.51	28.87				
Std. Error Mean	1.46	2.02				

(Field Data, 2020)

These results show that the farmers view about the CC indicators such as increased heavy rain (CI=99%. X^2 =26.869, $p < .01$), increased droughts (CI=99%. X^2 =13.861, $p < .01$), increasingly high temperatures (CI=99%. X^2 =24.155, $p < .01$) and flooding (CI=99%. X^2 =73.581, $p < .01$) are associated with their willingness to either adopt or not adopt CCAS. This is interpreted that the farmers' CC risk perception concerning these adverse events predictively causes them to make CC adaptation decisions.

The findings show that the respondents would not likely uptake CCAS based on their risk perceptions on floods, heavy rain and droughts with their respective difference in index scores of -18.6, -4.5 and -1. This means that the communities would be resilient in the face of these hazards based on their existing IK developed climate change adaptation approaches. On the other hand, the respondents are likely to opt for CCAS in cases of very high temperatures; probably because they don't have any mitigation measures to address their adverse effects.

In concurrence to the findings in this study, a study by Mwangi (2016), among the pastoralists, showed a more practical indicator in terms of the respondents emphasizing their understanding of drought to be scarcity of pasture and rainfall. This perception explain other parameters such as delays in onset/early termination of long rains, that may have been mundane in the view of the correspondents.

More succinctly, the persistent cases of prolonged droughts exercabate socio-economic vulnerabilities among the *Maasai* communities who mainly depend on pastoralism as a livelihood. They easily relate to the ravages of drought as it deprives of their livestock of means of survival; pasture and water, which subsequently reduces the households' herd sizes through deaths. Increased cases of prolonged drought have resulted into them either abandoning the weak cattle in the dry pasture to die or sell these "treasured assets" at throw-away prices. As one elder during the FGD stated:

> "*Zamani hatukuwa na kiangazi mingi kama siku hizi. Tulikuwa na ng'ombe hata elfu mbili, tatu hata tano pamoja na mbuzi na kondoo wengi sana kwa sababu nyasi na maji ilikuwa mingi. Maziwa ilikuwa mingi ya kulisha watoto. Siku hizi hata mtu akiwa na ng'ombe elfu moja ni bahati tu,*

ndio njaa iko mingi". (In the yester years there were no frequent cases of drought. We used to own between 2,000 and 5,000 herds of cattle including sheep and goats because water and pastures were available. We had enough milk to feed the children. Nowadays one would be lucky to have 1,000 cows and that's why we have a lot of famine).

The above argument strengthens the explanation to the effect that the perception of the local farmers about the climate change in Kajiado County has largely been seen in the prism of increasing drought vulnerabilities. As Mwangi (2018) elucidates on characteristic nexus that exists between the *Maasai's* human ecology–political economies of what generates drought-vulnerabilities, the prevailing production system mainly depends on favorable climate conditions that support the existence of water and pasture for their livelihood assets; the livestock.

Based on the results illustrated in Table 4.22, and Table 4.23, it can be deduced that the farmers' climate change adaptation intentions are formed by their acceptance and perceptions concerning climate change, just as it was found in a study about farmers' CC perceptions and adaptation intentions (Mitter *et al*., 2019). This is because, with knowledge on climate change, the farmer undergoes a process of motivated reasoning to enable him/her intuitively form a risk and opportunity appraisal in regard to a particular farming practice as conceived in the Theory of Planned Behavior (Ajzen, 1991).

In comparison with the Kenya Meteorological Department (KMD), the farmers' perception about climate change indicators, there are significant non-conformities. The statistics for a period of the 10 years under observation in this study which was obtained from KALRO, recorded at Maasai Rural Training Centre Station within Kajiado County (Appendix VII), show that there has been a progressive reduction amount of annual precipitation; a trend attributed to climate change.

Additionally, the risk awareness of the farmers may be perceived differently because of variances of time and socio-economic attributes that are prevalent in a place (IPCC, 2014). In agreement with this fact, the findings in this study show that there is an association between the adaptation capacity to respond to the ravages of extended periods of drought to pastoralism (the dominant production system) and the way the local farmers perceive the risks of climate change. Furthermore, the extent or scale of the farmers' vulnerability and exposure to drought hazards has an influence on the level of risk awareness, hence shaping the farmers' adaptation intentions. Farm and regional characteristics can also significantly modify the way a farmer will appraise the climate change related risks (Mitter *et al*., 2019).

Table 4.24: Farmer's Willingness towards Adopting CC Practices

Willingness towards adopting Climate Change practices (Would you consider adopting this farming practice?)	**Kajiado West % of "Yes" responses**	**Loitokitok % of "Yes" responses**
Put farming land under irrigation farming.	90	65
Do cultivation of drought resistant crops	97	95
Apply water resource management practices (e.g. water harvesting)	61	58
Rear superior livestock breeds.	93	63

(Field data, 2020)

For instance, farmers in a more arid Kajiado West Sub-county were readily receptive to climate change adaptation farming practices as compared to farmers in Loitokitok Sub-county that receives more frequent rainfall and do crop farming as shown in Table 4.24 above. These comparisons were analysed for purposes of determining what would be the preferences of farmers from two distinct ecological areas and who practice diverse farming practices. These findings reveal that the farmers in Kajiado west who encounter increasingly frequent cases of drought and whose high levels of drought vulnerability is manifested by regular incidents of livestock deaths are more willing to adopt to climate smart agriculture. For example, 95% of the farmers in Kajiado West were willing to put their farm land under irrigation farming as compared to farmers of Loitokitok; rather than depend entirely on rain-dependent agriculture.

However it is extremely important to explain the irony of these findings based on the fact that these (farmers in Kajiado West) are known to uphold the IK practices most (see Table 4.15); based on their preferred response mechanisms towards adverse effects of climate change as compared to those in Loitokitok Sub-county. Behaviorally, their willingness is borne out of their perception of the future risks of CC, yet when it comes to the actual adoption action, they still stick to the more familiar IK practices. This is in consonant with a study that was done on willingness to adopt (WTA) a technology on one hand and willingness to pay (WTP) for the same technology.

There are factors that may influence both sides of the dichotomy in which a farmer will actually assess the benefits of adopting the new practice as she/he mirrors these benefits against the costs involved (Karytsas *et al*, 2019). This explains the case of the farmers in Kajiado West, in which these two contradictory findings find them willing to “escape” the ravages of extended drought by accepting to alternative means of response, yet not ready to incur any forms of liabilities in doing so.

4.6.3: Farmer's Attitudes and Climate Change Adaptation Strategies

Based on the Theory of Planned Behavior, farmers' intentions to embrace an agricultural technology can also be predictably explained by their attitude, which is one of the influencing intrinsic factor (Ajzen, 1991; Maleksaeidi and Keshavarz, 2019; Meijer *et al*., 2015; Mitter *et al*., 2019). An attitude in the context of this study refers to the importance that a farmer assigns on the climate change related risks and also on adaptation to a particular agricultural practice. Consequently, the household representatives were first asked what they thought about climate change effects and also about the existing modern adaptation strategies.

The attitudes of the farmers were mainly examined in relation to what their views are towards climate change adaptation strategies. This was specifically done to determine if those attitudes were shaped by their belief in indigenous knowledge. It was therefore important to examine if their knowledge about climate change in their view, in terms of the perceived risks and impacts (farmers' climate change risk and opportunity appraisals) of climate change could be addressed by means of their indigenous knowledge practices. Further, based on their indigenous knowledge, the study sought to determine if the farmers could identify opportunities that could be utilized as a result of the climate change phenomenon.

The results shown in Table 4.24 further reveal that what the farmers experience as the main impact of climate change is the frequent episodes of drought (40%) which according to them, has occasioned lack of water and pasture for the livestock, threatening their principal livelihood assets. Since this question was open ended, all the suggested impacts came from the household representatives. A closer scrutiny at these suggestions such as death of livestock (about 15%), hunger (about 9%), migration of animal and human population (5%) and poor agricultural production due to low income are all closely related to the impacts of droughts (about 5%) - an aggregate of 74%. This therefore can be interpreted to mean that what the farmers view as the main effect of climate change on their lives, livelihood and food security is climate change trends that are manifested through frequent extended periods of droughts.

Table 4.25: Farmers' Perceptions about Impacts of Climate Change

What are the impacts of climate change in the community?	Frequency	Percentage
None	9	2.4
Death of livestock	57	14.9
Hunger	33	8.6
Drought, lack of water and pasture	149	39.0
Migration of animal and human population	19	5.0
Destruction of property like schools and business premises	18	4.7
Poor agricultural production due low income	18	4.7
Pests and Diseases	38	9.9
Floods	15	3.9
Unpredictable weather	8	2.1
High cost of living	5	1.3
Increased food and livestock production	13	3.4

(Field data, 2020)

This understanding by the farmers reflects their ability to do climate change risk and opportunity appraisal as suggested in the Model of Private Proactive Adaptation to Climate Change (MPPACC) developed by Grothmann and Patt, (2005) and illustrated in Figure 2.4. This model clearly illustrates how several individual and environmental factors interact to eventually determine a farmer's agricultural adaptation intention. On being asked whether they have ever heard about modern agricultural technologies/practices that address challenges related to climate change, majority of households at 74% responded to the affirmative. When asked why the farmers with all this knowledge still do farming practices such as overstocking which leads to overgrazing, the Olepolos Sub-chief during an in-depth key informant interview averred:

> "Our people have believed that this unfortunate phenomenon of increased cases of drought kill their cattle eventually. They feel that they would rather have many animals so that in the event that there will be livestock deaths, they will remain with some cattle. The belief that cattle is their principle unit of wealth has not helped matters either."

The above statement clearly shows that the perceptions of the Kajiado farmers on the impacts of climate change still favor the more traditional IK practices in spite of their knowledge about the CCAS.

However, as per the operational definition of the term "farmer's attitude", this study has revealed that though a significant number of farmers in Kajiado County appreciate that there has been a trend of increased tendencies of droughts (39%), which indicate climate change phenomenon in their area, they still don't believe that the solution is the CCAS. The MPPACC model elements that show the progression of motivation towards adopting the CCAS among farmers in Kajiado County demonstrate that the indigenous knowledge practices collectively as being an interference with their individual cognition causing an attitude of avoidance (Mitter *et al*., 2019).

Farmer's attitudes are formed in the context of preservation of existing environmental beliefs and cultural norms both of which are practiced based on the indigenous knowledge. Violation of these beliefs by adopting other “foreign” farming technologies may therefore be viewed as undesirable as it would have a negative effect on things that they really value (Mitter *et al*., 2019; Sanderson and Curtis, 2016; Stern, 2000).

CHAPTER FIVE

INFLUENCE OF INDIGENOUS KNOWLEDGE PRACTICES ON UPTAKE OF CLIMATE CHANGE ADAPTATION STRATEGIES

5.1: Introduction

This chapter discusses the findings on how indigenous knowledge practices among the local farmers in Kajiado County affect the uptake of scientifically designed climate change adaptation strategies. A number of variables that characterize both indigenous knowledge and climate change adaptation strategies were examined to establish associations and correlations.

5.2: Management of Indigenous Knowledge Systems and Uptake of Climate Change Adaptation Strategies

The findings clearly indicate that there are certain intrinsic aspects of farmers' agricultural practices that are inextricably held by local farmers and observed due to their indigenous knowledge and which subsequently either slow the uptake of CCAS, or make farmers shun the new farming technologies all together. These innate aspects determine how the farmers manage their natural resources, especially soils and foliage (forests and pastures), water resources, their agricultural production systems (livelihoods) as well as how they predict weather events.

5.2.1: Farmers' Knowledge about Climatic Changes

The study results show that in the event of unusual adverse climatic events, the farmers have over the years developed adaptation strategies that, in their view, have mitigated impacts of the hazards that threaten their food production and livelihoods. In exercising their beliefs in traditionally held practices, their tendency in adopting new agricultural technologies has been very slow.

The study sought to establish farmers' views on climate change as per occurrence of extreme events. The findings shown in Table 5.1 below indicate that majority of farmers, who were interviewed, agreed that the main indicator for the occurrence of the climate change phenomenon in their localities was frequent cases of extended droughts with 85% (324) of them responding in the affirmative. Similarly, 82% (315) of them agreed that although rainfall was rare in their locality, when it did occur, it was heavier than normal. In terms of specific existing ecological characteristics, most of the farmers that were interviewed in Loitokitok Sub-county, which experiences more annual rainfall and favors crop farming, had different views concerning CC phenomena in their area as compared to those in the more arid Kajiado West and Kajiado Central on temperatures and pest invasion indicators.

Table 5.1: Farmers' Views on Climate Change as per Occurrence of Extreme Events

	Kajiado West	**Kajiado Central**	**Loitokitok**	**Total**	**Percentage**
Occurrence of extreme events	Have you witnessed an increase of the following extreme events in your localities? ("yes" responses)				
Droughts	100	91	133	324	85
Very Heavy rains	102	77	136	315	82
Floods	66	49	70	185	48
Storms	5	1	9	15	4
Very High Temperatures	28	23	84	135	35
Pest invasion on crops	23	14	123	160	42

(Field Data, 2020)

For instance, 84 out of 141 farmers (60%) believed that there has been an increasing trend of very high temperatures while 123 (87%) of them affirmed that cases of pest invasions on their crops have been on the increase. These results indicate that the Kajiado County farmers have an understanding of the climate change trends; a knowledge that can lead them to form risk perceptions and eventually shape their adaptation intentions.

On how the farmers were able to determine the unusual weather trends, the study involved in-depth key informant interviews with elders that were viewed to be well informed about how to predict weather patterns within the community. All the three elders that were interviewed from the three sub-counties had their views concurring on the methodologies that they used to do weather prediction. One specific elder during an FGD in Kajiado West stated:

> "*Tuko na njia mingi ya kuangalia vile kunyesha ya mvua inaendelea, hali ya kiangazi na hata joto. Iko mimea na miti fulani sisi tunaangalia majani na maua yake kama mvua iko karibu, ama kama itaendelea kukuwa kiangazi. Na pia, hata tunaweza kuchinja mbuzi na kuangalia vile rangi ya matumbo yake iko. Saa ingine tunaangalia tu tabia ya ndege na wanyama hata kukauka ya nyasi na inasaidia kujua kama joto iko kiwango gani*". (We have so many ways which show us the rainfall patterns, drought trends and even temperature levels. There are certain plants and trees whose leaves and flowers clearly indicate to us if rain will soon fall or if the drought will persist. We can also slaughter a goat and observe the condition of its intestines. At times we just observe the behavior of birds and animals in addition to looking at drying of grass for us to determine levels of temperatures. He added that having used these indigenous knowledge, observatory tools have proved over the years that they are accurate, and therefore can be trusted).

Based on the MPPACC model (Figure 2.3) that was used in this study to determine the farmers' climate change as well as adaptation appraisals, it was observed that the above empirical findings are indicative of the general fact that an individual farmer's evaluation of climate change trends may lead him/her to form a risk avoidance decision. The results therefore indicate that these farmers' risk and opportunity appraisals which affect their socio-cognitive pathways can be positively associated with their adaptation intentions towards climate variations. This conclusion is informed by the fact that the farmer's appraisals based on their responses to questions concerning climate change parameters may influence their decisions to limit agriculturally related physical or monetary damages that emanate from extreme weather changes. Specifically, the majority 85% of the farmers interviewed who indicated that there has been an increasing trend of extended periods of drought (increased periods without rainfall using their traditional ways of weather monitoring), are obliged to adopt response mechanisms that will maintain and sustain the availability of pasture and water for the pastoral farmers.

The farmers risk perception of this CC phenomenon has been discussed extensively in Chapter Four. According to the Table 4.19 that shows findings on what the farmers considered as the biggest impact of CC to their livelihoods, about 40% of them indicated that the biggest threat to their farming was the diminishing pastures and water resources due to the increasing incidences of long droughts.

The choice of response approach whether CCAS or indigenous knowledge is further determined by the socio-economic and environment context factors as illustrated in the MPPACC model (Figure 2.3). These factors include socio-demographic and economic characteristics of the farmer including one's age, gender, level of education, land ownership, household size, sources of income/type of agricultural activity and farm size. As had been discussed in Chapter Four by the illustration of Table 4.2, most of these characteristics are associated with uptake or no uptake of the CCAS.

Environmental and ecological contextual characteristics were also analyzed based on the farmers' responses and results showing that farmers applied either indigenous knowledge practices or CCAS measures in mitigating the impacts of CC depending on these considerations. For instance, as explained in the findings shown in Table 4.9, 85% and 82% of the farmers interviewed in more arid areas of Kajiado West and Kajiado Central respectively, indicated that they would normally opt for a more IK oriented practice of migration during longer periods of drought. On the other hand, only 10% of the farmers in more wet and high altitude areas of Loitokitok being in favor of this practice.

Further scrutiny of the findings in Table 5.1 above can also be interpreted by observing the existing types of farming. For instance, since the main agricultural production activity in Kajiado West and Kajiado Central is pastoralism, they believe that the traditional practice of migration to greener areas in search of pastures and water in times of drought works well for them as the practice allows several paddocks to regain their nutrient reserves. Similarly, most of the respondents believe that the preservation of certain forest plants, rivers and streams has over the years mitigated against drought effects. They also maintained that management of livestock diseases by use of traditional herbs has been more effective in curbing epidemics and deaths. The findings have therefore been illustrated quantitatively through descriptive analyses, by use of frequency tables, bar graphs and pie charts and inferentially using tools such as Chi-square, logistic regressions in the subsequent sections of this chapter. Qualitative data has also been thematically analyzed and presented together with narratives.

The findings from this study established that majority of farmers placed a lot of trust in utilizing the IK practices other than other "externally" recommended agricultural technologies. This was determined from their responses on how long (period) they have used IK agricultural practices in combating adverse impacts of weather events in terms of years. Majority of the farmers in Kajiado County have utilized indigenous knowledge (IK). Only 2.1% have never applied IK in their farming (Figure 5.1). Nearly a half (48.4%) of the respondents reported that they had been using IK practices in their everyday farming and livestock keeping activities between 10 – 29 years.

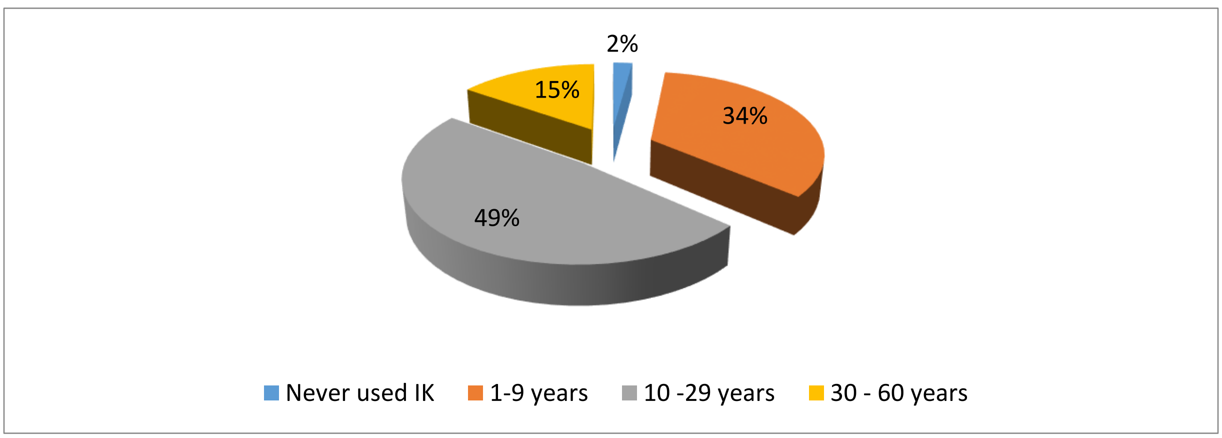

Figure 5.1: Number of Years a Farmer has been Using IK Practices (Field data, 2020)

Further, T-Test analysis was done to indicate the mean differences between the duration of utilization of IK and the level uptake of modern agricultural practices. The results revealed higher utilization of IK knowledge among farmers who did not use modern agricultural practices than those farmers using modern agricultural practices by -3.316 mean margin of error (Table 5.2). Furthermore, there was a strong statistical difference (t=2.632, p=0.009) of duration of IK application between farmers who utilized and who did not utilize modern agricultural practices as illustrated in Table 5.2 below. Succinctly, it can be deduced that farmers who had a long-term experience using IK practices were more unlikely to embrace scientific or new farming technologies in adapting to the climate change phenomenon.

Table 5.2: Differences between Duration of Using IK and the Level of Uptake of Modern Agricultural Practices among farmers in Kajiado County

	index score; Level of uptake of modern agricultural practices				
	No uptake (N=178)	Uptake (N=204)	Mean Difference	T	Sig.
Mean	17.860	14.544	-3.316	2.632	0.009***
Std. Deviation	12.909	11.710			
Std. Error Mean	0.968	0.820			

(Field data, 2020)

Further, inferential analyses were conducted to establish an association between the lengths of time a farmer has been practicing IK and his/her likelihood to adopt individual CCAS variables. Chi-square tests show that a number of CCAS elements that were considered to be the dependent variables in this study indicate varied associations with the length of time a farmer had practiced IK.

The results from the study reveal that the majority of the local farmers value and easily apply knowledge that has been traditionally passed on to them from their trusted elders who are perceived to have better understanding about handling issues of environment and farming. This outcome conforms to a study by Lwoga *et al*. (2016) on “Social, Cultural and Educational Considerations of Indigenous Knowledge in Developing Countries”. They reported that traditional communities have a well elaborate but concise knowledge system which can easily be internalized by the members and which is “individualized and used as a source of power, status and income in their communities”.

The community members readily embrace the tenets of this knowledge sometimes to an extent of attaching taboos on people that fail to adhere to them. For instance, the community prohibits the cutting of certain types of shrubs and trees that are considered sacred. To corroborate this fact, an officer working in the Kajiado County’s Climate Smart Agriculture Project, stated during an in-depth key informant interview that:

> “The locals largely believe in the set of traditional agriculture knowledge, especially on pastoralism, and rain prediction; which they use in challenging the modern knowledge proponents with. They even argue that much of the knowledge we purport to teach them, they either already have it or has been ‘borrowed’ from them!” He went ahead to explain that, during their field visits, they on several occasions, found the locals having dried and stored grass in a traditional manner, to be used to feed livestock during dry seasons. They also preserved certain paddocks from any grazing for some time to “replenish” them as well as protecting water pans and river banks.

The study sought to confirm which kind of information was trusted and applied in managing climate variability and any other adverse conditions that rendered the community vulnerable to subsequent impacts. It was important to determine what form of knowledge the farmers utilized in responding to the negative impacts of the natural events on grazing rangelands, water sources, soils and forests. The data was therefore analyzed in terms of the period in the past that farmers have been utilizing IK practices in managing the natural resources, environment, crop and livestock farming. This analysis was based on Situated Learning Theory (SLT) forwarded by Lave & Wengner (1991) that is based on the assumption that a learning process takes place among social acquaintances, in an environment of constant and ongoing interaction within contextual experience over a period of time and gets entrenched in a particular society (Vygotsky, 1978; Theodory, 2016).

Table 5.3 overleaf shows that long periods of practicing IK influences the farmers' likelihood of rearing animal breeds that include the superior varieties, managing fenced-off and reseeded natural pastures and practicing water conservation techniques with Chi-square values of 80.150, 95.387 and 70.223 respectively; with $p < .01$ (2 tailed). On the contrary the results show that the length of time practicing IK does not affect farmers' decisions to adopt doing irrigation farming, willingness to be involved in agricultural development planning, doing artificial insemination or even cultivating drought resistant crops.

By interpretation, the above results reveal that the farmers who have used IK longer will be reluctant to adopt new climate change adaptation farming practices such as rearing animal breeds that include the superior varieties, managing fenced-off and reseeded natural pastures and practicing water conservation techniques. The long period of utilizing IK farming practices does not have any influence on the farmer's willingness to doing irrigation farming, willingness to be involved in agricultural development planning, doing artificial insemination or even cultivating drought resistant crops.

Table 5.3: Association between the Numbers of years Respondent has used IK and the uptake of CCAS

CCAS practices	**Length of time Farmer has practiced IK**			
	Chi-Square Value	Df	Asymp. Sig. (2-sided)	Significance
Proportional acreage of land under irrigation farming.	41.259[a]	38	.330	Insignificant
Proportional numbers of animal breeds that include the superior Boran 21 breed among livestock farmers.	80.150[a]	38	.000	Significant
Involvement of local farmers in agricultural development planning	37.971[a]	38	.471	Insignificant
Artificial insemination	36.977[a]	38	.517	Insignificant
State of pasture Management	95.387[a]	38	.000	Significant
Level of cultivation of drought resistant crops	40.124[a]	38	.376	Insignificant
Water Management strategies	70.223[a]	38	.001	Significant

(Field Data, 2020)

The indigenous knowledge practices employed by the community members and for the management of climate related events is strongly observed and guarded by respected elders who are trusted as the custodians of such knowledge. During the focus group discussions with the elders in Kajiado West, it was observed that it was their duty to ensure that the traditional way of managing farming activities is guarded and preserved. One of the elders in the meeting stated:

> *"Hii desturi yetu ya kujua hali ya anga, ukulima na mazingira huwa inalindwa na wazee. Hawa wazee unaona hapa wako na ujuzi hata ya kutibu ng'ombe kama ni mgonjwa. Sasa hatuwezi tumia mbinu zingine sisi hatujui kama itasaidia. Tunaaambia hata watoto wetu kuheshimu na kulinda desturi*". (These traditions of knowing weather patterns, farming and environmental management are preserved by the elders. These elders you

> see here have knowledge including treating sick cattle. We cannot therefore use some other knowledge that we are not sure if it will help us. We keep telling our children to respect and preserve this tradition.)

Generally, these results agree with studies on how indigenous knowledge is trusted by local communities and is actively used in prediction of weather patterns (Nkuba *et al*., 2020; Nyakaisiki *et al*., 2019; Radeny *et al*., 2019; Vilakazi *et al.*, 2019). In ethno-veterinary practices (Jacob *et al*., 2004), social organization (Lwoga *et al*., 2019), agricultural adaptation and food systems (Biggs et al., 2013; Mbow *et al*., 2019) and farming systems (Biggelaar, 1991) among others. This study has however further established that there is an association between the level of local farmers' uptake of modern climate change adaptation strategies and what they adhere to as indigenous knowledge. Further investigation on this outcome during elders' FGD indicated a consensus that when the farmers apply what they have learned from folklores, it works. One of them explained;

> "*Sisi tunatumia tu ujuzi yetu ya kuzaliwa naye, na ile desturi ya wazee kuangalia hali ya anga, mifugo yetu, mito na porini*". (We have been applying the native skills as well as traditional customs from elders in looking after the weather, our livestock, rivers and forests).

5.2.2: Perception of Farmers about the CCAS in Relation to Utilization of IK Practices

The findings in this study show that the local farmers have perceived the introduction of modern farming practices, especially in response to the adverse effects of climate change, as an affront to the more respected indigenous knowledge as shown in Table 5.4. To determine this, the farmers were asked about what they viewed as a threat to IK, and a significant 43 % of respondents stated that intrusion of western knowledge is the most challenging factor. In fact, it is seen as a threat to the existence of the traditional farming practices that are considered as more effective and even sacred. This study therefore concluded that the perception of local farmers viewing the introduction of the CCAS as a threat to their IK had a negative influence to the uptake thereof.

Table 5.4: Challenges on Sustainable Use of IK in Farming Activities

Challenges in Sustaining the use of IK	Most challenging %	Challenging %	Fairly challenging %	Less Challenging %	Not challenging %
Intrusion of western knowledge	43	30	19	8	0.8
Inception of government-based adaptation strategies	41	24	28	5	2
Lack of government support	46	24	17	10	3
Disappearance of traditional farming system	36	29	23	11	2
Death of IK custodians	34	32	17	14	4
Lack of reliable sources of financial income	48	23	23	6	0.8
Lack of information on weather	47	24	15	12	2

(Field data, 2020)

When asked about challenges of sustaining the use of indigenous knowledge in farming and managing their environment, most farmers stated that the intrusion of modern farming practices greatly interfered with the observance of IK. However, lack of reliable sources of financial income and information on weather were perceived as the most challenging factors as shown that 48% and 47% of the farmers interviewed respectively cited this as the main challenge.

The results above indicate that external influence, especially from the government in terms of both action or inaction has largely posed a challenge to the sustainable utilization of IK. For instance, introduction of modern farming methods (43%) and CCAS (41%) by the government featured among key factors that interfere with the sustainable utilization of IK practices according to the farmers. This view subsequently explains a negative perception that these farmers have about the CCAS because these strategies are viewed as a threat to the “more convenient and effective” traditional farming practices.

Nkatha (2020) avers that, indigenous knowledge practices, especially among the pastoralist communities in Kenya are a collective product of their cultural and environmental characteristics. Consequently, this form distinctive knowledge of socioeconomic constructs. Argued alongside Mwangi (2018) who explains that the Maasai pastoralism is characterized by inextricably interlinked socio-ecological and historical factors, these findings show that the farmers’ indigenous knowledge is the one that drives this kind of production system; as has been illustrated elsewhere by findings on migration as the main response mechanism in the event of extended periods of droughts.

Any new farming technology that advocates for sedentary-oriented farming method has not been embraced well by the local farmers. Based on the Model of Private Proactive Adaptation to Climate Change (Grothmann, 2005), the local farmers’ appraisals on both risks and opportunities, these findings confirm that the uptake of CCAS among the majority of farmers in Kajiado County, who are nomadic pastoralists is slow or even non-existent.

However, it is important to note that the CCAS are more easily adopted among the farmers that were interviewed in Loitokitok Sub-County who mainly do arable farming. Based on the comparative analysis of responses from the three sub-counties as to whether they would consider CCAS, the results indicated that Kajiado West and Kajiado Central farmers, who mainly engage in pastoralism, are more reluctant to these new farming practices as shown in Table 5.5 below.

Table 5.5: Farmer's Willingness to Adopt CCAS per Sub-County

CCAS	Kajiado West	Kajiado Central	Loitikotok	Total (yes)	% of Loitokitok farmers
Proportional acreage of land under irrigation farming.	11	8	49	68	72
Proportional numbers of animal breeds that include the superior Boran 21 breed among livestock farmers.	8	13	52	73	71
Involvement of local farmers in agricultural development planning	2	6	18	26	69
Artificial insemination	2	4	3	7	33
State of pasture Management	40	46	8	94	9
Level of cultivation of drought resistant crops	3	7	7	17	41
Water Management strategies	43	67	59	169	35

(Field Data, 2020)

The results above indicate that among the farmers that were willing to put their land under irrigation farming, rare animal breeds that include the superior Boran 21 breed and were ready to involve themselves in county agricultural development planning, those from Loitokitok Sub-County were the majority by 72%, 71% and 69% respectively. Although the overall figures as proportions of the total number of respondents in the study were significantly low, the up-scaling of sensitization and dissemination of information about these three CCAS options among farmers in Loitokitok Sub-county can easily enhance adoption.

On the other hand the results in Table 5.5 show that pastoralist farmers in the more arid Kajiado West and Kajiado Central were more ready to adopt climate-smart pasture management practices showing 40 (43%) and 46 (49%) as compared with farmers in Loitokitok who were only 8 (9%). Generally, the findings show that both pastoralist farmers and arable farmers are more willing to adopt CCAS that deals with water resource management with 67 (40%) of Kajiado Central, 59 (35%) of Loitokitok and 43 (25) of Kajiado West farmers affirming to this.

Similarly, any CCAS initiatives that would target the enhancement of water conservation among farmers throughout Kajiado County, would be well received and adopted. These findings concur with other similar studies that also came out with results that pastoral communities who largely depend on livestock farming as the main livelihood activity, view dysfunctional water resource and pasture systems to be a huge threat to their food security and hence, farmers can easily be willing to adopt practices that sustain their availability (Gebeyehu *et al*., 2021; Kassie *et al*., 2014).

5.2.3: Ecological Variances and Perception about CCAS

When perceptions of farmers were analyzed based on farmer’s locations with ecologically different characteristics, the findings show that the ecological characteristics influenced farmers' perceptions on CCAS. As shown in Table 5.6, when asked on whether they considered intrusion of modern farming technologies has the greatest threat to IK practices, the farmers in a more arid region of Kajiado West, which has the majority of pastoralists had 76%, while only 10% of farmers occupying arable wetlands at the slopes of Mount Kilimanjaro in Loitokitok agreed that the CCAS interfered with the IK agricultural practices that have worked for them for ages.

Table 5.6: Threat to IK Practices through Intrusion of Modern Farming Practices per Sub-County

Sub-County	Not a threat	Threatening	Most Threatening
Kajiado West	2%	16%	76%
Kajiado Central	1%	26%	50%
Loitokitok	11%	45%	10%

(Field data, 2020)

From the above statistics, it can be concluded that the crop farming production system that is practiced in the arable lands of Loitokitok indicate that farmers are less likely to be influenced by the IK practices when they are being motivated or sensitized to adopt new farming technologies such as CCAS. On the other hand, the pastoralists in Kajiado West and Kajiado Central view the introduction of modern livestock farming practices as a threat to their traditional nomadic practices that enabled them to keep large herds of cattle. In support of the foregoing therefore, it can be deduced that the existing agricultural farming/production system determines which knowledge domain that will be preferred by the farmers; IK being preferred by nomadic pastoralists while arable crop farmers were adhering to scientific knowledge.

Crop farmers respond differently to climate change effects such as long droughts as compared with the nomadic pastoralists. Inferentially, on doing binomial logistic regression about the existing climate change response mechanisms Table 5.7 illustrates different levels of significant associations between the mechanisms and types of agricultural activity farmer engage in. The analysis results demonstrate how the type of agricultural activity the farmer in Kajiado County does can accurately predict the type of CC response mechanism that they will apply when confronted by a CC-related hazard.

A binomial logistic regression was run to understand the effects of the type of main farming occupation of a farmer into two categories; either cultivating or not cultivating maize (crop farming) as independent variables on one hand and type of IK-related CC response mechanism as dependent variables on the other. The same statistical tests were done for the pastoralism. From Table 5.7 overleaf, it was clearly revealed that maize crop farming (Arable agriculture) significantly predicted the type of response mechanism by farmers who in the event of climate change related extended droughts resigned to their fate and did nothing (p=.016), those who used traditional IK practices to survive (p=.007) and also migration (p<.01). Their respective negative constants of -.707, -.878 and -1.386 indicate that these crop farmers will likely not opt for such IK related response mechanisms should they be confronted by the CC-related hazard such as drought.

On the other hand, pastoralism (keeping cattle) fits into this model by the fact that from the regression analysis, it influences the farmers' response mechanisms significantly by use of traditional IK to survive (p=.001) and migration (p=.013). Categorizing of the main activity of a farmer into either agrarian, which mainly deals with cultivation of land, and livestock pastoralism has clearly manifested a dichotomy of the form of response to CC adverse effects. While crop farmers are not likely to opt for IK-related response practices, the pastoralists will likely opt for these practices, especially migration (nomadism).

Table 5.7: Binomial Logistic Regression Analysis between Climatic Change Response Mechanism and Type of Farming

Farming Practices	Response Mechanism	B	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Maize Farming	Resign to our fate and do nothing (1)	-.707	5.827	1	.016	.493	.278	.876
	Appeal to government for help through local administration (1)	.395	1.079	1	.299	1.484	.705	3.125
	Wait for Humanitarian assistance from NGOs, civil societies etc. (1)	.435	2.380	1	.123	1.546	.889	2.688
	Use traditional IK to survive (1)	-.878	7.378	1	.007	.416	.221	.783
	Seek help within social networks; relatives, clan, neighbors (1)	.276	.159	1	.690	1.318	.339	5.119
	Migration (1)	-1.386	19.023	1	.000	.250	.134	.466
	Constant	1.461	3.049	1	.081	4.310		
Pastoralism (keeping cattle)	Resign to our fate and do nothing (1)	-.118	.206	1	.650	.889	.534	1.479
	Appeal to government for help through local administration (1)	-.132	.125	1	.723	.876	.422	1.819
	Wait for Humanitarian assistance from NGOs, civil societies etc. (1)	-.313	1.225	1	.268	.732	.421	1.272
	Use traditional IK to survive (1)	-1.011	11.859	1	.001	.364	.205	.647
	Seek help within social networks; relatives, clan, neighbors (1)	1.064	2.285	1	.131	2.898	.729	11.511
	Migration (1)	-.738	6.217	1	.013	.478	.268	.854
	Constant	.993	1.467	1	.226	2.699		

(Field data, 2020)

The results are in agreement with a study that was done about the differences in perspectives of managing land resources between crop farmers and herders; the latter having a propensity to favor such traditional practices as nomadism while the former preferring intensive and maximum use of land that includes utilizing fertilizers to optimize production (Diogo *et al*., 2021).

5.3: Management of Farming Activities and Uptake of Climate Change Adaptation Strategies

The process through which the agricultural production is managed and how farming systems are designed within the community can have an influence on how farmers may view new farming technologies. The agricultural practices employed by the local farmers can either sustain productivity or exercabate the adverse effects of climate change. For instance, in Kajiado West and large parts of Kajiado Central Sub-counties, most of the farmers practiced the traditional nomadic pastoralism as the key means of livelihood and food production (Figure 5.2); a situation that has increased food security vulnerability levels among these communities as adverse effects of climate change set in. This finding agrees with results of a study that was conducted in Rwanda and Uganda on status, challenges and prospects in nutrition and food security in East Africa (Lokuruka, 2020).

This study found that the dominant farming activity is livestock keeping, a bigger proportion of which is pastoralism. The graph below, Figure 5.2, indicates that a huge majority of Kajiado County households keep some livestock.

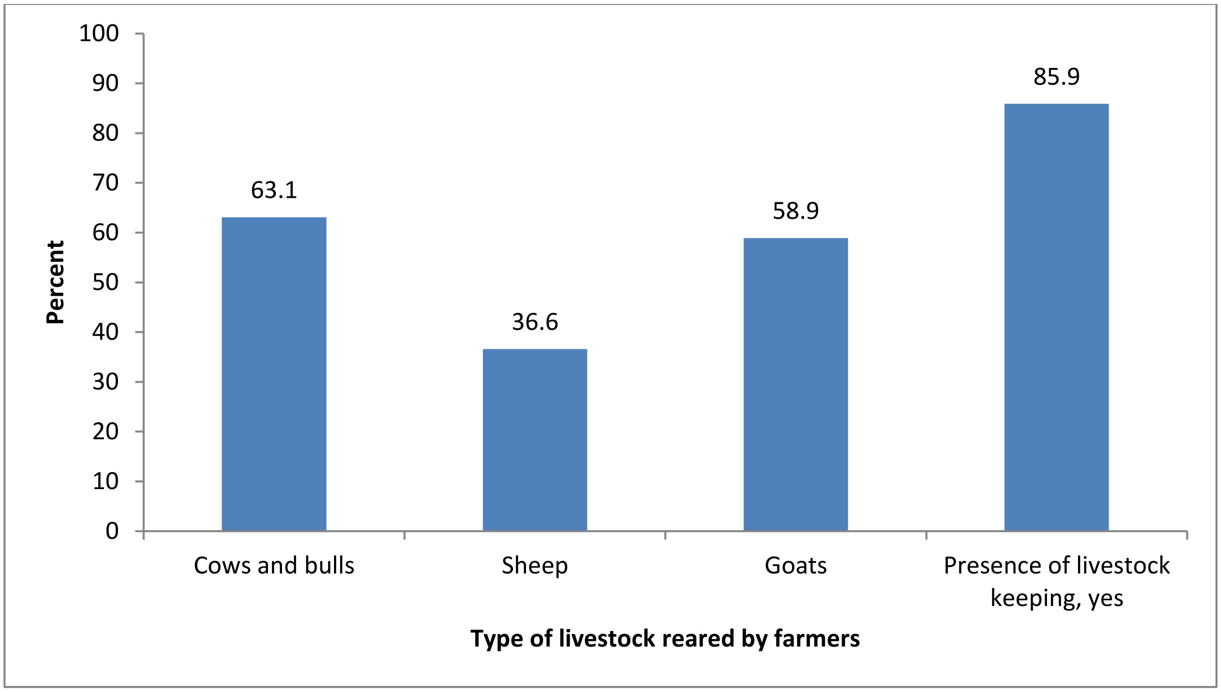

Figure 5.2: Households' levels of Livestock Farming (Field data, 2020)

The Kenya's National Climate Change Action Plan (NCCAP) for the period 2018-2022 (GOK, 2018) in its Mitigation Technical Analysis Report (MTAR) indicates that: With a large number of livestock, the livestock sub-sector is dominated by pastoralism, which is the most important economic and livelihood activity in the Arid and Semi-Arid Lands (ASALs) that comprise over 80% of the country's land area. Incidentally, the report also state that livestock farming in Kenya contributes to 50% of GHG gases, a process that occasions global warming and subsequently, the climate change events.

The effect of livestock farming in terms of how it contributes to the escalation of build-up of greenhouse gases is outside the scope of this study. However, it is analyzed as a predominant farming activity and how it affects the uptake of CCAS is critical. The presence of livestock keeping in the study area was evident with (85.9%) of the respondents interviewed indicating that they had kept at least one type of the livestock. The presence of livestock keeping was computed by summing up the livestock categories of 1 and 0, and then categorized into two i.e. yes and no respectively.

5.3.1: Pastoralism and Modern Farming Technologies

The study findings clearly show that the majority of the farmers have, over the years, embraced pastoralism, a nomadic way of livelihood activity, which involves animal husbandry that is characterized with periodic movement in search of water and pasture. Figure 5.3 illustrates the causes of migration trends among the farmers that participated in the study and had actually migrated. The fact that farmers move from place to place is confirmed by two sets of descriptive study results.

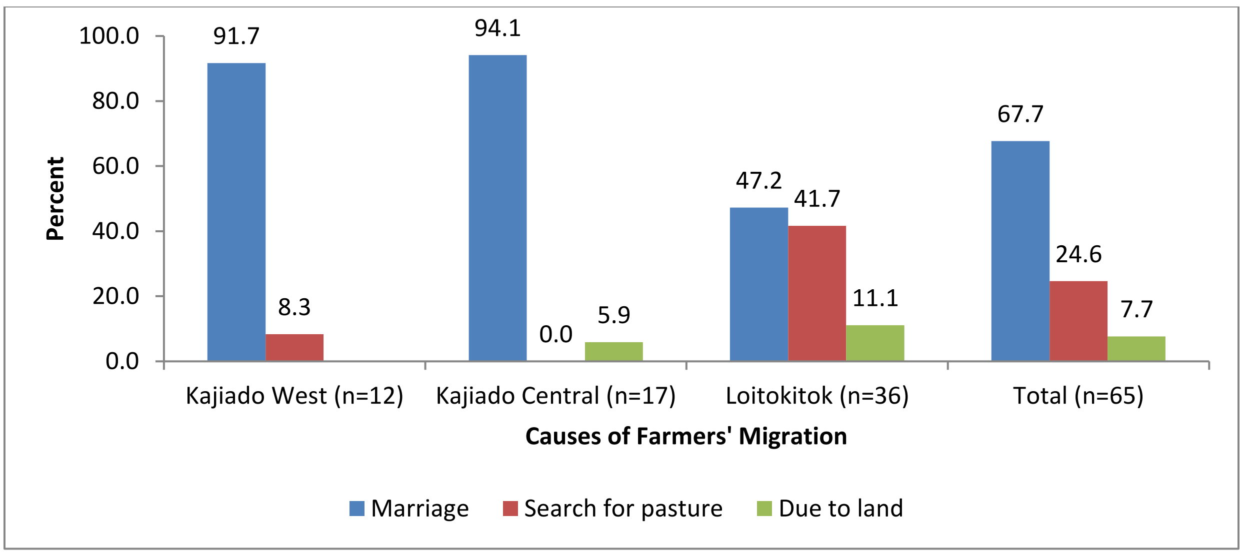

Figure 5.3: Causes of Migrations of Farmers (Field data, 2020)

First, the respondents were asked if where they live is their original homes. Approximately 17% of the respondents stated in the negative. Of those who had actually migrated, 68%, 25% and 8% of them said they moved to those places because of marriage, in search of pasture and land related issues respectively.

These results indicate minimal migratory tendency as should have been normal with the nomadic pastoralists. It should be noted that this study was conducted in the month of February 2020, during which, there was increased precipitation all over the East African region, the highest ever-witnessed in 40 years. Plate 5.1 below shows a section within the Mbirikani area of Loitokitok Sub-County which denotes sprouting of geen vegetation in the Month of February, a month before the onset of the long rains. According to a special report about this heavy rainfall, FEWS NET (2020) explains that the phenomenon was as a result of a robust and long-lasting positive Indian Ocean Dipole (IOD).

Plate 5.1: Illustrating Green vegetation and Wet Conditions, Researcher and the Assistant (Field data, 2020)

The water pans and ponds had water, seasonal rivers running; sufficient for human and livestock. Plate 5.1 above shows one of the research assistant in one of the research locations demonstrating the evidence of greener landscape in the study area, which is otherwise considered to be semi-arid. This unusual climatic event, did therefore, help the pastoralists to access pastures and water readily for themselves and their animal, hence limiting migration tendencies. As one of the village elders stated:

> "*Saa hii kuna maji mingi na nyasi kwa ng'ombe, hakuna haja ya kuhama. Lakini mwezi kama hii pengine tungekuwa tumeenda kutafuta chakula ya ng'ombe kwa sababu ya kiangazi*". (For now, there is a lot of water and grass for the cattle. However, a month like this we may have moved to some other place to look for pasture for the cattle because of drought).

This narrative explains the minimal migration of the farmers during the period within which the study was conducted. In the usual prevailing weather conditions, the farmers would always be moving from their homes to pitch camp in areas that would have enough grass and water for their livestock. In other words, a large proportion of the livestock farmers would not opt for any new type of animal husbandry that would condition them to be sedentary. As illustrated in Table 5.8 below, when asked what they would opt for in case of adverse effects of climate change; and given multiple options, to give a response of "yes" or "no" the majority, approximately 60% opted for migration as shown in Table 5.8 below which indicate the "yes" responses.

Readily opting for the indigenous knowledge practices such as migration instead of scientifically designed mechanisms in response to the adverse effects of climate change, these farmers have indicated that in their view, IK-oriented response mechanisms are more effective than the CCAS.

Table 5.8: Farmers' Response Mechanisms to Adverse Effects of Climate Change

Climate change response options	**Frequency (N=382)**	**Percentage**
Resign to our fate and do nothing	184	48
Appeal to government for help through local administration	40	11
Wait for Humanitarian assistance from NGOs, civil societies etc.	103	27
Use traditional IK practices to survive	106	28
Seek help within social networks; relatives, clan, neighbors	10	3
Migration	227	60

(Field data, 2020)

These results illustrate that, irrespective of the new scientific climate-change-oriented farming technologies, the more traditional nomadic farming practice is still dominant among the Kajiado County farmers. Subsequently, this farming practice has an influence on the uptake of any other climate change adaptation strategies. Most of the CCAS are designed to promote sedentary forms of farming, contrasting with the nomadic practices that are preferred by the local farmers.

Table 5.9: Relationship between Response Mechanisms by Farmers to the Extreme Weather Events and the Level of Uptake of CCAS

Climate Change response options	**Index score; Level of uptake of modern agricultural practices**			**Inferential values**		
	No uptake	Uptake	Difference	X^2	P-value	Significance?
Resign to our fate and do nothing	25.7	22.5	-3.2	6.335	0.012 *	Yes
Appeal to government for help through local administration	3.9	6.5	2.6	1.486	0.223	No
Wait for Humanitarian assistance from NGOs, civil societies etc	13.6	13.4	-0.2	0.857	0.355	No
Use traditional IK practices to survive	18.3	9.4	-8.9	22.283	0.000 ***	Yes
Seek help within social networks; relatives, clan, neighbors	0.5	2.1	1.6	2.919	0.088	No
Migration	22.8	36.6	13.8	15.379	0.000 ***	Yes
Overall score: Response mechanisms by farmers to the extreme weather events						
Mean	26.6	20.2	-6.4	t=3.498	0.001 ***	Yes
SD	15.9	19.6				
Std. Error Mean	1.2	1.4				

(Field data, 2020)

Further inferential statistical analysis as presented in Table 5.9 above show that the research objective variables indicate significant relationship(s) between the indigenous knowledge oriented response mechanism and uptake of the CCAS. These variables show an inverse association when subjected to bivariate correlation analysis. Notably, for instance, migration as an indigenous knowledge practice has a negative relationship with keeping of sedentary-oriented superior breeds of cattle as one of the CCAS, as shown in Table 5.9. For instance, the uptake of the CCAS is significantly affected by farmers' likely options of utilizing indigenous knowledge practices to survive with $X^2 = 22.283$ and migrations with $X^2 = 15.379$ ($p < .01$).

These statistics reveal a trend in which the options that farmers would opt for and which have a significant association with their uptake of climate change adaptation strategies include: Resigning to their fate and do nothing ($X^2 = 6.335$, $p < .05$), use traditional IK practices to survive ($p < .01$) and migration ($p < .01$). Further, the inferential statistical analysis on migration as an indigenous knowledge livestock management practice as it relates to the uptake of CCAS shows an inverse correlation. This means that the local farmers in Kajiado who depend on nomadic pastoralism as a source of food are averse to adopting the CCAS; these new farming techniques are perceived to potentially disrupt their migration tendencies.

Moreover, when singling out migration (nomadism) as the key IK practice for responding to drought by most of the farmers interviewed, the bivariate correlation analysis between this practice and the keeping of superior cattle breeds as a CCAS adaptation approach, the results showed significant inverse relationship of the coefficient of -.165 (p<.01) as shown in Table 5.10 below.

Table 5.10: Bivariate Correlations of IK Migration and Keeping of Superior Breeds of Livestock

		Climate change response mechanism - Migration	CCAS farming Practice-Keeping of superior breeds
Climate change response mechanism – Migration	Spearman Rank Correlation	1	-.165**
	Sig. (2-tailed)		.001
	N	382	382
CCAS farming Practice-Keeping of superior breeds	Spearman Rank Correlation	-.165**	1
	Sig. (2-tailed)	.001	
	N	382	382

(Field data, 2020)

This finding is interpreted to mean that increased levels of migration practices as a means to avert the impacts of drought among farmers influences them not to keep other types of cattle. These variables manifest a socio-cultural mindset that is inextricably embedded in the minds of the local farmers who believe that the indigenous knowledge practices are more effective in addressing the climate change ravaging effects – especially droughts. The persistent adherence to IK practices by Kajiado County farmers, exacerbates drought vulnerability.

According to a study by Mwangi (2018) within the same region it was revealed that among these farmers, there is active strong indissoluable connection between their farming activities and their experiences on handling extreme weather events. They have encountered gradual increase of occurences of unusually long droughts over the years in which historically, they have built up their own social and cultural contingency measures to curb the effects of this hazard on their livelihoods. However, Maasai-Pastoralism is still embroiled in a vicious circle of drought-disasters as manifested by annual experiences of livestock deaths. Although there have been reported cases of livestock mortality, there seems to be a resolute adherence to pastoralism among *Maasai* farmers as the main livelihood and production system.

These findings are in consonant with other studies whose results show that these nomadic communities out-rightly resist any "foreign" introduction of alternative livelihoods that interfere with their nomadic way of life (Lokuruka, 2020), with some of the groups even suggesting that the CC phenomenon is a man-made consequence of same people responsible for its occurrence (Stammler and Ivanova, 2020).

5.3.2: Management of Livestock & Humans Diseases and Conventional Treatment Methods

This study found that there is strong belief in traditional means of treatment of diseases for livestock and humans as well as management of pastures and soils among the majority of the farmers in Kajiado County. This finding resonates with the studies (Abebe, 2019; Jacob *et al*., 2004; Nkatha, 2020; Owfi and Barani, 2019) who all concur that indigenous knowledge structures and practices are utilized in treatments and care of humans and animals. It is in fact insinuated in some of the responses, that modern scientific-oriented treatment methods are an affront to the otherwise effective traditional mechanisms.

To emphasize on the above narrative, the respondents insisted that they have their own traditional herbs which can be administered to their livestock in form of liquid concoctions or ashes in cases of diseases and which according to them, have more recovery potency than the modern veterinary treatments. An elder in the FGD explained:

> *"Sisi tuko na madawa yetu ya kienyeji tunatumia kutibu ng'ombe na mbuzi, hata binadamu; iko sawa kabisa kushinda hiyo madawa ya daktari".* (We have our traditional medicines that we use to treat cows, goats and even human beings. They are more effective than the medicines from the veterinary doctor).

This is actually in agreement with other studies (Abebe, 2019; Jacob *et al*., 2004; Nkatha, 2020; Owfi and Barani, 2019) that have examined the role of traditional/indigenous methods in treating livestock and human diseases. However, this particular study goes further to show that the adherence to these traditional methods of treatment, have slowed down the adoption tendencies of conventional treatment methods; and by extension, based on the theory of planned behaviour (TPB)(Ajzen, 1991), it has affected the uptake of conventional climate change adaptation strategies among the livestock farmers in Kajiado County. In agreement with this theory, this study can show that the farmers have not yet been motivated enough by the outcomes of the modern medical practices to facilitate desired adaptation decision-making.

The above arguments notwithstanding are the emerging possibilities of the climate change impacts creating an enabling environment for the survival of plant, livestock and human pathogens (Sharma *et al*., 2019). In terms of food insecurity and sustainable livelihoods, this could create secondary level vulnerability for pastoralists who may only be able to treat commonly known and treatable maladies.

5.3.3: Management of Rangelands and Conventional Land resource Management

Similar to the findings on treatment in the preceding section, this study found that the farmers in Kajiado preferred their indigenous practices of managing rangelands, soils, crops, forests and pastures. The study shows that a majority used traditional methods in natural resource management, including the environment when it comes to handling climate change impacts as indicated by practices such as migration and use of IK practices with 60% and 28% respectively giving this affirmation (Table 5.8). This issue is such a sensitive matter to the extent that, the farmers feel that, it is actually the modern natural resource management that has contributed to the increased intensity of droughts (Table 5.11).

For instance, when asked about what they think contributes to the frequent droughts (element of climate change), given multiple options, the “Yes” responses as shown in the frequency Table 5.11, most of them attributed it to “modern development-oriented” activities. The data here was tabulated focusing on how a participant responded to each “cause of response”. For instance, 251 (66%) of participants agreed that environmental degradation and industrialization causes climate change. Follow-up enquiries on this generated responses such as, there are more vehicles factories that produce a lot of smoke which “prevent rain from falling”; clearing of forests (the highest frequency at 78%) for charcoal burning and construction, which “make the rivers to dry” and encroachment into natural habitats through expansion of urban areas. Deforestation is of very big concern to the pastoralists, who attribute it to frequent and fast drying of rivers and ponds that they use to water their livestock.

Table 5.11: Causes of Climate Change

What contributes to climate change in your area?	Frequency (Yes) N=382	%
Environmental degradation/Industrialization	251	66
Pollution	265	69
Deforestation	299	78
Modernization/urbanization	174	46

(Field data, 2020)

The same argument also is emphatically expressed about the management of soils, with one of the women in the FGD categorically stating that the modern fertilizers are destroying the soil nutrients, leading to reduction in crop production, she said:

> "*Hii mbolea yao ya dukani inaharibu shamba! Udongo hakuna nguvu, usipotumia, hakuna kitu utapata. Ndio sisi tumerudi kwa mbolea ya samadi, inafanya vizuri*". (The fertilizer from the shop is destroying our soils! The soils are not strong, and if you don't use it, you won't get anything. We have therefore decided to go back to use animal manure as fertilizer and it is working well.)

The above assertion was interpreted to mean that the use of organic manure from the livestock wastes, which has been used for ages, thanks to transferability of IK, is far more preferred among the farmers to the modern, scientifically produced agriculture fertilizers as a way of enhancing productivity. This argument is in spite of the fact that when excessive production of livestock waste and urine if not managed properly, it contributes to significant emissions of methane-one of the major greenhouse gases that cause global warming (GOK, 2013).

As a follow-up question on what should be done to mitigate against these causes of climate change, repeated suggestions from the respondents which were thematically analyzed. They included: preservation of certain indigenous trees and shrubs that they believe can conserve the environment, conservation of grazing land by subdividing them into zones, use of organic manure as fertilizers, migrations to facilitate soil and pasture recovery; cultivation of traditional drought resistant sorghum and millet species, among other traditional (IK) natural resources management practices. One of the ladies in the FGD in Loitokitok affirmed this fact by stating:

> *"Sisi hapa kwa ukulima wa ngombe kuanzia zamani, hatutupi samadi ya ngombe. Tunaitumia kama mbolea kwa shamba na pia kuichoma moshi yake wakati wa usiku, inafukuza ile wadudu wale wanapea mifugo ugonjwa. Pia tuko na mimea yetu ile tunapanda na hata kukiwa kiangazi inatupea mazao, kama hii aina ya mtama umeona hapa*." (In this place in rearing cattle, we do not discard the dung but use it as fertilizer and also burn it at night as the smoke drives away vector insects. We also have drought resistant crops which we plant when there is serious drought and still manage to harvest, like the type of sorghum you just saw in our farms.)

In cases when climate change results to extended periods of drought, late onset/shorter length of long rains, reduced amounts of rains (indicated by the amount of water in rivers, swamps and ponds), the local farmers opt for traditional response mechanisms; especially migrations. When asked about what they would do in cases of adverse effects of climate change in their location, and given multiple options as shown in Table 5.8, majority (60 %) of them affirmed that migration would be the best response mechanism. As will be discussed in the subsequent section in this chapter on sources of income, approximately 66% of farmers in Kajiado County depend on livestock farming, particularly through pastoralism, as the main livelihood production system (Figure 5.5 below).

This study subsequently found that a significant number of farmers, who practice pastoralism, believe in their traditional practices, which they believe has been effective in addressing drought-related vulnerabilities; which is in agreement with other studies farmers have a view that this offers them some form of resilience (Ameso *et al*., 2018; Mwangi, 2018).

The findings are also further illustrated by the farmers' general response on the question about how long they have applied indigenous knowledge on soil, pastures, water and forests management. The results showed that the majority of them have practiced IK for a period of between 10-29 years at 48%, while few of them (2%) have never applied IK as shown in Figure 5.4.

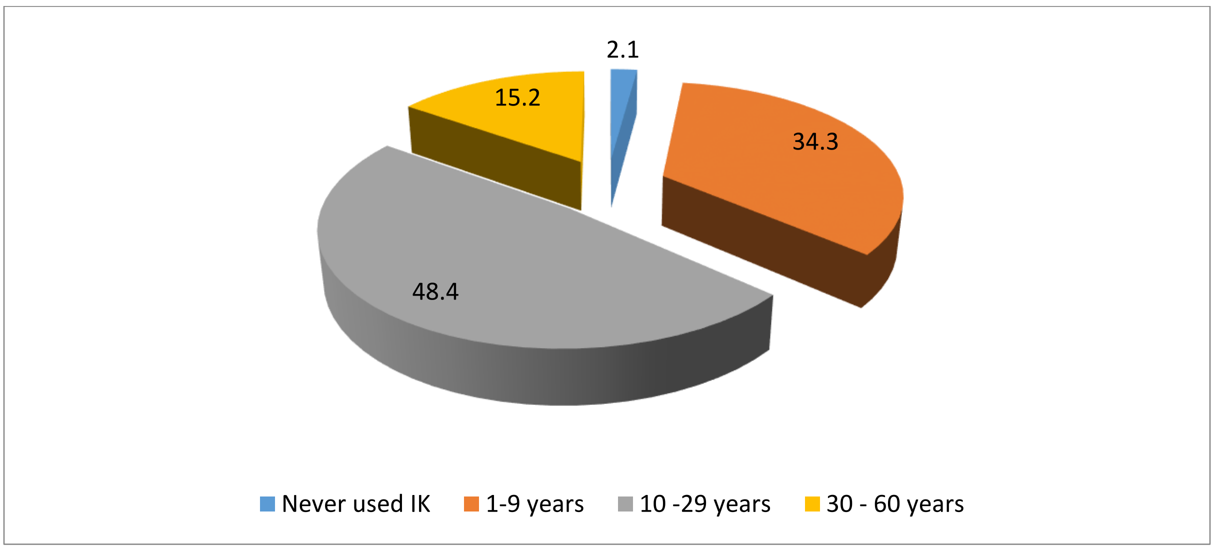

Figure 5.4: Households' Period of utilizing Indigenous Knowledge in Farming (Field data, 2020)

The above figure demonstrates that over 82% of the farmers in Kajiado County have applied indigenous knowledge in management of the natural resources, livelihood assets and the environment. It therefore can be inferred that the slow uptake of climate change adaptation strategies which, are modern and science-oriented, is attributed to the belief that these farmers have in the traditional management systems.

5.4: Sources of Income and Uptake of Climate Change Adaptation Strategies

The household heads were asked to state what their sources of income as well as livelihood sources were. The objective was to establish if these sources have influence on the farmers' adoption decisions. The sources were categorized as those from livestock products and farm produce, employment, salary and remittances. The respondents were also allowed to state any other form of income that was not among the three options. Figure 5.5 below shows the main sources of income of the respondents. Among the notable livelihood activities which accounted for 16% included operating businesses like *boda boda* operator (motorcycle transport services), causal labor (construction, guard, sand harvesting) and handicrafts and artisanal activities.

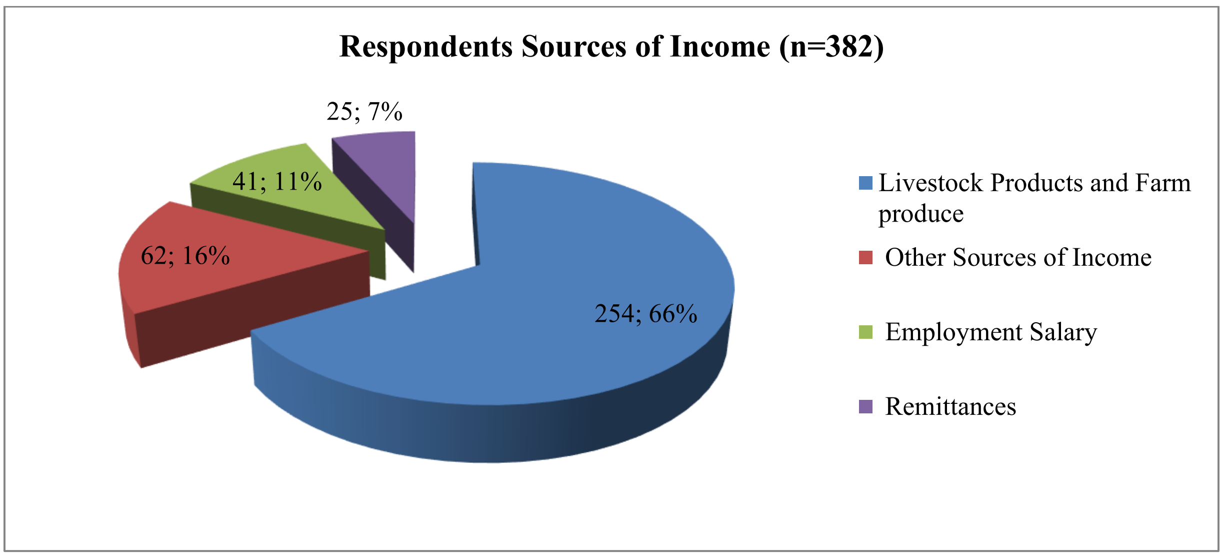

Figure 5.5: Main Sources of Income for Kajiado County Farmers (Field data, 2020)

Although the statistics indicate that the households are practicing agro-pastoralism, there are marked variances of the proportions between farmers practicing pastoralism as compared with those that do food crop agriculture. As shown in Table 5.12, the farmers in more arid regions of Kajiado West and Kajiado Central, who are mainly pastoralists' account for 96% and 89% respectively while in wet region of Loitokitok, they account for less (76%). On the other hand, cultivation of the main food crop, specifically maize, is done by 18% of the households in Kajiado West, 24% in Kajiado Central and a significant proportion of farmers - 55% in Loitokitok Sub-county.

Table 5.12: Comparison between Pastoralism and Crop Farming Activities in Kajiado Sub-counties

Sub county	Responses –Yes	Frequency	Percent
Kajiado West	Crop farming	20	18
	Livestock kept	105	96
Kajiado Central	Crop farming	31	24
	Livestock kept	116	89
Loitokitok	Crop farming	77	55
	Livestock kept	107	76

(Field data, 2020)

The above findings subsequently mean that the socio-ecological characteristics determine the specific farming activities that are dominant in a location. The study findings underscore the fact that the intensity of practicing IK differs based on these characteristics and by extension therefore, can influence the farmers' uptake of the newly introduced CCAS in carrying out their agricultural activities. It can therefore be deduced from these findings that farmers who are pastoralists strongly believe in IK practices more than their arable farmers counterparts. The study therefore sought to establish if there is any correlation between the type of farming and the uptake of CCAS.

To determine this connection, a Chi-Square analysis between farmer's source of agriculture-oriented income/livelihood and his/her choice of response mechanism to CC was conducted. Chi-square analysis shown in Table 5.13 clearly indicated that sources of agriculture-oriented income/livelihood among Kajiado County farmers as independent variable, does influence how farmers opt for either indigenous knowledge practices or adapt to new farming innovations to respond to adverse effects of climate change. The farmers whose main occupation is maize crop farming will tend to seek help from government (CI=99%. $X^2 = 7.233$, $p < .01$) or humanitarian organization (CI=99%. $X^2 = 25.041$, $p < .01$); the two entities that would recommend and give assistance based on the CCAS as a response to the adverse effects of CC.

Table 5.13: Relationship between Type of Farming and CC Response Mechanism

Type of Farming/Independent variable	Climate change response/Dependent variable	Pearson Chi-Square	df	Asymp. Sig. (2-sided)	Significance
Maize					
	Resign to our fate and do nothing	.129	1	.720	Insignificant
	Appeal to government for help through local administration	7.233	1	.007**	Significant
	Wait for Humanitarian assistance from NGOs, civil societies etc.	25.041	1	.000**	significant
	Use traditional IK to survive	22.326	1	.000**	Significant
	Seek help within social networks; relatives, clan, neighbors	1.254	1	.263	Insignificant
	Migration	41.159	1	.000**	Significant
Pastoralism (keeping cattle)					
	Resign to our fate and do nothing	.053	1	.818	Insignificant
	Appeal to government for help through local administration	.183	1	.669	Insignificant
	Wait for Humanitarian assistance from NGOs, civil societies etc.	1.417	1	.234	Insignificant
	Use traditional IK to survive	18.422	1	.000**	Significant
	Seek help within social networks; relatives, clan, neighbors	2.351	1	.125	Insignificant
	Migration	13.140	1	.000**	Significant

(Field data, 2020)

On the other hand, there is no significant association between livestock farming and responding to adverse impacts of CC through government mitigation strategies (X^2 = .883, p = .669) or assistance and or recommendations from humanitarian agencies (X^2 = 1.417, p = .234). Instead, there is strong correlation between livestock farming and application of IK practices; migration (CI=99%. X^2 = 13.140, p < .01) and using traditional IK to survive (CI=99%. X^2 = 18.422, p < .01). By interpretation, these statistics show that the pastoralists would prefer applying IK practices to respond to a serious impact of CC such as an extended/long period of drought. It is however important to note that the statistics indicate that there is likelihood that both maize and livestock farmers will still practice IK in these extreme events.

These results reveal the intrinsic value that the majority of Kajiado County farmers, the *Maasai,* place on livestock as the main livelihood assets and not on other liquid financial assets. It is further observed that the pastoralism a mong the Maasai-, is the most dominant livelihood-production system (Mwangi, 2018) and hence these communities would like to engage in disaster risk reduction measures that will maintain and sustain the survival of their livestock assets.

It is imperative to underscore the fact that farmers who are high-income earners would have the leverage to make adaptation costs be easily affordable. Just as Mbow *et al*., (2019) report, in the wake of persistent climate change adverse effects on agricultural productivity, "Low-income producers and consumers are likely to be most affected because of lack of resources to invest in adaptation and diversification measures." These findings agree with many studies among them; Abubakar *et al*., 2019, Belay *et al*., 2017, Lawson *et al*., 2019, and Sunny *et al*., 2018, in regard to income as a key determinant of farmers' adaptive decisions among farming communities across the globe. It is becoming apparent that the sources of that income may further influence the decisions. There are livelihood sources that may not really give sustainable returns, especially if production costs are not optimal. It is indicative from these findings that the majority of households, at 66% earn a living from livestock products and other farm produce.

As has already been authenticated by other studies, agricultural activities that don't bring in adequate returns for the farming households, constrain such households from making significant adoption decision-making (Kumar *et al*, 2017). The farmers whose agricultural ventures realize bigger economic performance are more adaptive to new innovations, than the marginal or small-scale farmers who are largely dependent on subsistence outputs. Consequently, economic performance, the benefit/cost ratio of high crisis management group was greater than that of medium and low crisis management groups.

Further, it is important to note that the pastoralists, when asked if they sell their animals for meat as a source of revenue, only 2%, 4% and 3% responded to the affirmative in Kajiado West, Kajiado Central and Loitokitok Sub-county respectively. This means that the only produce for sale from livestock keeping is milk with Kajiado West, Kajiado Central and Loitokitok Sub-county farmers posting 59%, 55% and 65% of the corresponding farmers respectively.

The results further reveal a tendency in which those who responded in the affirmative when asked about crop farming were also leaning towards seeking and adopting to scientific climate change adaptation strategies. Table 5.13 shows that the maize farmers, who are mainly concentrated on the southern region of Kajiado County, would appeal for expert help from either the government officials or NGOs and civil societies. When farmers were asked about what would be their most preferred response mechanisms to adverse effects of climate change (e.g. extended periods of drought), the dominant response showed a strong preference to seeking help from humanitarian assistance from NGOs and other civil societies.

There was a statistically significant association between this response option and maize farming as a type of agriculyural activity. This was indicated by Pearson Chi-square value of 25.041 and a degree of freedom (df) of 1, at CI 99%, $p < .01$. Interestingly, the same farmers said they would opt for migration as a means of response, a rather more indigenous knowledge practice. This is obviously explained by the fact that in case the help from such organizations delay or not forthcoming the farmers would have migration as an alternative.

On further enquiry to seek an explanation for this unique irony, the response for this from the women in Imbilikani location as shown in Plate 2 overleaf during the FGD categorically stated that:

"*Kazi ya shamba ni ya wamama. Wazee huwa wanaenda kutafuta malisho na maji ya mifugo sehemu zingine mbali*." (The work in the shambas (crop farms) is mainly done by the women, while our men usually migrate to far areas for search of pasture and water for their cattle).

Plate 5.2: Researcher With Women FGD Participants in Imbilikani Sub-Location (Field data, 2020)

This claim means that though there is some trend towards diversifications in livelihood production systems (in the form of the communities slowly embracing other forms of livelihoods), the uncertainty still exists between them (*Maasai* community) and their indigenous ways of earning a living.

These findings concur with Mwangi (2018) who accurately avers that in spite of the fact that this livelihood production system has occasioned climate-change engineered drought vulnerability-Maasai-pastoralism, is a strongly coupled social-ecological system that causes slow uptake of modern farming practices that may interfere with their unique traditional production system. This argument is further buttressed, by these findings as shown in Table 5.10 in which respondents who practice pastoralism would not likely seek or adopt other external climate change response mechanisms from government or humanitarian assistance agencies as revealed by statistically insignificant associations at CI = 95%, $p > .05$.

Consequently, the pastoralists would utilize their own indigenous knowledge practices including migration, as indicated by Pearson Chi-squares of 18.422 and 13.140 respectively with both posting at CI= 99%, $p < .01$. Farmers may attach themselves to a certain indigenous means of livelihood and hence their survival and based on that experience, be reluctant to try utilizing new ways of earning a living. To support this point, one of the elders in Kajiado West, during an FGD, clearly stated;

> Sisi mali yetu ni ng'ombe; ukiwa na ng'ombe mingi basi wewe ni tajiri *(For us, our wealth is cattle; the bigger the herd size, the richer you are).*

However this kind of socio-ecological mindset which also has roots in history, has been exposing the pastoralists to drought related vulnerabilities (BurnSilver, 2016; Mwangi, 2018).

5.5: Climate Prediction and CCAS

The perception of local farmers in terms of what they consider as a more effective means of weather prediction and by extension, trends of climate change, depends on their indigenous knowledge practices. Regardless of the fact that the local farmers can access weather information from scientific research institutions as shown in Table 5.14 below, their perception and attitudes concerning that information is that it is not trustworthy, and hence it's not easily adopted. This is therefore one of the indigenous knowledge aspect that influences the farmers' uptake of the climate change adaptation strategies in Kajiado County.

Table 5.14: Sources of Information on Weather

What is the source of information about the extreme weather events	Response of Kajiado County farmers	
	YES %	NO %
Radio	83	17
TV	40	60
Newspapers	17	83
Neighbor	48	52
Family members	18	82
Weather reports from provincial administration	14	86
Schools and colleges	3	97

(Field data, 2020)

In conformity with these findings, a study on the *Use of Indigenous Knowledge in Predicting Changes in Seasonal Rainfall by Smallholder Farmers of Ruteete Subcounty, Kabarole District* in Uganda, by Nyakaisiki *et al*. (2019) found that indigenous knowledge has been used in observing and monitoring weather patterns especially rainfall trends. However, this study specifically highlights a behavioral feature among the Kajiado County farmers, especially based on the Theory of Planned Behaviour (Arjen, 1991), that although they can access scientific climate change information, they are hardly motivated to adopt new farming techniques. On the contrary they are more comfortable in following their indigenous knowledge which they perceive to be more reliable.

It was also important to analyze if a farmer's knowledge on how to interpret weather events based on sources of information would influence their uptake of the CCAS. The study findings established that a significant number of farmers receive information on extreme weather events and climate change from the radio (83%) as illustrated in Table 5.14. However, it is imperative to note that a considerable proportion of farmers (48%) opted for the information about these extreme weather events from their local neighbors, mainly elders with the ability to predict these events.

In addition, extensive and in-depth discussions at a local leaders and elders' FGD, the weather information that the local farmers receive from the conventional sources is perceived to be inaccurate as compared with indigenous knowledge weather sources. One of the elders categorically stated;

> "*Kutoka zamani sisi tunatumia wazee kutuambia vile mvua itanyesha na vile jua itawaka kwa kila mwezi. Sisi tunajua, ukilinganisha na ile maneno tunaskia kwa redio na serikali, hao hawasemi ukweli. Wanasema mvua itanyesha, na hainyeshi! Sisi tunaangalia vile upepo inaenda, vile nyota iko, vile ndege na wanyama pori wanatembea, na tunajua vile hali ya anga itakuwa*". (Since time immemorial we normally use elders to predict how it will rain or how dry spell will be month after month. When you compare between weather reports from radio and government, they don't say the truth. They say it will rain, yet it doesn't rain! As for us we simply look at wind movements, look at the patterns of stars, how birds and wild animals move and we determine how the weather will be.)

The assertion that knowledge on the climate change extreme events and the prediction thereof has an influence on the uptake of climate change adaptation strategies in Kajiado County was further examined through the inferential statistical analysis tool of Pearson's Chi-square to establish an association. The results are shown in figure 5.15 below. These results show that knowledge and prediction by farmers about drought and rainfall is significantly associated with the uptake of modern climate change adaptation strategies. At Confidence Level of 99%, with x^2 for rainfall and drought being 26.869 and 13.861 respectively, the p-value for both is at $p<.01$. This can be interpreted to mean that farmers feel that they are resilient to these extreme weather events by accurately predicting the adverse climatic changes, using indigenous knowledge, hence being able to respond accordingly.

Table 5.15: Relationship between knowledge of climate change for extreme events and the Level of Uptake of CCAS

Extreme events	**index score; level of uptake of modern agricultural practices**			**Inferential statistics**		
	No uptake	**Uptake of**	**Difference**	**X^2**	**P-value**	**Sigificance?**
[1]Very heavy rain, yes (%)	43.5	39.0	-4.5	26.869	0.000***	Yes
[1]Storm, yes (%)	1.0	2.9	1.9	2.492	0.114	No
[1]Drought, yes (%)	42.9	41.9	-1.0	13.861	0.000***	Yes
[1]Pest invasion on crops, yes (%)	17.3	24.6	7.3	3.163	0.075*	Yes
[1]Very high temperatures, yes (%)	10.5	24.9	14.4	24.155	0.000***	Yes
Wild fires, yes (%)	0.5	0.5	0.0	0.019	0.891	No
Floods, yes (%)	33.5	14.9	-18.6	73.581	0.000***	Yes
Landslides, yes (%)	0.8	0.8	0.0	0.028	0.866	No
Thunder, yes (%)	1.8	4.5	2.7	3.127	0.077*	Yes
Very low temperatures, yes (%)	1.3	1.6	0.3	0.006	0.939	No
Overall score climate change; Extreme events						
Mean	49.44	49.90	0.464	t= -0.181	0.856	No
SD	19.51	28.87				
Std. Error Mean	1.46	2.02				

(Field Data, 2020)

These findings affirm that one of the ways by which farmers and communities can address climate change related vulnerabilities is in accurate predictions of current as well as future rainfall patterns as was found by other similar studies (Ziervogel and Opere, 2010; Zhang and Nakagawa, 2018). In conformity with these findings, a study on the use of indigenous knowledge in predicting changes in seasonal rainfall by smallholder farmers of Ruteete Sub county, Kabarole District in Uganda, by Nyakaisiki *et al*.(2019) found that indigenous knowledge has been used in observing and monitoring weather patterns especially rainfall trends.

However, this study specifically highlights a behavioral feature among the Kajiado County farmers, especially based on the Theory of Planned Behaviour (Arjen, 1991), that although they can access scientific climate change information, they are hardly motivated to adopt new farming techniques. On the contrary, they are more comfortable in following their indigenous knowledge.

5.6: Knowledge, Attitudes and Perceptions of Farmers towards Climate Change Parameters

This study also sought to determine the relationship between the farmers' perception on climate change trends and how that influences their adoption decisions of the CCAS. As shown in Table 5.16 below, there are varied perceptions among farmers on different extreme weather events.

Table 5.16: Relationship between Attitudes/perceptions towards climate change and the Level of Uptake of CCAS

	index score; Level of uptake of modern agricultural practices					
	No uptake	Uptake	Difference	X^2	P-vale	Significance?
Increasing rainfall amount during rainy season, yes (%)	14.9	22.0	7.1	3.421	0.064*	Yes
[5]Decreasing rainfall amount during rainy season, yes (%)	3.9	9.7	5.8	7.622	0.006***	Yes
Increasing length of rain season, yes (%)	5.5	9.2	3.7	2.182	0.140	No
[5]Decreasing length of rain season, yes (%)	3.1	13.1	10	22.073	0.000***	Yes
Early onset of rain days, yes (%)	8.4	12.0	3.6	1.223	0.269	Yes
[5]Late onset of rain days, yes (%)	2.6	30.1	27.5	111.230	0.000***	Yes
Increase of strong winds events, yes (%)	0.0	3.9	3.9	13.623	0.000***	Yes
[5]Increasing temperature of the area, yes (%)	2.1	14.4	12.3	34.838	0.000***	Yes
[5]Decreasing temperature of the area, yes (%)	0.3	2.6	2.3	6.403	0.011**	Yes
Increasing rainfall amount during rainy season, yes (%)	3.4	11.0	7.6	13.612	0.000***	Yes
Decreasing rainfall amount during rainy season, yes (%)	19.4	22.0	2.6	0.006	0.937	No
Overall score: Attitudes/perceptions towards climate change						
Mean	5.17	26.18	21.01	**t=-11.771**	0.000***	Yes
SD	9.28	22.17				
Std. Error Mean	0.70	1.55				

(Field data, 2020)

Notably, Chi-square analyses indicate that the traditionally observed drought related trends such as late onset of rainy days $X^2 = 111.230$ p=.000; increasing temperature of the area, $X^2 = 34.838$, p=.000 and decreasing length of rain season, $X^2 = 22.073$, p=.000 are significantly associated with the uptake of the CCAS; in the descending order of significance.

Analyses conducted on qualitative data collected from the questionnaires, FGD and KII responses pointed to thematic areas that conformed to quantitative findings. For instance, majority of the KII and officials in relevant government departments such as agriculture (crop, livestock, fisheries, water, environment and natural resources), local administration (chiefs and sub-chiefs) and other non-state actors (NGOs) generally concurred on community's strong adherence to traditional adaptation practices amidst adverse weather events such as drought. A particular KII with one of the environmental officers in the department of Water, Environment and Natural Resources working for the implementation of climate change mitigation and adaptation initiatives as well as building resilience and adaptive capacity of local communities stated that the local communities believe they have interacted with climate stresses over the ages. He averred:

> "In our interactions with community elders who are also farmers, they categorically state that they are familiar with weather trends using their traditional knowledge and that whenever they have adverse climate events like extended droughts, they have their own mitigation strategies that they have used over the ages – claiming that these have worked for them. They believe migrations have been the most effective practice which has worked for them including it being an environmental conservation strategy."

The above observation confirms cognitive bias that has been built over the years among the local farming communities who have interacted with extreme weather events as they carried out their agricultural activities. In agreement with similar studies, this cognitive bias interferes with the farmers' willingness to adapt to climate change phenomenon in practicing modern CCAS (Talanow *et al*., 2021)

The above significant associations illustrate the relevance of the Situated Learning Theory (SLT) forwarded by Lave & Wengner (1991) to exploring how indigenous knowledge in adapting to climate change impacts in Kajiado County has been so entrenched. The assumption here is that a learning process that has taken place among social acquaintances, in an environment of constant and ongoing interaction. Contextual experience has been assimilated by local farmers in such a way as to create a strong cognitive bias that it has been a challenge to accept alternative adaptation mechanisms (Vygotsky, 1978; Theodory, 2016).

5.7: Farmers' Knowledge about the Causes of Climate Change and Uptake of CCAS

This study also sought to establish the influence of the farmers' knowledge about the causes of CC on their willingness to adapt to modern scientific CCAS. As illustrated in the frequency Table 5.17, majority of the respondents concurred that environmental degradation; pollution and deforestation are main causes of climate change with 66%, 69% and 78% of them respectively affirming (responding "yes").

Table 5.17: Farmer's Knowledge of Causes of Climate Change

Causes	Kajiado West	Kajiado Central	Loitokitok	% of the Total
Environmental degradation	108	88	55	66
Pollution	81	65	119	69
Deforestation	97	114	88	78
Modernization	40	44	90	46

(Field Data, 2020)

Research has proved that human activities are at the forefront as contributing to the global warming phenomenon (Trenberth, 2018). It can be deduced that the farmers in Kajiado County have an accurate view of what causes CC. Direct consequences of deforestation, which 78% of farmers thought is a key cause, interferes with the carbon sink process, a scenario which significantly increases carbon gases build-up in the atmosphere. This study attempted to establish if there were associations between knowledge among farmers on causes of climate change and how this influences them in adapting to CCAS. Table 5.18 below illustrates the nature of these associations from the Pearson's Correlation calculations as indicated.

Table 5.18: Chi-Square Pearson's Correlation Calculations for Association between Farmers' Knowledge about CC Causes and Uptake of CCAS

Cause of Climate Change	CCAS Uptake variables	Chi-square value	df	Sig. (2-tailed)	Correlation
Environmental degradation	Increase of Superior breeds of cattle.	10.761	1	.001	-.168
	Fenced off and reseeded natural pasture	30.962	1	.000	.285
	Better pasture establishment by using more than one grass species	9.465	1	.002	.157
Pollution	Proportion acreage of land under irrigation farming.	9.871	1	.002	.161
	Increase of Superior breeds of cattle.	4.316 `	1	.038	.106
	Fenced off and reseeded natural pasture	6.922	1	.008	-.135
Deforestation	Proportion acreage of land under irrigation farming.	4.077	1	.044	-.103
	Increase of Superior breeds of cattle	10.236	1	.001	-.164
	Involvement in agricultural development meetings	9.788	1	.002	-.160
	Fenced off and reseeded natural pasture	22.381	1	.000	.242
	Better pasture establishment by using more than one grass species	7.420	1	.005	.142
	Water resource management practices (e.g. water harvesting)	26.789	1	.000	.265

(Field data, 2020)

Table 5.18 above shows that, the farmers who believed that environmental degradation is responsible for the CC phenomenon were more likely to adopt CCAS practices such as fencing off and reseeding natural pasture (X^2 = 30.962, p = .000) and better pasture establishment by using more than one grass species to spread the risks (X^2 = 9.465, p =

.002). Conversely, these farmers would not favor engaging in keeping livestock that include the superior breed with correlation calculation showing an inverse coefficient of -.168 ($X^2 = 10.761$, $p = .001$). Notably, the farmers who believed that CC was as a result of pollution are strongly more likely to adopt CCAS practice of doing irrigation farming ($X^2 = 9.871$, $p = .002$) while detesting fencing off of natural pastures ($X^2 = 6.922$, $p = .008$).

It is also notable that farmers who held the opinion that CC phenomenon emanated from wanton destruction of forests do actually agree with adapting to the phenomenon by fencing off and reseeding natural pasture ($X^2 = 22.381$, $p = .000$). The same farmers also could engage in better pasture establishment by using more than one grass species to spread the risks ($X^2 = 7.420$, $p = .005$) and willing to establish water resource management practices such as water harvesting ($X^2 = 26.789$, $p = .000$). However, such farmers do not favor CCAS practices as shown by negative correlation coefficients. The practices include putting land under irrigation farming ($X^2 = 4.077$, $p = .044$), keeping livestock that include the superior breed among livestock farmers ($X^2 = 10.236$, $p = .001$) and willingness to be involved in agricultural development planning at village, ward or constituency committees ($X^2 = 9.788$, $p = .002$).

Similar analyses that were done to determine how farmers' knowledge about the causes and consequences of CC influences their decision-making on adapting to new technologies illustrated that farmers are likely to seek new coping mechanisms alternatives (Adebayo *et al*., 2012; Raghuvanshi and Ansari, 2017). Depending on what their perceptions concerning causes of CC are, farmers readily form sound risk awareness bases from which they could easily venture into adapting to relevant mitigation measures. Incidentally, modernization/urbanization (expansion) has not been viewed by majority of the respondents as a contributing factor to climate change.

However, key informants interviews (KII) with the county environment, agriculture and water management officers, confirmed that there was a general belief among famers in Kajiado County that, urbanization/modernization plays a key role in environmental degradation, pollution and deforestation. One environmental officer stated:

> "From our interactions with community members as we carry out our community awareness and sensitization campaigns on environmental management, some of the local farmers challenged us about widespread clearing of forests to create space for construction of towns and industries/factories, especially the latter being responsible for cases of environmental degradation and pollution."

The assertion further affirmed the analysis results identifying deforestation (78%, Table 5.8) as the main cause of climate change and which, according to farmers can be addressed through adapting to better management of pastures and water resources.

5.9: Effect of Existing IK Practices in Response to CC on Uptake of CCAS

In order to determine the effect, binomial logistic regression analysis was carried out to find out whether the existing IK response mechanisms among the farmers had an influence on the uptake of CCAS at an alpha level of 0.05. A binomial logistic regression was run to understand the effects of continuous practice of each type of IK responses, particularly migration, on the uptake/no uptake of the CCAS. This statistical analysis was used because the dependent variables (Modern farming practices variables) were measured in two distinct categories i.e. “Yes” or “No” to denote uptake or no uptake respectively. The "Variable in the Equation" table shows the contribution of independent variable to the model and its statistical significance. The results of the analysis were as indicated in Table 5.19.

Regression analyses of the data indicate that there is negative effect of IK on Uptake of CCAs. For instance, respondents who opted to “resign to our fate and do nothing” were, 64.4% less likely to increased acreage of land under irrigation farming, 70.4% less likely to be involved in agricultural development planning at village, ward or constituency committees, 51.4% less likely to practice artificial insemination for livestock, 86.8% less likely to fenced off and reseed natural pasture, 42.3% less likely to increased cultivation of drought resistant crops and 19.6% less likely to involve themselves in water resource management practices (e.g. water harvesting).

Those who opted to use traditional IK to survive were 55.1% less likely to increased acreage of land under irrigation farming**,** 42.3% less likely to increase the numbers of animal breeds that include the superior breed among livestock farmers, 87.0% less likely to fenced off and reseed natural pasture, 75.0% less likely to increased cultivation of drought resistant crops and 94.7% less likely to involve themselves in water resource management practices (e.g. water harvesting).

Those who opted to seek help within social networks; relatives, clan, neighbors were 92.4% less likely to fenced off and reseed natural pasture, 87.8% less likely to increased cultivation of drought resistant crops and 96.9% less likely to involve themselves in water resource management practices (e.g. water harvesting).

However , more importantly, the farmers who actively practiced nomadism (migration) were 72.0% less likely to increase acreage of land under irrigation farming and 78.7% less likely to increase the numbers of animal breeds that include the superior breed among livestock farmers.

Table 5.19: Binary Logistic Regression Analysis of Uptake of CCAs and Existing IK Response mechanism on Climate Change

Variables in the Equation									
Modern Farming Practices	**Response Mechanism**	**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp (B)**	**95% C.I. for EXP(B)**	
								Lower	**Upper**
Increased acreage of land under irrigation farming.	Resign to our fate and do nothing	1.155	.355	10.613	1	.001	3.174	1.584	6.359
	Use traditional IK to survive	.734	.428	2.941	1	.086	2.083	.901	4.816
	Seek help within social networks; relatives, clan, neighbors	-.517	.785	.434	1	.510	.596	.128	2.776
	Migration	1.551	.395	15.435	1	.000	4.717	2.176	10.225
	Constant	-3.352	1.070	9.813	1	.002	.035		
Increased numbers of animal breeds that include the superior breed among livestock farmers	Resign to our fate and do nothing	-.275	.323	.727	1	.394	.759	.404	1.429
	Use traditional IK to survive	.478	.396	1.457	1	.227	1.613	.742	3.508
	Seek help within social networks; relatives, clan, neighbors	.235	.844	.077	1	.781	1.265	.242	6.616
	Migration	1.284	.375	11.705	1	.001	3.612	1.731	7.538
	Constant	-2.303	1.018	5.122	1	.024	.100		
Involvement in agricultural development planning at village, ward or constituency committees	Resign to our fate and do nothing	1.295	.468	7.650	1	.006	3.652	1.459	9.143
	Use traditional IK to survive	-.575	.519	1.230	1	.267	.563	.204	1.555
	Seek help within social networks; relatives, clan, neighbors	-.710	.899	.623	1	.430	.492	.084	2.866
	Migration	2.159	.574	14.141	1	.000	8.662	2.811	26.688
	Constant	-3.813	1.365	7.801	1	.005	.022		

Practicing artificial insemination for livestock	Resign to our fate and do nothing	.799	.815	.960	1	.327	2.223	.450	10.981
	Use traditional IK to survive	.106	.849	.016	1	.900	1.112	.211	5.868
	Seek help within social networks; relatives, clan, neighbors	-1.957	1.285	2.318	1	.128	.141	.011	1.755
	Migration	.153	.973	.025	1	.875	1.166	.173	7.848
	Constant	-20.190	6074.258	.000	1	.997	.000		
Fenced off and reseeded natural pasture	Resign to our fate and do nothing	2.003	.429	21.820	1	.000	7.412	3.198	17.176
	Use traditional IK to survive	2.047	.435	22.176	1	.000	7.743	3.303	18.150
	Seek help within social networks; relatives, clan, neighbors	-2.565	.918	7.804	1	.005	.077	.013	.465
	Migration	-2.004	.476	17.728	1	.000	.135	.053	.343
	Constant	-.913	1.142	.640	1	.424	.401		
Increased cultivation of drought resistant crops	Resign to our fate and do nothing	-.810	.633	1.638	1	.201	.445	.129	1.538
	Use traditional IK to survive	1.517	.849	3.190	1	.074	4.558	.863	24.080
	Seek help within social networks; relatives, clan, neighbors	-1.638	.970	2.851	1	.091	.194	.029	1.301
	Migration	-.799	.693	1.331	1	.249	.450	.116	1.748
	Constant	-.624	1.217	.263	1	.608	.536		
Water resource management practices (e.g. water harvesting)	Resign to our fate and do nothing	-.445	.318	1.959	1	.162	.641	.344	1.195
	Use traditional IK to survive	3.090	.396	60.771	1	.000	21.971	10.104	47.777
	Seek help within social networks; relatives, clan, neighbors	-3.448	1.070	10.379	1	.001	.032	.004	.259
	Migration	-2.210	.389	32.290	1	.000	.110	.051	.235
	Constant	3.065	1.208	6.436	1	.011	21.445		

(Field data, 2020)

Additionally, these farmers are 79.5% less likely to be involved in agricultural development planning at village, ward or constituency committees, 27.0% less likely to practice artificial insemination for livestock, 85.6% less likely to fenced off and reseed natural pasture, 30.2% less likely to increased cultivation of drought resistant crops and 83.2% less likely to involve themselves in water resource management practices (e.g. water harvesting).

Practicing migration during the CC-related prolonged drought statistically significantly predicted reluctance on CCAS uptake of increased acreage of land under irrigation farming (p = .000). This IK oriented practice also significantly influenced a farmer's decision to increase numbers of superior animal breeds (p = .001), to involve themselves in agricultural development planning (p = .000), to fence off and reseeded natural pasture (p = .000) or doing water resource management practices (e.g. water harvesting) (p = .000). Continuous use of other IK coping mechanisms also predicted reluctance by farmers on CCAS uptake of fencing off and reseeding natural pasture (p = .000) and water resource management practices (e.g. water harvesting) (p = .000).

There was only one predictor variable that had impact on uptake or no uptake of increased numbers of animal breeds that include the superior breed among livestock farmers which was migration (p=.001). Those who resigned to their fate and did nothing (p=.006) and migrate (p<.001) were more likely to be involved in agricultural development planning at village, ward or constituency committees or not.

From the responses of the farmers, indicating that they would resign and do nothing, a clarification was sought during the *KIIs* with elders and also FGD sessions. There was a concurrence that most farmers would do "progressive observations" of their environment as the effects of CC evolved. One of the elders averred:

> *"Hizi hali mbaya za anga mara nyingi tunaangalia tu vile kunaendelea. Sisi tunaamua ya kufanya tukiona vile iko, kiangazi ikiwa kiasi, tunavumilia tu mpaka msimu inapita, lakini ikiwa kali sana, sisi tunahama*." (In most cases we normally observe these adverse effects of

> weather as they evolve. We normally make decisions depending on the prevailing conditions, when not very intense, we just persevere until the season dissipates, and however, if it is very severe, we just migrate).

The above assertion seems to justify the fact that “doing nothing” response is one of the responses that appear to influence whether the farmers would adapt to the CCAS. However, as compared with “migration”, the effect of “doing nothing” is not as significant on uptake of the CCAS among the farmers as shown in the regression statistics in Table 5.14. These findings can therefore be interpreted to mean that IK practices, particularly migration (nomadism) that is a common activity of pastoralists who live in Kajiado County have a negative effect on the uptake of CCAS.

The above results concur with other studies which have indicated that without deliberate efforts to motivate farmers with such incentives as improved market networks and/or provision of subsidies on inputs and access to financial credit are necessary (Amfo and Ali, 2020; Jha *et al*., 2020; Mogomotsi *et al*., 2020). Local farmers would continue to stick to IK practices and be reluctant to uptake the climate change adaptation strategies.

CHAPTER SIX

EFFICACY OF EXISTING CLIMATE CHANGE ADAPTATION AGRICULTURAL TECHNOLOGIES FOR SUSTAINABLE AGRICULTURE

6.1: Introduction

In assessing the effectiveness of the existing climate change adaptation strategies being applied in Kajiado County, this study was guided by the National Climate Change Action Plan (NCCAP) for the period 2018-2022 (GOK, 2018), which stipulates the national government response mechanisms to the effects of climate change; as well as the Kajiado County Integrated Development Plan (KCIDP) (County Government of Kajiado, 2017). The study therefore highlights and analyzes climate change adaptation approaches by relevant national and county government departments with a view of determining their efficacies.

This chapter discusses the variables identified in the specific objective three and seeks to evaluate the mitigation strategies in the context of the adverse effects of climate change within the study area. The study, based on its scope, focused on both mid-term and long-term plans that are relevant to the socio-ecological, economic and cultural characteristics of the resident communities of Kajiado County. To be effective these strategies are evaluated based on how inclusive and acceptable they are to local communities, early warning systems, knowledge base of the farmers, level of technology being applied, capital and infra-structure required for implementation.

6.2: Existing Agriculture Climate Change Adaptation Strategies in Kajiado County

This study, in its effort to identify the agriculture climate change adaptation strategies in Kajiado County, delved into reviewing the current literature that cover the policy frameworks of implementing climate change related mitigation regulations and recommendations from relevant national/county government institutions and other non-governmental implementation partners. Key among the relevant documents that formed part of this study's secondary data was the Mitigation Technical Analysis Report (MTAR), which provides the evidence base for the prioritized climate change mitigation actions in the five-year National Climate Change Action Plan (NCCAP) 2018-2022 (GOK, 2018).

Some of the key strategies spelt out in the plan within the agricultural sector include the promotion of indigenous knowledge on crops, modifying food habits and creating awareness on climate change impacts on the agriculture value chain. Apart from these plans being largely futuristic and based on certain critical assumptions, their implementation on the ground cannot be quantified as the data reveals in latter sections of this chapter. For instance, the issue of sources of funding for the implementation of these plans has been cited severally in the report. In addition, the plan does not explicitly indicate the linkages between the technical stakeholders and key IK local informants.

Similarly, the Kajiado County Integrated Development Plan 2018-2022, has expounded on the adverse impacts of CC on agriculture and recommended such strategies as doing awareness campaigns among the community on climate change mitigation, adaptation, impact reduction and early warning. The plan does not indicate how the existing indigenous knowledge practices among local farmers can be harnessed to bolster the uptake of the CCAS.

For purposes of correctly querying the level of uptake of CCAS as influenced by the IK practices among farmers in Kajiado County, the review reveals that the plan did not consider the role that IK can play in developing effective CCAS. Whereas autonomous strategies include livelihood diversification, irrigation, change in planting date, crop and livestock insurance and using tolerant varieties of crops which are location-specific, the planned strategies are more policy oriented and include investment in infrastructure to facilitate supplies and marketing, subsidies to cushion farmers, research on drought resistant varieties, innovation and tax regimes. The plan may have been developed without the direct input of authorities of IK at the grassroots level. Subsequently, key parameters of strategy implementation such as appropriate financial flows, a new technology framework and an enhanced capacity building framework may not have had supportive impacts locally.

The findings in Table 6.1 below show that, of the farmers who agreed to the adoption of CCAS, the largest proportion cited water resource management as a key strategy with 196 (37%) of them suggesting it as an important practice.

Table 6.1: Farmers' preferred options of CCAS

CC Adaptation Practices	No. of Farmers supporting	Percent	Rank
Water resource management practices (e.g. water harvesting)	169	37	1
Fenced off and reseeded natural pasture	94	21	2
Proportional numbers of animal breeds that include the superior breed among livestock farmers.	73	16	3
Involvement in agricultural development planning at village, ward or constituency committees	26	6	4
Increased cultivation of drought resistant crops	17	4	5
Practicing artificial insemination for livestock.	9	2	6

(Field Data, 2020)

The data above also illustrates the rankings of the CCAS as preferred by the farmers in Kajiado County. Practicing Artificial Insemination for breeding purposes was cited as the least preferred strategy of adapting to climate change effects. Considering that water resource and pasture (21%) seem to be the two main practices that can easily be effectively adopted by these farmers who are mainly livestock farmers. The existing CCAS in Kajiado County to support farmers grappling with adverse effects of CC need to be more effective in the two areas – availability of water and pastures for their animals. The climate risk vulnerabilities for pastoralists in Kajiado County have been persistence due to long droughts that have gradually depleted water and pasture resources. As other studies have indicated, migration/mobility of the pastoralists in search of these key commodities is a precarious pastoral risk management strategy because of their dwindling availability (Filho *et al*., 2020).

6.3: Farmers Views on Effectiveness of CCAS

One of the key issues that this study sought to establish was the level of knowledge about modern agricultural policies that address climate change related challenges among the farmers in Kajiado County. Awareness creation on the mitigation and adaptation strategies against impacts of CC has been cited as the key facilitating factor in implementing the CCAS. Determining farmers' knowledge level illustrated how much effort by the implementation actors has been put on reaching out with the messages about the CCAS to the farmers. To establish this fact, the farmers were asked whether they have ever heard about modern agricultural technologies/practices that address challenges related to climate change. Their responses are illustrated in Table 6.2 overleaf. The table shows that 284 (74%), which were the majority of the farmers interviewed, had already heard about the modern agricultural technologies that address the challenges of climate change.

Table 6.2: Level of Knowledge about CCAS among Farmers

Have you ever heard about modern agricultural technologies/practices that address challenges related to climate change?	**Frequency**	**Percentage**
Yes	284	74.3
No	84	22
Don't know	14	3.7
Total	382	100

(Field data, 2020)

However it can be noted that nearly 26% of the farmers have never heard about the CCAS. Although the majority of farmers had indicated that they are aware of the CCAS, the data did not reflect the application of this knowledge into practicing the technologies in their agricultural activities. One elder in Olepolos in Kajiado Central during the KII stated that that information is released to them only passively with no clear plan of follow-up. He explained:

> Mara mingi sisi tunapata haya maneno wakati wa baraza ya chifu. Lakini ni ngumu sana kupata hawa wakubwa wa kilimo kuja kwa maboma zetu kuona vile tuna chunga hii ng'ombe. *"In many occasions, we receive this information at meetings at the chief's camp. It is very rare for these officers of agriculture coming to our livestock farms to see what we are doing"*.

The above statement lends credence to the fact that the implementation of CCAS would only be effective if there had been increased level of engagement with the farmers, demonstrating a clear plan for follow-up. Poor linkages between government agencies, local government departments and the community members can be a huge constraint to new technology implementation.

These results agree with findings of a study by Ampaire *et al*. (2017) in Uganda on the institutional challenges to climate change adaptation in which it was established that without concise and active vertical and horizontal communication channels among the players, the CC adaptation strategies cannot be implemented effectively. For instance, the respondents were asked from their experience, how effective the modern agricultural practices are in solving climate change challenges. Table 6.3 below shows the findings to this query, with 57% of them stating that the CCAS can be very effective in addressing the adverse effects.

Table 6.3: Effectiveness of the Existing CCAS in Solving Climate Change Challenges

	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Very Effective	17	4.5	4.5	4.5
Effective	37	9.7	9.7	14.1
Somehow Effective	52	13.6	13.6	27.7
Ineffective	81	21.2	21.2	49.0
Very Ineffective	195	51.0	51.0	100.0
Total	**382**		**100.0**	

(Field data, 2020)

From the findings shown in Table 6.3, majority of the respondents, numbering 195 (51%) believed that the modern agricultural practices can be very ineffective in addressing the climate change adverse effects. Notably only 17(4.5%) and 37(9.7%) of the respondents agreed that the CCAS are very effective and effective respectively. These results are indicative of how the farmers still stick to indigenous knowledge practice of nomadic pastoralism during extended periods of drought.

Again, as discussed in Chapter 5 about the learning process and socio-cultural environment within which members of the community learn IK, the concept is so entrenched in their mind that the change towards other “foreign” practices may take some time (Tanyanyiwa, 2019; Theodory, 2016). Although CCAS may be effective in solving challenges of CC, the government players and other relevant non-state actors have not been able to effectively implement a follow-up plan to ensure that the CCAS are adopted.

6.4: CCAS Implementation Challenges

This section discusses the problems associated with the implementation of the existing CCAS within Kajiado County based on the findings. There are many challenges that are mainly associated with the perceptual and socio-cognitive processes within which, the local farmers need to have undergone for them to make adoption decisions in favor of the recommended CCAS. Lack of adapting to the new farming technologies and/or acquiring new livelihoods has greatly hampered the effective and efficient implementation of CCAS and consequently rendering them unsustainable in addressing food insecurity in Kajiado County.

The study findings show that the views of the local farmers (particularly the local knowledge that is not only hinged on the social values of the farming communities but also on their climate change related risk perceptions), are manifestly lacking in the existing CCAS frameworks. Both NCCAP and KCIDP for the five year period of 2018-2022 do not explicitly indicate any structures within which the indigenous knowledge systems were incorporated. The study went ahead to find out from the custodians of this knowledge whether the local knowledge on response mechanisms has been solicited by the government through their local or national representatives, the response indicating very minimal interactions.

6.4.1: Involvement of Stakeholders in Identification of Climate Change Adaptation Strategies

According to the NCCAP, the Mitigation Technical Analysis Report (MTAR) was a product of evidence-based process that was done on an inclusive and collaborative manner involving key stakeholders (GOK, 2018). However, on conducting the document analysis this, report does not feature any clear indigenous knowledge input from the local elders/leaders. The report was generated from the inputs from technical experts who gave their scientific-based views obtained from technical observations in and excluded contributions from the local farmers who utilize traditional mechanisms in response to ravages of climate change in their area. To confirm this exclusion, the respondents were asked to state whether they have ever been involved in the agricultural development plans.

Table 6.4 indicates that over 93% of the household respondents had never encountered any local farmers being involved in designing of agricultural development plans. When asked to freely suggest ways which they can enhance modern scientific agricultural practices for effective adaptation to climate change, the most common generalized suggestion was that there should be increased education and awareness creation about indigenous knowledge. The farmers felt that inclusion of the traditional practices in the CCAS approaches would be more effective because they have witnessed the former's efficiency especially in prediction of weather trends and in particular rainfall patterns. Omission of the local knowledge inputs in the CCAS negates the essence of their utility because the local farmers are the primary implementers.

Table 6.4: Inclusion of Indigenous Knowledge in Agricultural Development Plans

Involvement in agricultural development planning				
	Response	Frequency	Percent	Valid Percent
Valid	No	356	93.2	93.2
	Yes	26	6.8	6.8

(Field data, 2020)

Lack of inclusion of local farmers in the county agricultural planning at the local level renders these plans unusable by the local farmers to some extent and therefore unsustainable towards food production. One of the key responses from one lady small-scale commercial tomato farmer in Loitokitok Sub-county emphasized this fact during the women FGD; stating:

> Sisi hawa watu wa agriculture hatuwaoni wakija hata kututembelea sisi wakulima wadogo wadogo kutupea mawaidha ama kutaka kujua vile sisi tunafanya hii kilimo ya nyanya. Wako hata hapa Loitokitok na ofisi, lakini hawa huenda tu kwa wale wakulima wenye mashamba makubwa makubwa wenye matrakta mingi, wale huatumia mbinu ya wazungu. Na sisi yetu hii inatutosha tu, juu hao wakulima wakubwa wanaharibu udongo yao na hizo mbolea. "*We rarely see these agriculture officers coming to visit us small scale farmers to advise us or even to check on how we manage our tomato farming. They even have an office here in Loitokitok, but they (officers) prefer visiting large scale farmers who have many tractors who use western strategies of farming. We are contented with our own farming practices because those large scale farmers are destroying their soil by use of modern fertilizers".*

According to IPCC, 2014, one of the key characteristics of an effective climate change adaptation strategy is its level of inclusion of the indigenous knowledge as this has been proven to increase effectiveness of adaptation. Integration of indigenous knowledge systems into adaptation efforts is considered a more efficient way of responding to the adverse impacts of climate change in the context of sustainable development. The importance of integrating indigenous knowledge into the conventional CCAS is discussed at length in Chapter Seven.

During KII a county agricultural officer stated that there have been implementation challenges of the government developed Climate Change adaptation policies among the community farmers. The participant stated:

> "Effective implementation of the policies developed by the relevant government agencies has been very problematic. Dissemination of the information to local farmers has always been met with apathy and suspicion due to some form of prejudice on the belief that new technologies are meant to stop them from nomadic pastoralism, a farming practice dearly embraced by the locals. They also view these technologies as those that are too complex for them and bear cost implications. They also view us as "outsiders" who don't know their way of life and survival."

6.4.2: Farmers' Appraisals of Climate Change Risks and Opportunities

In this study, the respondents were asked to state reasons as to why there is a challenge of utilizing the CCAS; and being provided with multiple options as shown in Figure 6.1.

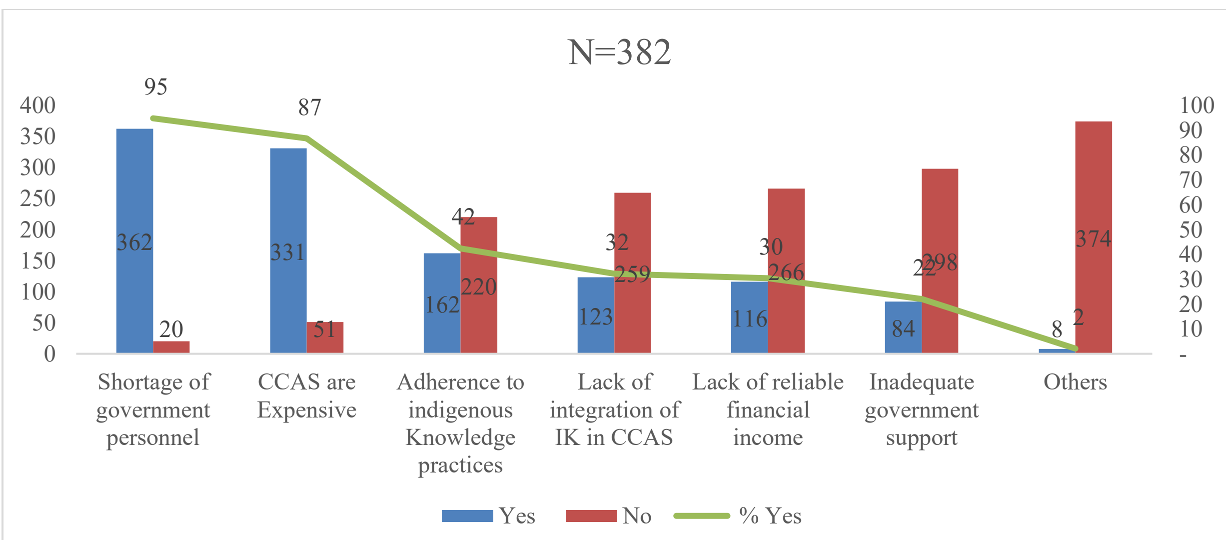

Figure 6.1: Challenges of Applying CCAS among Local Farmers (Field Data, 2020)
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As indicated in Figure 6.1, 162 (42%) of them actually agreed that they are prone to adhering to their indigenous knowledge practices in carrying out their farming activities, while 32% believed that the CCAS do not include indigenous knowledge as statistics show in the bar-chart, Figure 6.1 below. These two factors underscore the problems associated with the implementation of CCAS based on the perception that these are foreign practices that may not be applicable to the local needs.

In addition, the results show that the 331 (87%) of farmers perceive CCAS as problematic to implement because they are expensive and 85 (22%) of them agreeing that there is inadequate support from the government and that there is shortage of requisite government personnel to coordinate and facilitate implementation of the plans. Whereas the above first two sets of factors (IK adherence and lack of IK into the CCAS) are mainly based on psychological processes, the latter two (expense and lack of government support) explain the resource constraints, a factor that is in agreement with the interplay of variables within the MPPACC model (Grothmann and Patt, 2005). The risk perceptions in relation to climate change were analyzed from data obtained from the local farmers' responses on effects and impacts of climate change in their region.

The farmers are naturally averse to these strategies because factors that influence their climate change risk appraisals may differ from those that are advanced by the scientific experts (Mitter *et al*., 2019). The results indicate that it would be unlikely to augment local support for the CCAS if they don't have the indigenous knowledge input because as Nkatha (2020) reports, "Culture, environment and, therefore, knowledge of socioeconomic constructs are intricately interwoven". This would therefore mean that the

CCAS would only be sustainable if their response mechanisms are locally oriented i.e. easily understood, culturally adaptable and acceptable by the local farmers and are related to their existing livelihoods.

This study adopted the Model of Private Proactive Adaptation to Climate Change by Grothmann and Patt (2005) which was further utilized by Mitter *et al*. (2019) who aver that the positive adaptation intentions towards desired climate change strategies are formed after the local farmers do their climate change risk and opportunity appraisals based on their socio-economic and demographic characteristics, existing indigenous knowledge systems, regional ecological characteristics and their perceptions and attitudes. Failure of adequate level of CCAS implementation by the local farmers renders these strategies ineffective in ensuring sustainable agricultural production in Kajiado County.

6.4.3: Regional Ecological and Socio-Economic Characteristics

Desegregating the data according to the ecological regions, the results shown in Table 6.5 indicate that the adoption of CCAS has significantly been slowed down by the continual adherence of local farmers to the IK within Kajiado West and Kajiado Central with 83 (76%) and 36 (36%) of the farmers respectively as compared with Loitokitok Sub-County whose only 32 (23%) of the farmers agreeing to sticking to IK practices. They show that in more arid areas, the farmers predominantly practice pastoralism, a livelihood that is largely characterized by indigenous knowledge practices that mainly include the traditional nomadic lifestyle.

Table 6.5: Tendency of Farmers' Adherence to IK and Challenges to implementation of CCAS Regionally

Sub county			Frequency	Percent
Kajiado West	Valid	No	27	24
		Yes	83	76
		Total	110	100
Kajiado Central	Valid	No	84	64
		Yes	47	36
		Total	131	100
Loitokitok	Valid	No	109	77
		Yes	32	23
		Total	141	100

(Field data, 2020)

In agreement with other studies these findings underscore the relevance of perceptual and socio-cognitive processes among farmers, which depend on regional and farm characteristics that are always localized in nature (Grothmann and Patt, 2005; Mitter *et al*., 2018; Mitter *et al*., 2019). As Mwangi (2018) avers, the *Maasai* pastoralism, which is the dominant livelihood source in Kajiado County, is inextricably intertwined with the socio-cultural as well as historical tenets of the resident farmers; and this has created their spirited observance of the indigenous knowledge practices that goes with it in spite of increasing cases of drought vulnerability.

The above scenario is notwithstanding that intensive livestock farming, which is dominated by pastoralism, and which encourages keeping of large herds of cattle, contributes to 50% of the GHG emissions in Kenya (GOK, 2018). Therefore, the acceptance of CCAS by local farmers' through agricultural activities is a sure way of addressing high level GHG emissions, consequently establishing sustainable agricultural production in the long-term. The effectiveness of the existing CCAS for sustainable agriculture cannot therefore be guaranteed if the users of the recommended strategies fail to adopt them in their farming activities. One key informant interviewee (the county livestock sub-sector officer) admitted to the challenges of accessing farmers in remote areas of Kajiado West who also strongly observe nomadism in their livestock farming.

Further, inferential statistical tests show that there is a significant association between farmers' responses on adhering to IK practices rather than CCAS, and the sub-county where they resided. The statistics in Table 6.6 show that the determinant variables are statistically significant. For instance the analysis set at $p<0.01$ for the 382 respondent farmers, the adaptation of CCAS is highly significant for adherence to IK and resident sub-county of the farmer.

The high Pearson Chi-square values of X^2=101.567, 73.907 and 59.980 for inadequate government support, adherence to IK practices and lack of integration of IK into the CCAS respectively in relation to specific region where the respondents resided, can be explained from information obtained from in-depth interviews from key informants and FGD as well as general observations within the study area.

Table 6.6: Regional Characteristics Influencing Implementation of CCAS

Crosstabs: ***Challenges of implementing CCAS*** **and** ***Resident County of farmer***	**Chi- Square Tests**			
	Pearson Chi-square value	**df**	**Asymp. Sig. (2-sided)**	**Significance**
Adherence to IK	73.907	2	$.000^{***}$	Significant
Expensive	15.561	2	$.000^{***}$	Significant
Lack of reliable sources of finance/income	47.432	2	$.000^{***}$	Significant
Lack of IK Integration	59.980	2	$.000^{***}$	Significant
Inadequate government support	101.567	2	$.000^{***}$	Significant

(Field data, 2020)

6.4.4: Local Structures for Implementing CCAS using Indigenous Knowledge

The findings show that the existing mechanisms utilized by relevant government entities in reaching out to local farmers with a view of harnessing indigenous knowledge into CCAS are very weak. One key informant, a county coordinator for the Agricultural Sector Development Support Programme, admitted that although there are village committees that are meant to be functional in terms of sharing local based solutions to drought related vulnerabilities, accessing this information is a challenge. He stated:

> "There are village committees that we work with, which normally volunteer important information on how best the traditional mechanisms utilized by the pastoralists can be enhanced and supported to address drought related vulnerabilities. However there are challenges in sustaining the membership of these committees because of nomadic movements. There are also difficulties in correct interpretation of terms of the traditional practices thereby interfering with correct information management on one hand and being unable to communicate some of the highly technical CCAS concepts that don't register any meaning to the local farmers on the other. Some of these communities also live in far and remote areas that are inaccessible".

The above assertions demonstrate how the existing CC adaptation frameworks have greatly failed to make impact on negative climate change effects on sustainable agricultural production in Kajiado County.

According to NCCAP, Kajiado County lies within what it considers as Arid and Semi-Arid region, which is characterized by inadequate rainfall that can't support crop agriculture. Majority of the households therefore depend on large scale but nomadic pastoralism. This, according to its Mitigation Technical Analysis Report (MTAR), the National Climate Change Action Plan 2018-2022 indicates that the agricultural sector contributes half of the GH gases emissions in the country with livestock farming comprising half of these emissions (GOK, 2018). Accordingly, the mitigation measures have to address the CC-related adverse effects that are responsible for the build-up of the green-house effect in Kenya. The current mitigation measures according to the MTAR include, introduction of the Climate Smart Agriculture (CSA) program which embraces agriculture that sustainably increases productivity, enhances resilience, reduces or removes GHG emissions, and enhances the achievement of national food and nutrition security and development goals (GOK, 2018).

Although the ravages of climate change on livelihoods among farmers in Kajiado County being manifestly real, the County's CIDP does not seem to have included the main MTAR recommendations in its linkage with the SDGs as per its goal number 13 taking urgent action to combat climate change and its impacts. Whereas the NCCAP (GOK, 2018) recommends in its CC mitigation strategy that there must be a deliberate program in the livestock sector in effecting Greenhouse Gas emissions reduction, the CIDP does not have these recommendations in its blueprint. Considering that the livestock sub-sector is the main livelihood activity, mitigation measures should focus on the reduction of GHG emissions that are linked to this agricultural activity. Consequently, it can be deduced that the CIDP strategic plans for addressing the CC phenomenon in Kajiado County has a disconnect with the NCCAP mitigation strategies rendering CIDP CC recommendations ineffective.

The findings show that the local institutions are very weak and can not play a interface role to facilitate interactions between farmers and the technical institutions that run the CCAS programs in Kajiado County. In terms of community resilience to negative impacts of CC, specifically in regard to droughts, this region continues to incur crop failure and livestock deaths every year. The existing local institutions are so weak in mobilizing climate-smart agricultural mechanisms to the scale that would mitigate the effects of droughts.

CHAPTER SEVEN

STRATEGIES FOR ENHANCING THE INTEGRATION OF INDIGENOUS KNOWLEDGE PRACTICES WITH CCAS

7.1 Introduction

The focus of this chapter was to establish if there have been any attempts towards achieving integration of the climate change related IK practices and the CCAS, identify the relevant policies in place (on this aspect) and interrogate their implementation. The chapter also attempted to mirror these findings with best and successful practices employed elsewhere in the world.

7.1 Efforts towards Achieving Integration of the IK Practices with the CCAS

This study sought to examine any existing approaches that have been used to integrate the IK practices with the CCAS with the aim of responding to the effects of climate change. The areas of analysis included involvement of local farmers in climate-change-related community vulnerability and capacity assessments, levels of community awareness on CCAS, farmers' perception on effectiveness of CCAS, existence of integrated platforms for agricultural development planning, mechanisms of acquiring indigenous knowledge information and institutional arrangements within relevant state and non-state actors. Descriptive and inferential statistical analyses were conducted to draw conclusions on whether there are any forms of integration of both IK and scientifically developed strategies applied by the farming communities in Kajiado County.

This study therefore sought to determine if there was a platform on which local farmers with their IK practices and agricultural extension officers with their CCAS could interact and find ways of integrating the two approaches. In order to establish whether there was a forum or structure through which the agricultural extension officers could interact with the local indigenous farmers, the respondents were asked if they have ever been involved in any agricultural development planning at village, ward or constituency committees. Table 7.1 shows that only about 7% of them indicated that they have been involved in such an exercise.

Table 7.1: Involvement of Local Farmers in Agricultural Development Planning Committees

			Sub county			Total
			Kajiado West	Kajiado Central	Loitokitok	
Involvement in agricultural development planning at village, ward or constituency committees	No	Count	108	125	123	356
		% of Total	28.3	32.7	32.2	93.2
	Yes	Count	2	6	18	26
		% of Total	.5	1.6	4.7	6.8
Total		Count	110	131	141	382
		% of Total	28.8	34.3	36.9	100.0

(Field Data: 2020)

In addition, even with that negligible involvement, there seems to be more involvement by crop farmers in Loitokitok Sub-county who accounted for nearly 5% as compared to the nomadic pastoralists of Kajiado West Sub-county who accounted for less than 1% of the total counts. This means that although such structures may be in existence, efforts to ensure sufficient local farmer involvement are extremely wanting.

According to the IPCC (2020), “agricultural practices that include indigenous and local knowledge can contribute to overcoming the combined challenges of climate change, food security, biodiversity conservation, and combating desertification and land degradation.” Similarly, well researched scientific undertakings to develop ways of mitigating negative impacts of climate change on sustainable agriculture have also been proven effective (David-Chavez and Gavin, 2018; Hiwasaki *et al*., 2014; IPCC, 2014b; IPCC, 2020; Kieslinger *et al.*; 2019; Monroe *et al.,* 2019). The study was therefore to establish the existence of integrated models that interlink the two domains; a climate change adaptation approach that is considered more effective and sustainable (Basdew *et al*., 2017; IPCC, 2020; Makondo and Thomas, 2018).

7.2: Implementation of Relevant Policies towards Integration

It was important for the study to interrogate the existing policy frameworks in place that would facilitate integration of IK practices and CCAS. The study sought to establish whether the integration-oriented CCAS information that would be utilized in adapting to effects of climate change was adequately being disseminated to the local farmers, and the agencies involved. When asked from which sources they received this information, the farmers who affirmed that they received this information indicated multiple sources. Further examination of the data collected revealed that 68% of those who gave “yes” responses as illustrated by the Table 7.2 below showed that their main source of CCAS information was the media (Radio or TV). Notably, only 3% of respondents considered religious institutions as having played a role in disseminating the CCAS.

The findings show that very few farmers (9%) received information from agricultural extension officers, who are the key people interfacing IK practices from local farmers, with the government and research institutions that develop CCAS. In fact the results show that radio and media outlets (68%) and family members (48%) are the major sources through which the farmers got to hear about government agricultural policies.

Table 7.2: Sources of Agricultural Policy Information

Sources	**Yes Responses**	
	Frequency	Percent
Parents/Family	184	48
Friends/Neighbors	88	23
Social groups	138	36
Church/mosques	10	3
Community gathering	36	9
Village leaders/Elders	87	23
Media (Radio/TV)	260	68
Government Extension staffs	34	9
NGOs	74	19

(Field data, 2020)

The disconnect between the extension workers and the local farmers has therefore hampered the implementation of these policies to a very great extent, in addition to the creation of negative perception among the farmers towards any information that comes from the extension officers. The local farmers therefore find it difficult to appreciate the "usefulness" of such information sources the are perceived to be external and detached from the reality on ground. This factor has had an influence on their willingness to adopt a new technology alongside the existing IK farming practices. The same outcome was found in other similar studies (Melesse, 2018; Toma *et al*., 2018; Worku, 2019; Wossen *et al*., 2017).

Fairly remarkable from these findings is that the scientific adaptation approaches are communicated among social groups, with 36% of the respondents indicating that they received this information from such forums. Incredibly, the institutions that are perceptibly charged with the dissemination of CCAS information and sensitizing the farmers about its benefits such as government agricultural extension departments and the community gatherings facilitated by local authorities were not considered as formidable sources.

It is also important to note that the results showed that the CCAS information is disseminated by parents or family members with 48% of the respondents stating that they received this information from their kin. This source may be lacking the requisite technical capacity to articulate the benefits of CCAS. Central to these findings is that the manifestation of inadequate interaction between the local farmers on one hand and the government and non-state actors on the other, the latter being the key entities charged with disseminating the CCAS, illustrates the low levels of opportunities for integrating the IK and CCAS.

In an effort to establish an association between the sources of obtaining scientific-oriented CCAS information and its uptake by the famers in Kajiado County, a Chi-square analysis was run and its statistics shown in Table 7.3 below. Although the figures are showing lack of significant association in the way local farmers are embracing irrigation agriculture, or keeping of superior breeds, nor getting involved in the agricultural development planning; it is however notable that these farmers have been sensitized by the extension staff and have been adopting some of the recommended CCAS such as management of pastures, planting of drought resistant crops and practicing sustainable water conservation initiatives as shown by Chi-square figures of 257.656, 196.449 and 235.550 respectively, with df of 128 and $p < .01$.

Table 7.3: Association between Sources of Obtaining Information and Uptake of CCAS

CCAS practices	Sources of Obtaining Information about CCAS			
	Chi-Square Value	df	Asymp. Sig. (2-sided)	significance
Proportional acreage of land under irrigation farming.	158.884[a]	128	.033*	Significant
Proportional numbers of animal breeds that include the superior Boran 21 breed among livestock farmers.	175.628[a]	128	.003**	Significant
Involvement of local farmers in agricultural development planning	119.283[a]	128	.697	Insignificant
Artificial insemination	119.656[a]	128	.688	Insignificant
State of pasture Management	257.656[a]	128	.000**	Significant
Level of cultivation of drought resistant crops	196.449[a]	128	.000**	Significant
Water Management strategies	235.550[a]	128	.000**	Significant

(Field data, 2020)

Available relevant literature on the above findings (Arruda and Krutkowski, 2017; Naab *et al*., 2019), concur to some extent that meaningful interaction between institutions and local farmers can build resilient agricultural sector through mainstreaming of climate change support services to local agricultural activities. However, there are still persistent institutional challenges of implementing the CC adaptation frameworks, a situation that this study has in its findings, and has attempted to address by confirming that there are inadequate efforts of effective dissemination of CCAS information by the mandated institutions.

7.3: Opportunities for Integrating IK and CCAS in Regard to Best Practices

The analysis of sources of agricultural information was conducted based on the need to establish one of the key themes of integrating indigenous knowledge and western scientific knowledge for climate change adaptation similarities, differences and linkages; so as to establish the "knowledge bridges" (Bohensky and Maru, 2011). The findings on responses about sources of scientific knowledge, especially in regard to mandated agricultural extension officers demonstrate that there is very little community awareness on CCAS among local farmers. If this information isn't extensively disseminated then the local farmers are not able to appraise the CCAS to ascertain any similarities, differences or linkages with their IK.

When asked about whether they have ever heard about modern agricultural technologies and practices that address challenges related to climate change, 284 (74.3%) of the farmers affirmed as shown in Table 7.4. However, these results, when compared to the findings on sources of this information illustrated in Table 7.2; which shows that 68% of farmers received this message from Radio, this kind of message delivery is significantly passive and at worst, doesn't present effective opportunity for feedback. This kind of messaging has not translated the CCAS into useful information since the messages have not been put into practice. Worse still, nearly 26% of the farmers have never heard about the CCAS. This clearly shows that there is a huge gap in regard to a clear structure that can effectively facilitate interaction between the local farmers and the extension officers.

Table 7.4: Awareness about CCAS among Farmers in Kajiado County

			Sub-county			Total
			Kajiado West	Kajiado Central	Loitokitok	
Have you ever heard about modern agricultural technologies/practices that address challenges related to climate change?	No	Count	32	36	30	98
		% of Total	8.4%	9.4%	7.9%	25.7%
	Yes	Count	78	95	111	284
		% of Total	20.4%	24.9%	29.1%	74.3%
Total		Count	110	131	141	382
		% of Total	28.8%	34.3%	36.9%	100.0%

(Field Data, 2020)

Active interaction between the agricultural extension officers and the local farmers is the only effective process through which the integration of these two approaches can be realized.

7.3.1: Opportunities for Integrating IK and CCAS

The opportunities were explored in terms of identifying approaches of adaptation to CC which bear agreeable and similar information between IK practices and CCAS. Establishing this fact involved an analysis of how certain adaptation intervention measures that are directly carried out by the agriculture extension workers relate to the uptake of those measures by local farmers. The findings illustrated the critical role that the extension workers play as conveyors of information from or to local farmers and the research institution as revealed by the existing association between their work and the willingness by the local farmers to adopt CCAS. To determine this, Chi-square tests were done between government extension workers as source of information and uptake of CCAS, and results are shown in Table 7.5 below.

Table 7.5: Relationship between Government Extension Work as Source of Information and Uptake of CCAS

CCAS practices	**Government Extension Staff as Source of CCAS Information**			
	Chi-Square Value	df	Asymp. Sig. (2-sided)	significance
Proportional acreage of land under irrigation farming.	.837a	1	.360	Insignificant
Proportional numbers of animal breeds that include the superior Boran 21 breed among livestock farmers.	4.234	1	.040	Insignificant
Involvement of local farmers in agricultural development planning	2.726	1	.099	Insignificant
Artificial insemination	6.786	1	.009	Significant
State of pasture Management	37.266	1	.000	Significant
Level of cultivation of drought resistant crops	.180	1	.671	Insignificant
Water Management strategies	37.638	1	.000	Significant

(Field data, 2020)

The results show that there is significant impact of agricultural extension work in two CCAS adaptation initiatives tht largely support livestock farming. The above statistics highlights the association that exists between the government extension work and uptake of CCAS recommended management of pastures (CI=99, $X^2 = 37.266$, $p<.01$) and water harvesting and conservation approaches (CI=99, $X^2 = 37.266$, $p<.01$). This is interpreted to mean that increased agricultural extension work engagement by the officers to the local farmers can easily predict positive uptake of pasture management and water conservation CCAS.

Farmers seem not to be willing to implement the other agropastoral adaptation reccomendations from extension workers. For instance, there is no significant relation between extension work and implementation of irrigation farming ($X^2 = 0.837$, $p<.01$).

However, the recommended pasture and water management strategies can be considered as primary opportunities to secure IK/CCAS integration processes. Being that the main livelihoods sources among populations in Kajiado County is pastoralism (County Government of Kajiado, 2017), the focus of farmers is on pastures and water. It can therefore be concluded that the government extension services are mainly concentrated on sensitizing farmers about the two strategies – conservation of water and pastures; and that the respondents who affirmed that they had CCAS information from extension staff, were mainly sensitized on the two approaches of responding to ravages of climate change.

These results also show that the extension work can similarly be effective in other areas of CC intervention if more targetted efforts are employed. The Kajiado County Integrated Development Plan for 2018 – 2022, states in its report that a key threat is overdependence on pastoralism and some of the challenges that the county is facing toward solving low agricultural production is inadequate number of agricultural extension workers (County Government of Kajiado, 2017). This is to emphasize the critical role that the agricultural extension workers can play as an interface in integrating the IK practices and the CCAS, especially in facilitating the formations of integration frameworks (Bohensky and Maru, 2011).

The above statistics also concur with other similar studies which came up with same conclusions that state and non-state agriculture extension institutions are the most effective actors in not only facilitating the diffusion of new agricultural technologies into the farming communities but also key in obtaining important local information that can be used to formulate more sustainable CCAS (Altalb *et al*., 2015; Eidt *et al*., 2019; Melesse, 2018; Osumba *et al*., 2021;). In a more succinct assertion, on the work of examining the role of extension work on agricultural technology transfer among farmers, Melesse (2018) states that "Extension service is a very crucial institutional factor that differentiates adoption status among farmers."

7.3.2: Other Best Practices for Integration

Other opportunities for integrating IK practices with the CCAS that could not be established on the study site, but which have worked well elsewhere include the introduction of the role plays and CC related cultural information exchange programmes that can be deliberately organized and facilitated by the County government. Such a strategy would really motivate the local farmers to share and showcase what has worked for them in response to CC impacts. One of the departments at the County that was found to be working utilizing a participatory engagement with the local farmers was the Agricultural Sector Development Support Programme (ASDSP). However, some structural challenges were a real hindrance to achieving this goal. One officer opined during a KII interview:

> "We have clear strategies on how we can engage with our local farmers, especially the pastoralists towards addressing CC challenges and working out and agreeing on the adaptation options. They are even aware of our existence and mandate. However, reaching them on consistent basis is a real problem due to remoteness of some of the *manyattas* (villages); their migratory tendencies during droughts, financial constraints to cover logistical needs and inadequate staff. Particularly, funding of these programmes is a real issue."

The above statement accounts for lack of local-level organizational efficiency to set up stakeholder forums for information sharing.

Documented evidence show that such platforms can enhance the incorporation of IK into CCAS and facilitate the development of effective adaptation strategies that are cost-effective, participatory and sustainable (Ajani *et al*., 2013; Hill *et al*., 2020). In addition, the integration process can also be accelerated through incentivized approaches such as facilitation of markets for the agricultural produce as well as introduction of subsidies for inputs for the local farmers. Studies show that if the farmers can be given incentives for integrating their practices with CCAS through promises of market linkages and access to credit, for instance, this would establish a partnership within which information sharing can be strengthened (Shiferow *et al*., 2009).

7.4: Challenges of Integration of Knowledge

The findings have already illustrated the important role that government agriculture extension workers can play in technology transfer, and by extension create opportunities for integrating the two domains of agricultural knowledge – the IK and scientific knowledge. They provide a working interface between the custodians of IK and those who are engaged in research and generate scientific CCAS information. From the key informant interview with a lady ward extension officer at Iloodokilani in Kajiado West Sub-county, she underscore the crucial role they play in interacting with the farmers in their villages, hence being able to collect information on IK. The participant stated:

> "Our mandate indeed includes gathering information on agricultural practices that are locally developed and which resonate with their socio-economic and cultural capacities that have made them to be resilient in the

> events of drought hazards. We are also meant to present these views in any platforms that we meet with technical personnel, because the locals rarely get an opportunity to interact with researchers. However, facilitation related issues especially finances and sufficient number of staff have proved a real challenge to us".

Even where local farming innovations are encouraged through the bottom-up participatory approach of building community resilience in the face of climate change adverse effects, there is still a need for extension services actors to form and facilitate the local institutional capacities (Eidt *et al*., 2020; Osumba *et al*., 2021). This concept underscores the importance of the role that agriculture extension services play in creating an enabling environment for integrating the locally developed adaptation strategies with those which are scientifically developed especially in the identification of similarities and linkages of the two knowledge domains. However, from the findings of this study, there seems to be minimal role that the extension officers are playing in this regard. Consequently, it can be deduced, that there are no meaningful integration mechanisms.

Although a big percentage of the respondents (68%; Table 7.2) stated that much of the information that they have about scientific oriented climate change adaptation strategies was obtained from the media, a follow-up enquiry to the media houses to confirm about their own sources of information was not done as it was beyond the scope of this study. Additionally, these findings were corroborated by in-depth FGD that was conducted for the women farmers in Loitokitok Sub-county, an area within the largely semi-arid county that is humid and in which much of the arable farming is being done. One of the women categorically stated:

> Tunajua kuna ofisi ya kilimo hapa Loitokitok town, lakini sisi hao wafanyikazi wa hapo hatuwaoni. Ni bahati sana kuwaona wamekuja hapa

> mashinani kutuambia hiyo maneno ya kukumbana na mabadiliko ya hali ya anga. Kwa hiyo sisi tunatumia tu ujuzi wetu wa asili kukumbana na hali ya kiangazi. Sana sana hao watu wa NGO kama Red Cross ndio wanatutembelea kutueleza umuhimu wa kupanda miti, umuhimu wa kuhifadhi maji ya mvua na kufuga ngombe wa gredi. *"We are aware there is department of agriculture office in Loitokitok Town but we don't see the officers. One would be very lucky to see an officer come to these rural areas to tell us how we can respond to the effects of climate change. Therefore, we keep on using our indigenous knowledge in combating this issue of droughts. Mostly, it is the officials from NGOs who visit us to tell us about the importance of planting trees, rain water harvesting and keeping superior breeds of cows"*.

The above assertion presents a situation in which integrating the CCAS into IK in climate change adaptation is very challenging based on the fact that community sensitization is inadequate. One of the ward extension officers in Kajiado Central Sub-county during an in-depth key informant interview concurred with the affirmation that community awareness on CCAS is very low but decried insufficient staffing and lack of resources to facilitate the sensitization exercise. The participant averred:

> We no longer receive any new staff to boost the extension work. Those that have been transferred or retired are not promptly replaced. As you can see, this is an expansive sub-county with very poor road networks, some of the villages being very remote and not easily accessible. Programme equipment including vehicles or motorbike are inadequate, and those that are broken down take long to be repaired. It is therefore a big challenge to carry out awareness campaigns about new farming technologies especially if you consider that one has to see how these technologies are being implemented on the ground.

It was also pointed out that the nomadic culture that is practiced by many households among the *Maasai* pastoralists also defies efforts for officers to organize farmers into community agriculture groups and carry out meaningful trainings on new adaptation strategies. He continued to affirm that community empowerment is an avenue in which the local farmers can integrate the scientific knowledge into their IK practices to ensure a more sustainable climate change adaptation; but the process is quiet slow considering the stated challenges.

These findings are in concurrence with the Theory of Planned Behavior (1991) which in this case the formation of positive attitudes and perceptions concerning among the local farmers the CCAS can only be realized if they are exposed to meaningful information about their benefits, hence motivating them to comply and integrate those activities into the IK practices that are already internalized. This will also help the farming communities to discover what works for them and what does not in the process of adopting Disaster Preparedness Behaviour (Najafi *et al*., 2017). Sensitization and awareness campaigns creates an opportunity for farmers to find ways on what approaches among the CCAS can be integrated into the IK practices, something that is currently, according to these findings, not being done in an effective and efficient manner.

In comparison to the existing IK practices among local farmers, the subsequent appraisal of the new agricultural technologies will help them develop self-efficacy that can be in favor of integrating the CCAS into their farming activities. Considering the associations that exist between socio-cultural and geographical characteristics on one hand and willingness to adopt CCAS on the other, as illustrated by the Model of Private Proactive Adaptation to Climate Change (Figure 2.3), an enabling environment facilitated by critical actors such as agricultural extension officers can occasion integration process more effectively.

7.5 Approaches of Disseminating and Integrating CCAS Information with IK

The knowledge linkage platforms are important in integrating agricultural technologies. This study therefore sought to establish the existence of these platforms, and also to determine the composition of the stakeholders that participate in these platforms.

In most of the KII interviews with representatives of government departments such as agriculture, livestock and fisheries, environment, water & natural resources, meteorology as well as non-state actors, there was a concurrence in the qualitative analysis that there are challenges of involving the key custodians of IK, especially the elders at grassroots level during the formulation of the CC adaptation frameworks. An officer in the department of livestock particularly stated:

> The development of these strategies is designed to include all the stakeholders, including the local farmers. However, there are some challenges in the process of selecting the persons who join in the multi-agency discussion forums at the grass root level. Naturally, we depend on the local administration like chiefs and sub-chiefs to identify for us the ideal persons to join us. It is unfortunate that those who get selected do not fit the criteria either because of political interests on the ground or clan-based biases. The items of discussions and agenda also at times become so technical that the local representatives feel left out and fail to effectively contribute their views. There is a lot that is still needed to be done.

The above assertion confirms Binary Logistic Regression Analysis findings about uptake of CCAs and existing IK response mechanism on Climate Change which show that majority of the farmers who simply resign to their fate and do nothing instead of attempting alternative knowledge that they are not familiar with, influences their CCAS decision making process.

For a seamless fusion of IK and scientific-based CCAS, a linkage between the two has to be identified and established. These platforms that link farmers' social structures as well as their levels of trust with new sets of agricultural technologies determine the process of knowledge integration and information adoption as findings from other studies suggest (Amaru and Chhetri, 2013; Eidt *et al*., 2013; Eidt *et al*., 2020).

CHAPTER EIGHT

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS.

8.1: Summary of Findings

This chapter summarizes the conclusions that have been made based on the study findings according to the research specific objectives. Subsequent recommendations are made towards addressing the envisaged purposes of this study

8.1.1: Determinants of Indigenous Knowledge Practices

The key outcome of the study is that adherence or non-adherence to IK practices to the exclusion of other farming technologies is influenced by the farmer's individual socio-demographic factors. The level of education played a key role in the CC adaptation approach revealing a slower uptake among less learned farmers which could be attributed to a gap in terms of inadequate CCAS sensitization and awareness efforts considering that the majority of them were illiterate. Based on the findings in regard to gender and age of a farmer, it was manifestly clear that adaptation programs that would target the youth and women by increasing their involvement in agriculture would boost CCAS uptake.

The IK practices that are largely labor intensive, are more sustained by traditional families that have larger numbers of members. Economically, the study results show that farmers view the adoption of CCAS as having some financial implications on their incomes. It would therefore mean that CCAS programs that reflect envisaged improved returns for new technologies are more likely to be received well by farmers as revealed by increased uptake among those with higher incomes.

As shown in the study results, farmers that resided in a particular location with a unique climatic and geophysical profile are involved in a specific type of farming that can thrive in the prevailing conditions. This is an indication that an effective approach that includes the IK climate change adaptation practices and the CCAS can be applied in a complimentary manner to achieve the desired results in a region that possesses diverse climatic and geophysical conditions.

The socio-demographic and economic characteristics of farmers in determining the farmer's tendency to practice IK ranked differently in terms of their significance. These factors therefore correctly fitted in the MPPACC model as contextual factors that played a significant role in influencing a farmer's appraisals, subsequently shaping his/her decision to either adapt to new agricultural CCAS or stick to their IK practices.

8.1.2: Effect of Indigenous Knowledge Practices on Uptake of CCAS

The summary findings from regression analysis indicate that farmers' IK practices negatively influenced their uptake of CCAS significantly at $p<.001$. The findings showed that the acquisition of IK was largely from the farmers socio-cultural interactions with their immediate acquintances over a long period of time. This setting conformed to the situation in which IK was so deeply entrenched among the local farmers. According to the Situated Learning Theory, the study supported the conclusion that efforts to encourage farmers to practice alternative climate change adaptation approaches that are not in harmony with their existing practices would face challenges. Additionally, the community elders have a responsibility of ensuring that traditional way of managing farming activities is guarded and preserved, because it had worked for them over the years.

Based on the farmers' perceptions about climate change impacts, management of farming activities, natural resource management, treatment of pests and diseases and weather predictions, the farmers still favor existing IK practices to CCAS. The study also concluded in its findings that the way of carrying out of farming activities among local small scale farmers in Kajiado County is largely traditional and that the main livelihood activity is nomadic pastoralism; an indigenous farming practice among majority of farmers in the county. Examination of farmers' perception on extreme climatic events produced the findings indicating that increased occurences of prolonged periods of droughts was the key phenomenon that threatened their livelihoods.

Furthermore, the findings also show that the existing unique geo-ecological characteristics in their location, the farmers are more likely to develop specific agricultural IK practices that would be supported by those conditions. This is because they have interacted with the prevailing environment over the years and adapted to them in a way that would ensure resilience. Finally, the key finding of this study was that the examined IK practices variables had an inverse relation with the CCAS variables. The four CC adaptation mechanisms related to IK showed a significant relation with the famers' uptake of modern agricultural practices – the CCAS. This means that given alternatives, the farmers would still employ IK oriented response options. For instance, the farmers that engaged in IK practices nomadism (migration) were less likely to increase acreage of land under irrigation farming, rear superior livestock breeds or practice artificial insemination.

8.1.3: Effectiveness of Existing CCAS

Existing CCAS are not effective in addressing the impacts of climate change in Kajiado County. Pasture and water resources management strategies are the most preferred CCAS approaches. Although 284 (74%) of the respondents stated that they have heard about the CCAS, they have not been inspired to adopt the CCAS. Further enquiries show that 57% of the respondents believe that the CCAS are very effective in addressing the CC ravages. This still show that a significant number of farmers do not believe that the CCAS are a solution to the adverse effects of CC as compared with the IK practices.

The study established that although both NCCAP and KCIDP for the five year period of 2018-2022 and should have addressed the CC adverse effects in their blueprints, they do not explicitly indicate any structures within which the indigenous knowledge systems were incorporated. The contribution of IK in the formulation of mitigation measures is manifestly lacking. This notwithstanding, the effectiveness of CCAS squarely depended on the level of acceptance and adoption likelihood of the local farmers. Omission of the local knowledge inputs in the CCAS negates the essence of their utility because the local farmers are the primary implementers. Additionally, the study results indicate that over

93% of the household respondents have never been involved in the designing of local agricultural development plans. This gap results into ineffective implementation of the CCAS by the mandated institutions. The challenges related to the nomadic pastoralism as a way of life among the majority of livestock farmers keep on interfering with the composition of the ward and constituency agricultural development committees.

The study also established that the CIDP strategic plans for addressing the CC phenomenon in Kajiado County are not synchronized with the NCCAP mitigation strategies rendering CIDP CC recommendations ineffective. The absence of clear linkages between the two strategies caused inefficiency and ineffectiveness of the the existing county CCAS in Kajiado County. There is need to focus on local institutions as key tools for running effective and sustainable CC adaptation programs. Organizational development approaches aimed at improving the capacity of the local institutions would therefore go a long way in not only raising awareness among farmers but also offer a governing structucture within which key resources for adaptation can be accessed.

8.1.3: Strategies for Enhancing Integration of the Knowledge Systems

The results of the study show that the extension work can be effective in other areas of CC intervention if more efforts are employed to integrate traditional knowledge with more scientific knowledge domain. This important role of the extension workers as well as government research institutions can be complimented by the input of other non-state sector players such the NGOs in an integrative synergy roping in the contribution of the community's ideas. Management of pastures and water conservation strategies that are related to CCAS, can offer the best opportunity for government extension workers to enhance uptake and also engage the farmers in sharing IK information for purposes of integration.

However, the findings show that an integration structure within which important information on climate change adaptation response mechanism can be synchronized is non-existent although all these relevant stakeholders exist and do their individual bits in sensitizing the Kajiado County communities on climate change. The integration of the IK and CCAS, according to the findings, is made difficult because the perceptions by local farmers on the agricultural extension work in Kajiado County is such that the officers are only focused on offering their services to large scale commercial farmers, ignoring the majority small scale farmers.

The findings however have highlighted that some CCAS adaptation approaches which seek to address the water and pasture management are actually acceptable among the farmers. Based on the philosophy of Afrikology (Nabudere, 2010) on possibility of integration of several knowledge domains and as illustrated by the the Alaskan knowledge integration model (Barnhardt and Kawagley, 2005), the uptake of CCAS can still suffice in Kajiado County, if IK inputs are considered.

8.2: Conclusions

The overall conclusion according to the findings of this study is that, indigenous knowledge practices influence the uptake of the climate change adaptation strategies among majority of the farmers in Kajiado County in Kenya. The farmers' adherence to their age long traditional ways in responding to ravages of climate change, especially prolonged droughts, has shaped their attitudes and perceptions to favour continuous application of IK practices in adapting to impacts of CC. Specifically, the findings led to the following conclusions:

1. The findings on socio-demographic characteristics of farmers indicated that the level of education played a key role in the CC adaptation approach revealing a slower uptake among less learned farmers which could be attributed to a gap in terms of inadequate CCAS sensitization and awareness efforts considering that the majority of them were illiterate. Younger farmers were more receptive to CCAS, while households with more members preferred IK adaptation practices. The farmers with higher incomes showed willingness in embracing CCAS although the prevailing geo-ecological characteristics of the farmer's location greatly influenced the uptake.
2. The farmers were fully knowledgeable about climate change, clearly demonstrating that the key observable phenomena were a trend of increasing lengths of periods of drought over the recent years. It was further established that these practices had significant influence on the uptake of CCAS. Management of the indigenous system which guides how farmers run their farming activities, environment and natural resources is so guarded and entrenched among community members strongly influencing their perceptions and attitudes, thereby affecting uptake of new CCAS. Water and pasture resource management among the CCAS approaches were more acceptable among the farmers.

3. Existing CCAS are not effective in addressing the impacts of climate change in Kajiado County as indicated by inadequate presence of the activities of the relevant promoters especially the extension workers. In addition, the existing local institutions that would otherwise facilitate interaction between CCAS promoters and the farmers are so weak in mobilizing climate-smart agricultural mechanisms to the scale that would mitigate the effects of droughts.
4. There is no comprehensive integration plan that spells out how the climate change implementation framework or structure is developed with the contribution of the custodians of indigenous knowledge. The CCAS extension work related initiatives that supported the pastoral farming such as pasture and water resource management were found to be agreeable among farmers. However the Agropastoral strategies such as irrigation and the rearing of superior breeds of cattle were not readily embraced.

8.3: Recommendations

Based on the findings of this study, there is a need to put more efforts into designing climate change response and development plans that leverage on key farmers' socio-demographic, economic and ecological characteristics that favour uptake of CCAS. Factors such as education, age, monthly household income levels can be used to develop targeted intervention adaptation strategies to enhance uptake. Additionally, the relevant government and non-governmental CCAS implementation organisations need to focus on strategies that resonate with the existing types of farming in Kajiado County. Since, pastoralism is the dorminant agricultural practice, the CCAS that address pastures and water resource management need to be enhanced as a way of introducing other strategies.

An information sharing strategy that is efficient and effective in reaching more farmers need to be developed to alleviate the current challenges faced by the agricultural extension institutions. Any improvement to enhance indigenous knowledge practices more efficient may involve a well elaborate integrative approach that would modify farmers' attitudes and perceptions towards modern, scientific-based climate change adaptation strategies (Tanyanyiwa, 2019).

1. Based on the findings on the gender and age of a farmer, it was manifestly clear that adaptation programs that would target the youth and women by increasing their involvement in agriculture would boost CCAS uptake. The CCAS programs that reflect envisaged improved returns for new technologies are more likely to be received well by farmers as revealed by increased uptake among those with higher incomes.
2. Deliberate input of the IK management concepts in regard to weather predictions, environmental conservation and proven locally based CC response mechanisms into adaptation plans need to be prioritized while developing CCAS.
3. Designing CC adaptation approaches that mirror or compliment the locally developed response mechanisms would not only enhance adaptation rates but also enrich the farmers' knowledge about other more robust strategies and subsequently increase community resilience to CC adverse impacts. The available Kajiado Integrated Development Plan, National Climate Change Action Plan for 2018-2022 and any other relevant plans need to be synthesized with clear inputs

from indigenous knowledge aspects that can enhance information sharing to improve the effectiveness of the CCAS which are largely scientific developed.

4. There is need for an integration structure within which important information on climate change adaptation response mechanism can be synchronized. The formation of such a structure that is all inclusive needs to be spearheaded by the key stakeholders, the agricultural extension department of the Kajiado County Government. The agreeable CCAS among the farmers which were the pasture and water management strategies can be considered as primary opportunities to secure IK/CCAS integration processes. There is need to raise the capacity of local institutions which are key mechanisms for running effective and sustainable CC adaptation programs. Organizational development approaches aimed at improving the capacity of the local institutions would therefore go a long way in not only raising awareness among farmers but also offer a governing structucture within which key resources for adaptation can be accessed.

8.4: Recommendations for Further Research

1. As part of the main ways of mitigating the impacts of droughts it is important to determine the effect of overstocking in the livestock farming on the increased release levels of GHG, causing climate change.
2. The determination of the role of the media in dissemination of information and being an interface between key stakeholders. It is also important that the media houses confirm about their own sources of information about climate change adaptation strategies because this was not done as it was beyond the scope of this study.

3. The study only focused on the region largely inhabited by the nomadic pastoralists. This research suggests further similar empirical enquiry among other indigenous communities with different geo-ecological and socio-cultural characteristics.
4. A comprehensive study should be conducted to determine factors that contribute to inadequate participation of key government and non-government stakeholders in implementing CCAS at local/community level

REFERENCES

Abebe, F. B. (2019). Ethnobotanical Studies of Medicinal Plants used to Treat Human and Livestock Ailments in Southern Nations, Nationalities and Peoples' Region, Ethiopia: A Systematic Review. *Journal of Plant Studies*; Vol. 8, No. 1; 2019 ISSN 1927-0461 E-ISSN 1927-047X.

Abegunde, V.O., Melusi Sibanda, M., and Obi, A. (2019). The Dynamics of Climate Change Adaptation in Sub-Saharan Africa: A Review of Climate-Smart Agriculture among Small-Scale Farmers. *Climate* 2019, 7, 132; doi:10.3390/cli7110132

Abubakar, H. N., Garba, Y., Gana, A. K. and Jocob, I. A. (2019). Factors influencing adoption of rice improved production practices by farmers in adopted villages, Niger state, Nigeria. *Advances in Plants & Agriculture Research*. 2019; 9(1):183–189. DOI: 10.15406/apar.2019.09.00433

Adebayo, A. A., Onu, J. I., Adebayo, E. F. and Anyanwu, S. O. (2012). Farmers' awareness, vulnerability and adaptation to climate change in Adamawa State, Nigeria. *British Journal of Arts and Social Sciences*, 9(11):104-113.

Agrawal, A. (1995). *Indigenous and Scientific Knowledge: Some Critical Comments*. ResearchGate. DOI: 10.7454/ai.v0i55.3331. Available at: https://www.researchgate.net/publication/246458426_Indigenous_and_Scientific_Knowledge_Some_Critical_Comments.

Agrawal, A. (2010). Local institutions and adaptation to climate change, in Mearns, R. and Norton, A. (Eds), *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World*, The World Bank, Washington, DC, Vol. 2, pp. 173-178.

Ajani, E. N., Mgbenka, R. N., and Okeke, M. N. (2013). Use of Indigenous Knowledge as a Strategy of Climate Change Adaptation Among Farmers in Sub-Saharan Africa: Implications for Policy. *Asian Journal of Agriculture Extension, Economics and Sociology. 2(1): 23-40. 2013*. Article No. AJAEES.2013.003 Available at: https://www.researchgate.net/publication/272760438_Use_of_Indigenous_Knowledge_as_a_Strategy_for_Climate_Change_Adaptation_among_Farmers_in_sub-Saharan_Africa_Implications_for_Policy

Ajzen, I. (1991) *The Theory of Planned Behavior Organizational*. Behavior and Human Decision Processes. University of Massachusetts at Amherst. Academic Press. Inc. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.317.9673&rep=rep1&type=pdf. (Accessed: 23/11/2018)

Ali, I., Shah, A. A., Alotaibi, B. A., Xu, C., Ali, A. and Ali, Y. (2025). Unveiling the determinants of climate change adaptation among small Landholders: Insights from a Mountainous Region in Pakistan. *Climate Services*, Volume 38, April 2025, 100550

Alliance for a Green Revolution in Africa. (2014). *Africa Agriculture Status Report: Climate Change and Smallholder Agriculture in Sub-Saharan Africa*. Nairobi: Alliance for a Green Revolution in Africa. Available at: https://agra.org/wp-content/uploads/2017/09/Final-AASR-2017-Aug-28.pdf. (Accessed: 15/07/2019)

Allport, G.W. (1967). Attitudes. In M. Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 1-13). New York: John Wiley & Sons.

Altalb, A. A. T., Filipek, T. and Skowron, P. (2015). The Role of Agricultural Extension in the Transfer and Adoption of Agricultural Technologies. *Asian Journal of Agriculture and Food Sciences*: Volume 03 – Issue 05, October 2015. (ISSN: 2321 – 1571).

Altieri, M. A., Funes-Monzote, F. R. and Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agron. Sustain. Dev*. (2012) 32:1–13. DOI 10.1007/s13593-011-0065-6

Amaru, S. and Chhetri, N. B. (2013). Climate adaptation: Institutional response to environmental constraints, and the need for increased flexibility, participation, and integration of approaches. *Applied Geography*: **2013**, 39, 128–139.

Ameso, E. A., Bukachi, S. A., Olungah, C. O., Haller, T., Wandibba, S.and Nangendo.S. (2018). Pastoral Resilience among the Maasai Pastoralists of Laikipia County, Kenya. *Land* 2018, 7, 78; doi: 10.3390/land7020078.

Amfo, B. and Ali, E. B. (2020). Technology adoption by indigenous and exotic vegetable farmers. *International Journal of Vegetable Science*. Volume 27, 2021 - Issue 2. https://doi.org/10.1080/19315260.2020.1724228

Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L. and Asten, P.v. (2017) Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science and Policy 75 (2017) 81–90.*

Ansah, G. O. and Siaw, L. P. (2017). Indigenous Knowledge: Sources, Potency and Practices to Climate Adaptation in the Small-Scale Farming Sector. *Journal of Earth Science & Climatic Change* 8:12. DOI: 10.4172/2157-7617.1000431.

Aragón, F. M., Oteiza, F., & Rud, J. P. (2021). Climate change and agriculture: Subsistence farmers' response to extreme heat. *American Economic Journal: Economic Policy, 13*(1), 1-35.

ARC. (2018). *National Statement on Ethical Conduct in Human Research 2007* (Updated May 2018). Australian Research Council. Canberra. Available at: https://services.anu.edu.au/files/guidance/national-statement-2018-updated.pdf.

Arruda, G. M. and Krutkowski, S. (2017). Arctic governance, indigenous knowledge, science and technology in times of climate change: Self-realization, recognition, representativeness. *Journal of Enterprising Communities: People and Places in the Global Economy*. Volume 11 Issue 4.

Arunrat, N., Wang, C., Pumijumnong, N., Sereenonchai, S. and Caic, W. (2016). Farmers' intention and decision to adapt to climate change: A case study in the Yom and Nan basins, Phichit province of Thailand. *Journal of Cleaner Production.* Volume 143, 1 February 2017, Pages 672-685.

Aryal, J.P., Sapkota, T.B., Khurana, R. *et al*. (2020). Climate change and agriculture in South Asia: adaptation options in smallholder production systems. *Environ Dev Sustain* 22, 5045–5075 (2020). https://doi.org/10.1007/s10668-019-00414-4

Asefa, M., Diriba, C. and Tesema, W. (2022). Exploring Indigenous Knowledge for Cattle Diseases Diagnosis, Treatment and Modes ofApplication. *Research Square.* https://doi.org/10.21203/rs.3.rs-2121018/v1

Audefroy, J.F., and S´anchez, B.N.C. (2017). Integrating local knowledge for climate change adaptation in Yucat´an, Mexico, *Int. J. Sustain. Built Environ*. 6 (1) (2017) 228–237, https://doi.org/10.1016/j.ijsbe.2017.03.007

Badu, E., Agyei-Baffour, P., Acheampong, I. O., Opoku, M. P. and Addai-Donkor, K. (2018) Households Sociodemographic Profile as Predictors of Health Insurance Uptake and Service Utilization: A Cross-Sectional Study in a Municipality of Ghana. *Advances in Public Health.* Volume 2018 Article ID 7814206. Available at: | https://doi.org/10.1155/2018/*7814206*

Barigye, G. and Siraje, K. (2019). Community Development in the Rural Areas through Traditional Indigenous Knowledge. *International Journal of Research in Sociology and Anthropology* (IJRSA). Volume 5, Issue 2, 2019, PP 8-17. ISSN 2454-8677. http://dx.doi.org/10.20431/2454-8677.0502002.

Barnhardt, R. and Kawagley, A. O. (2005). Indigenous Knowledge Systems and Alaska Native Ways of Knowing. *Anthropology and Education Quarterly*, Vol. 36, Issue 1, pp. 8–23, ISSN 0161-7761, electronic ISSN 1548- 1492.

Basdew, M., Jiri, O. and Mafongoya, P. L. (2017). Integration of indigenous and scientific knowledge in climate adaptation in KwaZulu-Natal, South Africa. *Change Adaptation Socioecological Systems*. 2017; 3: 56–67

Bekuma, T., Mamo, G. and Regassa, A.(2023). Indigenous and improved adaptation technologies in response to climate change adaptation and barriers among smallholder farmers in the East Wollega Zone of Oromia, Ethiopia. *Res. Glob.* 6 (December 2022) (2023), 100110, https://doi.org/10.1016/j.resglo.2022.100110.

Berkes, F. (2004). Rethinking community-based conservation. *Conservation Biology*, *18*, 621– 630.

Biggelaar, C.D. (1991) Farming systems development: Synthesizing indigenous and scientific knowledge systems. Agriculture and Human Values, Volume 8, pages25–36(1991). Available at: https://link.springer.com/article/10.1007/BF01579654. (Accessed: 25/02/2020).

Biggs, E.M., E.L. Tompkins, E.L., Allen, J., Moon, C. and Allen, R. (2013). Agricultural adaptation to climate change: Observations from the mid-hills of Nepal. *Climate and Development*, 5, 165–173, doi:10.1080/17565529.2013.789791.

Bjornlund, V., Bjornlund, H. and van Rooyen, A. (2022). Why food insecurity persists in sub-Saharan Africa: A review of existing evidence. *Food Security*. 14, 845–864 (2022). https://doi.org/10.1007/s12571-022-01256-1

Bobadoye A.O., Ogara, W.O, Ouma, G.O., Onono, J.O.(2014). Comparative analysis of rainfall trends in different sub counties in Kajiado County. *International Journal of Independent Research Studies*, vol 2, N0 4.

Bobadoye A.O., Ogara, W.O, Ouma, G.O., Onono, J.O. (2016) Pastoralist Perceptions on Climate Change and Variability in Kajiado in Relation to Meteorology. *Academic Journal of Interdisciplinary Studies*. MCSER Publishing, Rome-Italy Vol 5 No 1. Available at: Evidencehttps://www.researchgate.net/publication/297891877_Pastoralist_Perceptions_on_Climate_Change_and_Variability_in_Kajiado_in_Relation_to_Meteorology_Evidence

Bradley, A.T. (2010) *Handbook to Practical Disaster Preparedness for the Family*. Library of Congress. Available from: http://www.amazon.com/Handbook-Practical-Disaster-Preparedness-Edition-ebook/dp/B0089NLHD4. (Accessed: 18/11/2018)

Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S. and Herrero, M. (2013). Adapting agriculture to climate change in Kenya: household strategies and determinants. *Journal of Environmental Management* 114:26–35. https://doi.org/10.1016/j.jenvman.2012.10.036.

Briggs, J., Sharp, J., Yacoub, H., Hamed, N and Roe, A (2007): Environmental Knowledge Production. Evidence from Bedouin Communities in Southern Egypt. *Journal of International Development* 19, pp. 239–251.

Bohensky, E. L. and Maru, Y. (2011). Indigenous Knowledge, Science, and Resilience: What Have We Learned from a Decade of International Literature on “Integration”**?** *Ecology and Society* 16(4): 6. http://dx.doi.org/10.5751/ES-04342-160406

Brown, P., Daigneault, A. and Dawson, J. (2019) Age, values, farming objectives, past management decisions, and future intentions in New Zealand agriculture. *Journal of Environmental Management*: Volume 231, 1 February 2019, Pages 110-120

Bryant, C., Smit, B., Brklacich, M., Johnston, T., Smithers, J. Chiotti, Q. and Singh. B. (2000). Adaptation in Canadian agriculture to climatic variability and change. *Climate Change* 45: 181–201

Burton, R. J. F. (2014). The influence of farmer demographic characteristics on environmental behaviour: A review. *Journal of Environmental Management*, 135(Supplement C), 19-26.https://doi.org/10.1016/j.jenvman.2013.12.005

Cáceres-Arteaga, N., María, K. and Lane, D. (2020). Agroecological practices as a climate change adaptation mechanism in four highland communities in Ecuador. *Journal of Latin American Geography* 19 (2020), pp. 47-73

Capa-Mora, D., Medina, J., Benítez, A. and Alvarez, L. J. (2025). Perspectives on Climate Change and Adaptation and Mitigation Measures amongst Farmers of Zamora – Ecuador. *Climate Services* Volume 38, April 2025, 100565

CIAT (2018) *Climate Risk Profile Kajiado County (pdf)*. Kenya County Climate Risk Profile Series. International Center for Tropical Agriculture- CIAT. Apartado Aéreo, Cali, Colombia. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/Kajiado_Climate_Risk_Profile_Final.pdf. (Accessed: 20/10/2018).

Chen, T. L., & Cheng, H. W. (2020). Applying traditional knowledge to resilience in coastal rural villages. *International Journal of Disaster Risk Reduction, 47* (August 2020), 101564. https://doi.org/10.1016/j.ijdrr.2020.101564

Chen, S. and Gong, B (2021). Response and adaptation of agriculture to climate change: Evidence from China. *Journal of Development Economics*. Volume 148 , January 2021, 102557. https://doi.org/10.1016/j.jdeveco.2020.102557

Chengula, K. L. (2018). *Exploring the Agricultural Innovation Continuum– The Case of Kenya Climate Smart Agriculture Project*. World Bank Goup. Agriculture Global Practice Available at: http://www.kilimo.go.ke/wp-content/uploads/2019/03/Kenya-Agricultural-Research-Conference_Sept-13-2018.pptx. (Accessed: 13/07/2019).

Chepkoech,W., Mungai,N.W., Stöber, S., Bett, H.K. & Lotze-Campen,H. (2018) Farmers' perspectives: Impact of climate change on African indigenous vegetable production in Kenya, *International Journal of Climate Change Strategies and Management*, Vol. 10 Issue: 4, pp.551-579, https://doi.org/10.1108/IJCCSM-07-2017-0160 (Accessed: 20/10/2018).

Chituu, B. (2022). Indigenous knowledge systems and the environment. *Green Business Gazette*. https://www.gbg.co.zw/2022/01/19/indigenous-knowledge-systems-and-the-environment/

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). New York: John Wiley & Sons.

Consiglieri (2016) *An in -depth study on Farmer's Behavior Change, Drivers and Barriers as well as 'Spontaneous' Impact on Family and Neighbors of SaFaL*. Consiglieri Private Limited. Dhaka, Bangladesh. Prepared for Solidaridad Network, Dhaka Bangladesh. Available at: https://www.solidaridadnetwork.org/sites/solidaridadnetwork.org/files/publications/Annex%20B-%20Study%20on%20Farmer%27s%20Behavior%20Change.pdf. (Accessed: 21/11/2018).

County Government of Kajiado (2017). *Kajiado County Integrated Development plan 2018-2022.* County Government of Kajiado

County Government of Kajiado (2019). *About Kajiado*. County Government of Kajiado. Available at: https://www.kajiado.go.ke/about-kajiado/. (Accessed: 11/10/2019).

Crano, W. D. & Prislin, R. (2006) *Attitudes and Persuasion*. Article in Annual Review of Psychology · February 2006 DOI: 10.1146/annurev.psych.57.102904.190034 · ReseachGate. Available at: https://www.researchgate.net/profile/Radmila_Prislin/publication/7449570_Attitudes_and_Persuasion/links/0fcfd508ab3cdeea01000000/Attitudes-and-Persuasion.pdf?origin=publication_detail (Accessed: 21/11/2018)

Cresswell, J. W. (2012) Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research.

Creutzig, F., Erb, K. H., Haberl, H., Hof, C., Hunsberger, C. & Roe, S. (2021). Considering sustainability thresholds for BECCS in IPCC and biodiversity assessments. *Global Change Biology*. Bioenergy. https://doi.org/10.1111/gcbb.12798.

Dahlquist, R., Whelan, M. P., Winowiecki, L., Polidoro, B., Candela, S., Harvey, C. A., Wulfhorst, J. D., McDaniel, P. A., Bosque-Pe´rez., N. A. (2007). Incorporating livelihoods in biodiversity conservation: a case study of cacao agroforestry systems in Talamanca, Costa Rica. *Biodiversity and conservation*, 16 (8), 2311–2333. Available at: http://www.sidalc.net/repdoc/A3643I/A3643I.PDF

Dang, H., Elton, L., Nuberg, I. and Bruwer, J. (2014). Understanding farmers' adaptation intention to climate change: A structural equation modelling study in the Mekong Delta, Vietnam. *Environmental Science & Policy* 41: 11–22.

Dang, H. L., Li, E., Nuberg, I. and Bruwer, J. (2019). Factors influencing the adaptation of farmers in response to climate change: a review, *Climate and Development*, DOI: 10.1080/17565529.2018.1562866

Dawadi, S., Shrestha, S., and Giri, R. A. (2021). Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies in Education*, 2(2), 25-36. DOI: https://doi.org/10.46809/jpse.v2i2.20

Dekens, J. (2007) *Local Knowledge for Disaster Preparedness: A Literature Review*. International Centre for Integrated Mountain Development, Kathmandu.

Deressa, T. T., Hassan, R.M. and Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. *Journal of Agricultural Science* 149: 23–31.

Dhanush, D, Bett, B. K., Boone, R. B., Delia, G. Kinyangi, J., Lindahl, J. F., Mohan, C. V., Ramírez , V. J., Robinson, T. P., Rosenstock, T. S., Smith, J. and Thornton, P. K. (2015). *Impact of Climate Change on African Agriculture: Focus on Pests and Diseases*. Agricultural Research Outputs. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Diogo, R.V.C., Dossa, L.H., Vanvanhossou, S.F.U., Abdoulaye, B.D., Dosseh, K.H.; Houinato, M., Schlecht, E., Buerkert, A. (2021). Farmers' and Herders' Perceptions on Rangeland Management in Two Agroecological Zones of Benin. *Land* 10, 425. https://doi.org/10.3390/land10040425

Donatti, C.I., Harvey, C.A., Martinez-Rodriguez, M.R., Vignola, R. Rodriguez, C.M.(2018). Vulnerability of smallholder farmers to climate change in Central America and Mexico: current knowledge and research gaps. *Climate and Development*, 11 (3) (2018), pp. 264-286, 10.1080/17565529.2018.1442796

Doran, E. M. B., Doidge, M., Aytur, S. and Wilson, R.S. (2022). Understanding farmers' conservation behavior over time: A longitudinal application of the transtheoretical model of behavior change. *Journal of Environmental Management* Volume 323, 1 December 2022, 116136

Dorji, T., Rinchen, K., Morrison-Saunders, A., Blake, D., Banham, V. and Pelden. S. (2024). Understanding How Indigenous Knowledge Contributes to Climate Change Adaptation and Resilience: A Systematic Literature Review. *Environmental Management* 74, 1101–1123 (2024). https://doi.org/10.1007/s00267-024-02032-x

Drost, E. A. (2011). Validity and Reliability in Social Science Research. *Education Research and Perspectives*, Vol.38, No.1. 105-124 Available at: https://www.researchgate.net/publication/261473819_Validity_and_Reliability_in_Social_Science_Research. (Accessed: 26 June 2019)

Dube, E. M. E (2018). The contribution of indigenous knowledge to disaster risk reduction activities in Zimbabwe: a big call to practitioners. *Journal of Disaster Risk Studies, Vol. 10, No. 1.*

Durrheim, K. (2004). Research design. In M. Terre Blanche & K. Durrheim (Eds.), *Research in practice: Applied methods for the social sciences* (pp. 29-53). Cape Town: University of Cape Town.

Dwyer, J., Mills, J., Ingram, J., Taylor, J., Burton, R., Blackstock, K., Slee, B., Brown, K., Schwarz, G., Matthews, K., & Dilley, R. (2007). *Understanding and influencing positive behaviour change in farmers and land managers - A project for Defra.* Gloucester: CCRI, Macaulay Institute

Eidt, C.; Hickey, G.; Curtis, M. (2012). Knowledge integration and the adoption of new agricultural technologies: Kenyan perspectives. *Food Security*. **2012**, 4, 355–367

Eidt, C.M., Pant, L. P. and Hickey, G. M. (2020). Platform, Participation, and Power: How Dominant and Minority Stakeholders Shape Agricultural Innovation. *Sustainability* 2020, 12, 461; doi:10.3390/su12020461

European Commission (Undated). *Adaptation to Climate Change*. European Commission, Climate Action. Available at: https://ec.europa.eu/clima/policies/adaptation_en. (Accessed: 04/12/2019).

European Union (2019). *The contribution of precision agriculture technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU*. Publications Office of the European Union. DOI: 10.2760/016263. Available at: https://ec.europa.eu/jrc/en/publication/contribution-precision-agriculture-technologies-farm-productivity-and-mitigation-greenhouse-gas. (Accessed: 12/07/2019).

Fahad, S., & Wang, J. (2020). Climate change, vulnerability and its impacts in rural Pakistan: A review. *Environmental Science and Pollution Research, 27*, 1334-1338.

FAO (2010). *The state of food insecurity in the world*. Rome: Food and Agriculture Organization of the United Nations. Available at: http://www.fao.org/3/a-i1683e.pdf (Accessed: 16/07/2019)

FAO (2013). *Climate-Smart Agriculture Sourcebook*. Food and Agriculture Organization of the United Nations; Department. NRMaE: Rome, Italy, 2013.

FAO (2014) *Success Stories on Climate-Smart Agriculture*. Available at: http://www.fao.org/3/a-i3817e.pdf . (Accessed: 17/11/2018)

FAO, IFAD and WFP. (2015). *The State of Food Insecurity in the World 2015. Meeting the 2015 International Hunger Targets*: Taking Stock of Uneven Progress; Food and Agriculture Organization: Rome, Italy, 2015

FAO (2019) Disaster Risk Reduction in Agriculture. FAO. *Policy Support and Governance*. Rome, Italy. Available at: http://www.fao.org/policy-support/policy-themes/disaster-risk-reduction-agriculture/en/. (Accessed: 15/07/2019)

Ferguson, M. J. and Bargh, J. A. (2004) How social perception can automatically influence behavior. Elsevier. *Trends in Cognitive Sciences* Vol.8 No.1.

FEWS NET (2019). *Kenya: Drought - 2014-2019*. FEWS NET, Nairobi, Kenya. Available at: https://reliefweb.int/disaster/dr-2014-000131-ken (15/07/2019).

FEWS NET (2020). *Short Rains in East Africa among the Wettest on Historical Record*. Special Report. Famine Early Warning Systems Network. Available at: https://reliefweb.int/report/south-sudan/eastern-africa-region-regional-floods-and-locust-outbreak-snapshot-january-2020.

Fernández-Llamazares, A., Lepofsky, D. and Mehana Blaich Vaughan, M. B. (2021) Scientists' Warning to Humanity on Threats to Indigenous and Local Knowledge Systems. *Journal of Ethnobiology* 2021 41(2): 144–169. https://doi.org/10.2993/0278-0771-41.2.144

File, D. M. and Nhamo, G. (2023). Farmers' choice for indigenous practices and implications for climate-smart agriculture in northern Ghana. *Heliyon*, Volume 9, Issue 11, November 2023, e22162

Filho, W. L., Taddese, H., Balehegn, M., Nzengya, D., Debela, N., Abayineh, A., Mworozi, E., Osei, S., Ayal, D. Y., Nagy, G. J., Yannick, N., Kimu, S., Balogun,D. L., Esubalew, A.A., Alemu, A., Li, C., Sidsaph, H. and Wolf, F. (2020). Introducing experiences from African pastoralist communities to cope with climate change risks, hazards and extremes: Fostering poverty reduction. *International Journal of Disaster Risk Reduction*. Volume 50, November 2020, 101738

Finnis, J. (1980). *Natural Law and Natural Rights*. Oxford: Clarendon Press.

Fletcher, M. Hamilton, R., Dresslera, W. and Palmer, L.(2021). Indigenous knowledge and the shackles of wilderness. *Perspective*, 118 (40) e2022218118. https://orcid.org/0000-0003-3571-5404a

Fre, Z. (2018). The case for indigenous knowledge systems and knowledge sovereignty. *Knowledge Sovereignty among African Cattle Herders*. UCL Press. Available at: https://www.jstor.org/stable/j.ctv3hvc5n.7. (Accessed: 22/04/2021)

Gebeyehu, A. K., Snelder , D., Sonneveld, B. and Abbink, J. (2021). How do agro-pastoralists cope with climate change? The case of the Nyangatom in the Lower Omo Valley of Ethiopia. *Journal of Arid Environments* 189 (2021) 104485

GOK (2013). *National Climate Change Action Plan*. Ministry of Environment and Mineral Resources. P.O. Box 30126-00100. Nairobi. Available at: https://cdkn.org/wp-content/uploads/2013/03/Kenya-National-Climate-Change-Action-Plan.pdf. (Accessed: 20/05/2019).

GOK (2018). *National Climate Change Action Plan (Kenya): 2018 – 2022. Volume 3: Mitigation Technical Analysis Report*. Nairobi: Ministry of Environment and Forestry.

GOK (2019). *Kenya Population and Housing Census 2019*. Distribution of Population by Administrative Units Volume II. Kenya National Bureau of Statistics. Nairobi Kenya.

Granderson, A. A. (2014): Making Sense of Climate Change Risks and Response at the Community Level: A Cultural-Political Lens. In *Climate Risk Management* 3, pp. 55–64.

Grothmann, T. and Patt, A. (2005). Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change* 15:199–213. https://doi.org/10.1016/j.gloenvcha.2005.01.002.

Guo, A., Wei, W., Zhong, F. and Wang, P. (2022). How do climate change perception and value cognition affect farmers' sustainable livelihood capacity? An analysis based on an improved DFID sustainable livelihood framework. *Sustainable Production and Consumption*, Volume 33, September 2022, Pages 636-650

Hailegiorgis, A., Crooks, A. and Cioffi-Revilla, C. (2018). An Agent-Based Model of Rural Households' Adaptation to Climate Change. *Journal of Artificial Societies and Social Simulation* 21(4) 4, 2018. Doi: 10.18564/jasss.3812 Url: http://jasss.soc.surrey.ac.uk/21/4/4.html

Hardaker, J.B.; Richardson, J.W.; Lien, G.; Schumann, K.D. Stochastic efficiency analysis with risk aversion bounds: A simplified approach. *Aust. J. Agric. Resour. Econ.* **2004**, *48*, 253–270.

Hardaker, B., Lien, G., Anderson, J. R. and Huirne, R.B.M (2015).*Coping with Risk in Agriculture*, 3rd Edition: Applied Decision Analysis. CABI

Heeb, L., Jenner, E. and Matthew Cock, M. J. W. (2019). Climate-smart pest management: building resilience of farms and landscapes to changing pest threats. *Journal of Pest Science* volume 92, pages951–969 (2019)

Henning, H. P. (2008): Everyday Cognition and Situated Learning. In H. D. Jonassen (Ed.): *Handbook of Research on Educational Communications and Technology*. 2nd Edition. New Jersey: Lawrence Eribaum Associates, Inc. Publishers, pp. 143–174.

Hill, R., Adem, Ç., Alangui, W.V., Molnár., Z., Aumeeruddy-Thomas, Y., Bridgewater, P., Tengö, M., Thaman, R., Yao, C. Y. A., Berkes, F., Carino, J., Cunha, M. C., Diaw, M. C., Díaz, S., Figueroa, V. E., Fisher, J., Hardison, P., Ichikaw, K. and Xue, D. (2020). Working with Indigenous, local and scientific knowledge in assessments of nature and nature's linkages with people. *Current Opinion in Environmental Sustainability*. Volume 43, April 2020, Pages 8-20

Hiwasaki, L., Luna, E., Syamsidik, Shawd, R. (2014). Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. *International Journal of Disaster Risk Reduction: 10(2014)15–27.* Elsevier.

Hlophe-Ginindza, S.N. and Mpandeli, N.S. (2020). The Role of Small-Scale Farmers in Ensuring Food Security in Africa In Food Security in Africa, *IntechOpen* (2020) Available from: https://www.intechopen.com/chapters/72086

Holland, R. W., Meertens, R. M. and Van Vugt, M. (2002). Dissonance on the Road: Self-esteem as a Moderator of Internal and External Self-justification Strategies. *Personal. Soc. Psychol. Bull*. 28:1713–24.

Homann, S. (2004). *Indigenous Knowledge of Borana Pastoralists in Natural Resource Management: A Case Study from Southern Ethiopia*. Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.ddb.de abrufbar. ISBN 3-86537-383-6

Howley, P., Donoghue, C.O. and Heanue, K. (2012). Factors Affecting Farmers' Adoption of Agricultural Innovations: A Panel Data Analysis of the Use of Artificial Insemination among Dairy Farmers in Ireland. *Journal of Agricultural Science*; Vol. 4, No. 6; 2012, ISSN 1916-9752 E-ISSN 1916-9760 Published by Canadian Center of Science and Education.

Igwe, P. A., Madichie, N.O. and Newbery, R. (2019) Determinants of livelihood choices and artisanal entrepreneurship in Nigeria. *International Journal of Entrepreneurial Behavior & Research.* ISSN: 1355-2554.

Ijatuyi, E. J., Lamm, A., Yessoufou, K., Suinyuy, T. and Patrick, H. O. (2025). Integration of indigenous knowledge with scientific knowledge: A systematic review. *Environmental Science & Policy*, Volume 170, August 2025, 104119.

IPCC (2007). *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, B. Metz, O. Davidson, P. Bosch, R. Dave and L. Meyer, Eds., Cambridge University Press, Cambridge, UK.

IPCC (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects*. Contribution of Working Group II to the Fifth Assessment

Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

IPCC (2014b): Climate Change 2014: Synthesis Report. *Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp 151

IPCC (2020). *Climate Change and Land*. An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Summary for Policy Makers.

Jacob, M. O., Farah, K. O. and Ekaya, W. N. (2004). Indigenous Knowledge: The Basis of the Maasai Ethnoveterinary Diagnostic Skills. *Journal of Human Ecology*, 16(1): 43-48.

Jellason, N. P., Baines, R., Conway, J. and Chukwuma C. Ogbaga, C.C. (2019) Climate Change Perceptions and Attitudes to Smallholder Adaptation in Northwestern Nigerian Drylands. *Social Sciences* 2019, 8, (31)

Jessen, T.D., Ban, N.C., Claxton, N.X. and Darimont C.T. (2021). Contributions of Indigenous Knowledge to ecological and evolutionary understanding. *Frontiers in Ecology and the Environment*, Volume 20, Issue 2 March 2022. Pages 93-101

Jha, S., Kaechele, H., Lana, M., Amjath-Babu and T.S., Sieber, S. (2020). Exploring Farmers' Perceptions of Agricultural Technologies: A Case Study from Tanzania. *Sustainability* **2020**, *12*, 998. https://doi.org/10.3390/su12030998

Johnson, R. B., Onwuegbuzie, A. J. and Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research* 2007; 1; 112. SAGE Publications. Available at: http://mmr.sagepub.com/cgi/content/abstract/1/2/112 (Accessed: 26 June 2019).

Jones, L. and Boyd, E. (2011). Exploring social barriers to adaptation: Insights fromWestern Nepal. *Global Environmental Change* 21: 1262–74. Kiptot, E., Franzel, S., Hebinck, P. and Richards, P. (2006). Sharing seed and knowledge: farmer to farmer dissemination of agroforestry technologies in western Kenya. *Agroforestry systems*, 68 (3), 167–179.

Karamesouti, M., Schultz, C., Chipofya, M., Jan, S., Galeano,C.E.M., Schwering,A. and Christian Timm, C. (2018). The Maasai of Southern Kenya Domain Model of Land Use. ISPRS Annals of the Photogrammetry, *Remote Sensing and Spatial Information Sciences*, Volume IV-4, 2018 ISPRS TC IV Mid-term Symposium "3D Spatial Information Science – The Engine of Change", 1–5 October 2018, Delft, The Netherland

Karytsas, S., Polyzou, O. and Karytsas, O. (2019). Factors affecting willingness to adopt and willingness to pay for a residential hybrid system that provides heating/cooling and domestic hot water. *Renewable Energy* Volume 142, pp 591-603.

Kassie, B.T., R¨otter, R.P., Hengsdijk, H., Asseng, S., van Ittersum, M.K., Kahiluto, H. and Keulen, H. van, (2014). Climate variability and change in the Central Rift Valley of Ethiopia: challenges for rainfed crop production. *J. Agric. Sci*. 52, 58–74

Kieslinger, J., Pohle, P., Buitr, V. and Peters, T. (2019). Encounters between Experiences and
Measurements: The Role of Local Knowledge in Climate Change Research. *Mountain Research and Development* · November 2019. DOI: 10.1659/MRD-JOURNAL-D-18-00063.1

Kiptot, E., Hebinck, P., Franzel, S. and Richards, P.(2007). Adopters, testers or pseudo-adopters? Dynamics of the use of improved tree fallows by farmers in western Kenya. *Agricultural systems*, 94 (2), 509–519. doi: 10.1016/j.agsy.2007.01.002

Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research*. Beverly Hills: Sage Publications.

Kitinya, K.T., Onwonga, R.N., Onyango, C., Mbuvi, J. P. and Kironchi, G. (2012) Climate Change and Variability: Farmers' Perception, Experience and Adaptation Strategies in Makueni County, Kenya‖. *Asian Journal of Agriculture and Rural Development*, Vol. 2, No. 3, pp. 411-421.

Kivunja, C. and Kuyini, A. B. (2017). Understanding and Applying Research Paradigms in Educational Contexts. *International Journal of Higher Education. Vol. 6, No. 5; 2017.* doi:10.5430/ijhe.v6n5p26. Available at: http://www.sciedu.ca/journal/index.php/ijhe/article/download/12169/7683.

KNBS (2010). *Households and Living Conditions of Kenya, 2009*. Government of Kenya Data Portal. Available at: http://kenya.opendataforafrica.org/bnkmqee/households-and-living-conditions-of-kenya-2009.

KNBS (2019). *2019 Kenya Population and Housing Census: Volume I*. Kenya National Bureau of Statistics,

Kom, Z., Nicolau, M.D. and Nenwiini, S.C.(2024). The Use of Indigenous Knowledge Systems Practices to Enhance Food Security in Vhembe District, South Africa. *Agric Res* 13, 599–612 (2024). https://doi.org/10.1007/s40003-024-00716-8.

Kom, Z., Nethengwe, N.S., Mpandeli, S., Chikoore, H. (2022) Indigenous knowledge indicators employed by farmers for adaptation to climate change in Rural South *Africa. J Environ Plan Manag*. https://doi.org/10.1080/09640568.2022.2086854

Kumar, V. (2014). Role of Indigenous Knowledge in Climate Change Adaptation Strategies: A
Study with Special Reference to North-Western India. *Journal of Geography & Natural Disasters. DOI: 10.4172/2167-0587.1000131*

Kumar, H. M. V, Shivamurthy, M., Gowda, V. G. & Biradar, G. S. (2017). Assessing decision-making and economic performance of farmers to manage climate-induced crisis in Coastal Karnataka (India) *Climatic Change* volume 142, pages143–153(2017)

LaPiere, R.T. (1967). Attitude versus actions. In M.Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 26-31). New York: John Wiley & Sons

Lave, J. and Wengner, E (1991): *Situated Learning: Legitimate Peripheral Participation*. Cambridge, MA: Cambridge University Press.

Lawson, E. T., Alare, R. S., Salifu, A. R. Z. and Hall, M. T. (2019). Dealing with climate change in semi-arid Ghana: understanding intersectional perceptions and adaptation strategies of women farmers. *GeoJournal.* https://doi.org/10.1007/s10708-019-09974-4(0123456789().,-volV() 0123458697().,-volV). Springer

Leal-Filho, W., Nzengya, D., Muasya, G., Chemuliti, J. and Kalungu, J.W. (2017). Climate change responses among the Maasai Community in Kenya. *Climatic Change*, 145 (1-2). pp. 71-83. ISSN 0165-0009.

Lewis, P., Monem, M. A. and Impiglia, A. (2018). *Impacts of Climate Change on Farming Systems and Livelihoods in the Near East and North Africa- With a special focus on small-scale family.* Food and Agriculture Organization of The United Nations, Cairo. Available at: http://www.fao.org/3/ca1439en/CA1439EN.pdf. (Accessed: 12/07/2019).

Lin, C. C., and Lockwood, M. (2014). Assessing sense of place in natural settings: A mixed-method approach. *Journal of Environmental Planning and Management, 57*(10), 1441–1464. https://doi.org/10.1080/09640568.2013.811401

Lwoga, E.T., Ngulube, P. and Stilwell, C. (2016). Indigenous Knowledge Management Practices in Indigenous Organizations in South Africa and Tanzania. Chapter in *Handbook of Research on Social, Cultural, and Educational Considerations of Indigenous Knowledge in Developing Countries·* September 2016 DOI: 10.4018/978-1-5225-0838-0.ch010

Lokuruka, M. N. I. (2020). Food and Nutrition Security in East Africa (Rwanda, Burundi and South Sudan): Status, Challenges and Prospects. In *Food Security in Africa.* DOI: 10.5772/intechopen.95037. License CC BY 3.0

MacAllister, T., Hikuroa, D. and Macinnis-Ng, C. (2021). Connecting Indigenous Knowledge to Science: Kaitiakitanga, Conservation and Resource Management. *New Zealand Journal of Ecology* , 47(1) - 3521

Macfadyen, S., McDonald, G., and Hill, M. P. (2018) From species distributions to climate change adaptation: knowledge gaps in managing invertebrate pests in broad-acre grain crops. *Agric Ecosyst Environ* 253:208–219. https://doi.org/10.1016/j.agee.2016.08.029

Macusi, E.S., Sales, A.C., Macusi, E.D., Bongas, H.P., Cayacay, M.A., Omandam, J. L., Schüler, M. and Vidal, C. (2023). Indigenous Knowledge Systems and Practices (IKSPs), Livelihood Resources and Aspirations of the Matigsalog and Ata Tribes. *Sustainability* 2023, 15(14), 11182; https://doi.org/10.3390/su151411182

Mafuwane, B.M. (2011). Research Design and Methodology. A chapter in the *Contribution of instructional leadership to learner performance*. University of Pretoria. Available at:

https://repository.up.ac.za/bitstream/handle/2263/24016/04chapter4.pdf?sequence=5.

Makate, C. (2020).Local Institutions and Indigenous Knowledge in Adoption and Scaling of Climate-Smart Agricultural Innovations among Sub-Saharan Smallholder Farmers. *International Journal of Climate Change Strategies and Management vol. 12.* No. 2 pp. 270 -287. DOI 10.1108/IJCCSM/2018-0055

Makuni, J. (2024). Impact of Climate Change Agreements on National Environmental Policies: A Cross-National Analysis. *American Journal of International Relations*, 9(2), 29–39. https://doi.org/10.47672/ajir.2268

Makondo, C. C. and Thomas, D. S. G. (2018). Climate change adaptation: Linking indigenous knowledge with western science for effective adaptation. *Environmental Science & Policy Volume* 88, October 2018, Pages 83-91. Elsevier

Malhi, G. S., Kaur, M., & Kaushik, P. (2021). Impact of climate change on agriculture and its mitigation strategies. *Sustainability, 13*(3), 1318. http://doi.org/10.3390/su13031318

Maleksaeidi, H. and Keshavarz, M. (2019). What Influences Farmers' Intentions to Conserve On-farm Biodiversity? An Application of the Theory of Planned Behavior in Fars Province, Iran. *Global Ecology and Conservation* 20 (2019). Elsvier 00698.

Manei, N., MacOpiyo, L. and Kironchi, G. (2016). Integration of indigenous knowledge with ICTs in managing effects of climate change and variability in Kajiado County, Kenya. *RUFORUM Working Document Series*. ISSN 1607-9345 No. 14 (2): 231-236. Available at: https://repository.ruforum.org/system/tdf/N.%20Manei.pdf?file=1&type=node&id=36831&force=.

Maru, Y., Gebrekirstos, A. and Haile, G. (2019) Farmers' Indigenous Knowledge of Tree Conservation and Acidic Soil Amendments: The Role of "baabbo" and "Mona" Systems: Lessons from Gedeo Community, Southern Ethiopia, *Cogent Food & Agriculture,* Volume 5 No. 1, 1645259

Masemula, M.B. (2013). *Integration of Modern Science and Indigenous Knowledge Systems: Towards a Coexistence of The Two Systems of Knowing in The South African Curriculum.* A Thesis Submitted for the Award of a Master's Degree in Philosophy of Education at The University of South Africa. UNISA, 003. South Africa.

Masinde, M., & Bagula, A. (2011). ITIKI: Bridge between African Indigenous Knowledge and Modern Science of Drought Prediction. *Knowledge Management for Development Journal*, 7(3), 274-290.

Masud, M. M., Al-Amin, A. Q., Junsheng, H., Ahmed, F., Yahaya, S. R., Akhtar, R., & Banna, H. (2016). Climate change issue and theory of planned behaviour: Relationship by empirical evidence. *Journal of Cleaner Production, 113*, 613-623.

Mathias, M.E. (1994). Magic, myth and medicine. *Economic Botany,* **48(1)**: 3 – 7. Available at: https://doi.org/10.1007/BF02901373

Maye, D., Ilbery, B. and Little, R. (2012). Rationalizing Risk: Grower Strategies to Manage Plant Disease in the UK Wheat and Potato Sectors. *The Geographical Journal* 178: 338–47.

Mazzocchi, F. (2006) Western science and traditional knowledge: Despite their variations, different forms of knowledge can learn from each other. *EMBO Reports*. 2006 May; 7(5): 463–466. doi: 10.1038/sj.embor.7400693. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1479546/

Mbow, C., C. Rosenzweig, L.G. Barioni, T.G. Benton, M. Herrero, M. Krishnapillai, E. Liwenga, P. Pradhan, M.G. Rivera-Ferre, T. Sapkota, F.N. Tubiello, Y. Xu, (2019). Food Security. In: *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems* [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)]. In press.

Mbuli, C.S., Fonjong, L.N. and Fletcher, A. J. (2021). Climate Change and Small Farmers' Vulnerability to Food Insecurity in Cameroon. *Sustainability* 2021, 13(3), 1523; https://doi.org/10.3390/su13031523

McIsaac, G. and Edwards, W.R. (1994) Sustainable Agriculture in the American Midwest: Lessons from the Past, Prospects for the Future. University of Illinois Press.

Melesse, B. (2018). A Review on Factors Affecting Adoption of Agricultural New Technologies in Ethiopia. *Journal of Agricultural Science and Food Research*. 9:3.

Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G. W., and Nieuwenhuis, M. (2015). The Role of Knowledge, Attitudes and Perceptions in the Uptake of Agricultural and Agroforestry Innovations Among Smallholder Farmers in Sub-Saharan Africa. *International Journal of Agricultural Sustainability*, Vol.13 (1), 40-54, DOI: 10.1080/14735903.2014.912493.

Mendoza, J.C., de la Cruz-Modino, R., Dorta, C., Martín- Sosa, P. and Hernández, J.C. (2022). Ecosystem modeling to evaluate the ecological sustainability of small-scale fisheries: A case study from El Hierro, Canary Islands. *Ocean. Coast. Manag.* 2022, 228, 106297.

Mercer, J., Kelman, I., Taranis, L. and Suchet-Pearson, S. (2010). Framework for integrating indigenous and scientific knowledge for disaster risk reduction. *Disasters*, 2010, 34(1): 214–239. doi:10.1111/j.0361-3666.2009.01126.x.

Mitter H, Kirchner M, Schmid E, Schönhart M (2014) The participation of agricultural stakeholders in assessing regional vulnerability of cropland to soil water erosion in Austria. *Reg. Environ. Change* 14:385–400. https://doi.org/10.1007/s10113-013-0506-7

Mitter H, Schönhart M, Larcher M, Schmid E (2018) The Stimuli-Actions-Effects-Responses (SAER)-framework for exploring perceived relationships between private and public climate change adaptation in agriculture. *Journal of Environmental Management* 209:286–300.

Mitter, H., Larcher, M., Schönhart, M., Stöttinger, M. and Erwin Schmid, E. (2019). Exploring Farmers' Climate Change Perceptions and Adaptation Intentions: Empirical Evidence from Austria. *Journal of Environmental Management* (2019) 63:804–821.

Mizik, T. (2021). Climate-Smart Agriculture on Small-Scale Farms: A Systematic Literature Review. *Agronomy* 2021, 11, 1096. https://doi.org/10.3390/agronomy11061096

Mogomotsi, P.K., Sekelemani, A. and Mogomotsi, G.E.J. (2020). Climate change adaptation strategies of small-scale farmers in Ngamiland East, Botswana. *Climatic Change* **159,** 441–460 (2020). https://doi.org/10.1007/s10584-019-02645-w

Monroe, M. C., Plate, R. R., Oxarart, A., Bowers, A. and Chaves, W. A. (2019). Identifying effective climate change education strategies: a systematic review of the research. Environmental Education Research. *Climate Change Education and Research*: Volume 25, 2019 - Issue 6

Moore, H. (1996): The Changing Nature of Anthropological Knowledge: An Introduction. In H. Moore (Ed.): *The Future of Anthropological Knowledge*. London, UK: Routledge.

Moore, S. J. and Nesterova, Y. (2020). *Indigenous knowledges and ways of knowing for a sustainable living.* UNESCO, Futures of Education, 7, place de Fontenoy. 75352 Paris Franc

Morgan, D. L. (2014). Pragmatism as a Paradigm for Social Research. *Qualitative Inquiry*. Vol XX(X) 1– 9. DOI: 10.1177/1077800413513733. Sage Publications. Available at: http://qix.sagepub.com/content/early/2014/01/31/1077800413513733.

Mudany, J. O., Mudany, M. A. and Ogutu, M. (2024). Impact of Climate Change on Livelihood Sustainability of Vulnerable Pastoral Communities in Kajiado, Kenya. *African Journal of Emerging Issues* (AJOEI). Online ISSN: 2663-9335, Vol (6), Issue 1, Pg. 50-74

Mugenda, O. M. and Mugenda, A. G. (1999). *Research Method, Quantitative and Qualitative Approaches*. African Center for Technological Studies.

Mukherjee, S., Mishra, A. and Trenberth, K. E. (2018). *Climate Change and Drought: A* Perspective *on Drought Indices*. ResearchGate. Current Climate Change Reports. DOI: 10.1007/s40641-018-0098-x. Available at:

https://www.researchgate.net/publication/324702167_Climate_Change_and_Drought_a_Perspective_on_Drought_Indices. (Accessed: 15/07/2019).

Mulenga, B.P., Wineman, A. and Sitko, N.J. (2017) Climate Trends and Farmers' Perceptions of Climate Change in Zambia. *Environmental Management* 59:291–306. https://doi.org/10.1007/s00267-016-0780-5.

Mwangi, M. (2018). Human Ecology–Political Economy Nexus of Drivers of Drought-Vulnerabilities on Maasai Pastoralists' Coupled Social-Ecological System in Kenya. *American Journal of Earth Sciences*, 2018; 5(3): 74-86. http://www.openscienceonline.com/journal/ajes. ISSN: 2381-4624 (Print); ISSN: 2381-4632 (Online)

Nabudere, D. W. (2011). *Afrikology, Philosophy and Wholeness: An epistemology.* Africa Institute of South Africa, South Africa. ISBN 978079830255.

Najafi, M., Ardalan, A., Akbarisari, A. & Noorbala, A. A., Elmi, H. (2017) The Theory of Planned Behaviour and Disaster Preparedness. *PLOS Currents Disasters*. 2017 September 6 (9): Available at: http://currents.plos.org/disasters/index.html%3Fp=31955.html (Accessed: 15/11/2018)

Ncoyini, Z., Savage M. J. and Strydom, S. (2022). Limited access and use of climate information by small-scale sugarcane farmers in South Africa: A case study. *Climate Services* Volume 26, April 2022, 100285

Ndjeunga, J. and Bantilan, C., (2005). Uptake of improved technologies in the semi-arid tropics of West Africa: why is agricultural transformation lagging behind? *Journal of agricultural and development economics*, 2 (1), 85–102. Available at: https://core.ac.uk/download/pdf/6699542.pdf.

Ndungu, C. K. & Mwangi, M. N. (2022). Factors Influencing Farmers' Adaptations to Climate Change and Variability in Arid and Semi-Arid Lands of Kitui and Kajiado Counties, *Kenya African Journal of Climate Change and Resource Sustainability*, 2(1), 28-41. https://doi.org/10.37284/ajccrs.1.1.1137.

Ng'ang'a, T.W., Coulibaly, J.Y., Crane, T. A., Gachene, C.K. and Kironchi, G. (2020). Propensity to adapt to climate change: insights from pastoralist and agro-pastoralist households of Laikipia County, Kenya. *Climatic Change* **161,** 393–413 (2020). https://doi.org/10.1007/s10584-020-02696-4

Ning, A., Adesina, F., & Osman, E. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies Global Change, 12,* 787-797.

Ngulube, P. (Ed.). (2016). *Handbook of research on theoretical perspectives on indigenous knowledge systems in developing countries*. IGI Global.

Nkatha, M. (2020). Centring Knowledge Democracy within Policymaking for Sustainability and Resilience: A Discussion of the Kenyan Drylands. *International Journal of Community Research and Engagement*, Vol. 13, No. 1

Nkuba, M.R., Chanda, R., Mmopelwa, G., Mangheni, M.N., Lesolle, D. and Kato, E. (2020). Indigenous Knowledge Systems and Indicators of Rain: Evidence from Rwenzori Region, Western Uganda. *Weather, Climate and Society*, 12(2): 213-234. http://doi.org/10.1175/WCAS-D-19-0027.1

Ntshangase, N.L., Muroyiwa, B. and Sibanda, M. (2018). Farmers' Perceptions and Factors Influencing the Adoption of No-Till Conservation Agriculture by Small-Scale Farmers in Zashuke, KwaZulu-Natal Province. *Sustainability* **2018**, 10, 555.

Nugun, P. J., Conway, John, S. and Baines, R. N. (2021) Understanding impacts and barriers to adoption of climate-smart agriculture (CSA) practices in North-Western Nigerian drylands, *The Journal of Agricultural Education and Extension*, 27:1, 55-72, DOI: 10.1080/1389224X.2020.1793787

Nunow. A, Nzioka, J. M., Ininda, J. M. & Kinama, J. M. (2019). The effects of climate change on household food security in Kajiado and Kiambu County, Kenya. *International Journal of Innovative Research and Knowledge Volume-4 Issue-4.* Available at: http://www.ijirk.com/issue_image/IJIRK-4.04.01.pdf. (Accessed: 25/10/2019).

Nyakaisiki, K., Mugume, I., Ngailo, T. and Nakabugo, R. (2019). The Use of Indigenous Knowledge in Predicting Changes in Seasonal Rainfall by Smallholder Farmers of Ruteete Subcounty, *Kabarole District. Journal of Geoscience and Environment Protection* 7, 13-22.

Nyale, E. H., China, S. S. and Nabiswa, F. (2019) The Extent of Adopting Climate Smart Agriculture Technologies in Addressing Household Food Security in Makueni County, Kenya. *International Journal of Scientific and Research Publications*, Volume 9, Issue 11, November, 2019. Available at: http://dx.doi.org/10.29322/IJSRP.9.11.2019.p9579.

Nygren, A. (1999): From Dichotomies to Situated Knowledges. In *Critique of Anthropology* 19 (3), pp. 267–288.

Ochoo, C. O. (2025). Assessing Climate and Disaster Risk Using Participatory Techniques: Experience from Pastoral Communities of Kenya. In: W. Leal Filho et al. (eds.), *Climate Change, Food Security, and Land Management*, https://doi.org/10.1007/978-3-031-71164-0_72-11

Ogundiran, A. (2019) Food security, food sovereignty, and indigenous knowledge. *Afr Archaeol Rev* 36:343–346. https://doi.org/10.1007/s10437-019-09349-7

Oloitipitip, F.R., Ndunda, E. and Gichuki, C. M. (2024). Adaptation Strategies to Climate Variability by Amboseli Ecosystem Households in Kajiado County, Kenya. *East African Journal of Environment and Natural Resources*. Volume 7, Issue 1, 2024 Print ISSN: 2707-4234 | Online ISSN: 2707-4242 Title DOI: https://doi.org/10.37284/2707-4242

Ombogo, M.O. (2013). *The impact of climate variability on pastoralism: Forage dynamics and trends of cattle population in Kajiado County, Kenya*. A Research project submitted in partial fulfillment of the requirement of Masters in Arts

Degree in Climatology in the Department of Geography and Environmental studies, University of Nairobi.

Organization for Economic Cooperation and Development (OECD) (2001) *Adoption of Technologies for Sustainable Farming Systems: Wageningen Workshop Proceedings*. OECD Publication, Paris, France. Available at: https://www.oecd.org/greengrowth/sustainable-agriculture/2739771.pdf. (Accessed: 12/07/2019).

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press, Cambridge, p. 279.

Osumba, J. J. L., Recha, J. W. and Oroma, G. W. (2021). Transforming Agricultural Extension Service Delivery through Innovative Bottom–Up Climate-Resilient Agribusiness Farmer Field Schools. *Sustainability* 2021, 13, 3938.

Ouko, O. C. (2024). Participatory Assessment of Climate and Disaster Risk among Pastoral Communities of Africa- A Case Study of Kajiado County, Kenya. *African Journal of Emerging Issues* (AJOEI). Online ISSN: 2663-9335, Vol (6). Issue 12, Pg. 53-76

Owfi, R. E. and Barani, H. (2019). A Review of Global Experiences on using of Indigenous Knowledge in Rangelands Management and Utilization Projects. *International journal of Rural Development, Environment and Health Research* Volume 3, Issue 3. Available at: https://dx.doi.org/10.22161/ijreh.3.3.1 ISSN: 2456-8678

Ozor, N. And Nnaji, C.E. 2011. The role of extension in agricultural adaptation to climate change in Enugu State, Nigeria. *Journal of Agricultural Extension and Rural Development* **3** (3): 42 – 50.

Petty, R. E. & Cacioppo, J. T. (1986) *The Elaboration Likelihood Model of Persuasion*. Advances in Experimental Social Psychology. Vol. 19. Academic Press. Inc. Available at: http://www.psy.ohio-state.edu/petty/documents/1986ADVANCESsPettyCacioppo.pdf (Accessed: 18/11/2018).

Petty, R. E., Tormala, Z. L., & Rucker, D. D. (2004). Resisting persuasion by counterarguing: An attitude strength perspective. In J. T. Jost, M. R. Banaji, & D. A. Prentice (Eds.), APA science series. *APA decade of behavior series. Perspectivism in social psychology: The yin and yang of scientific progress* (pp. 37-51). Washington, DC, US: American Psychological Association. http://dx.doi.org/10.1037/10750-00.

Petzold, J., Andrews, N., Ford, J. D., Hedemann, C. and Postigo, J. C. (2020). Indigenous knowledge on climate change adaptation: a global evidence map of academic literature. *Environmental Research Letters **15** (2020)113007.*

Piontek, F., Müller, C., Pugh, T. A. M., Douglas B. Clark, D.B., Deryng, D., Joshua Elliott, J., González, F.J.C., Flörke, M., Folberth, C., Franssen, W., Frieler,K., Andrew D. Friend, A.D., Simon N. Gosling, S.N., Hemming, D., Khabarov, N., Kim, H., Mark R. Lomas, M.R., Masaki, Y., Mengel, M., Andrew Morse, A.,

(2014). Multisectoral climate impact hotspots in a warming world. *National Academy of Sciences of the USA.* 111(9): 3233–3238. doi: 10.1073/pnas.1222471110.
Radeny, M., Desalegn, A., Mubiru, D., Kyazze, F., Mahoo, H., Recha, J., Kimeli, P. and Solomon, D. (2019). Indigenous knowledge for seasonal weather and climate forecasting across East Africa. *Climatic Change* 156:509–526. . https://doi.org/10.1007/s10584-019-02476-9
Raghuvanshi, R. and Ansari, M. A. (2017). A Study of Farmers' Awareness About Climate Change and Adaptation Practices in India. *International Journal of Applied Agricultural Sciences.* 3(6): 154-160 ·DOI: 10.11648/j.ijaas.20170306.13
Rhoades, R. E., Zapata Ríos, X., & Aragundy Ochoa, J. (2008). Mama Cotacachi - History, local perceptions, and social impacts of climate change and glacier retreat in the Ecuadorian Andes. In B. Orlove, E. Wiegandt, & B. H. Luckman (Eds.), Darkening peaks: *Glacier retreat, science, and society* (pp. 216–225). University of California Press.
Ritchie, Roser, Mispy, Ortiz-Ospina (2018). *Measuring progress towards the Sustainable Development Goals*. SDG-Tracker.org, website. Available at: https://sdg-tracker.org/climate-change. (Accessed: 26/12/2019).
ROK (2012). *Agriculture Act: Chapter 318*. National Council for Law Reporting with the Authority of the Attorney-General. Nairobi, Kenya.
Sadiq, M. A., Kuwornu,J. K. M., Al-Hassan, R. M. and Alhassan, S. I. (2019). Assessing Maize Farmers' Adaptation Strategies to Climate Change and Variability in Ghana *Agriculture* 2019, 9(5), 90; https://doi.org/10.3390/agriculture9050090.
Sain, G., Czaplicki, S., Guerten, N., Shikuku, K.M., Grosjean, G. and Läderach, P. (2018). Farm-Level and Community Aggregate Economic Impacts of Adopting Climate Smart Agricultural Practices in Three Mega Environments. *PLoS One*. 2018; 13(11). doi: 10.1371/journal.pone.0207700
Sanderson, M.R. and Curtis, A. L. (2016). Culture, climate change and farm-level groundwater management: An Australian case study. *Journal of Hydrology.* Volume 536, May 2016, Pages 284-292
Sarker, J. R. and Al Hasan, M. (2021) Farmers' adaptation strategies to combat climate change in drought prone areas in Bangladesh. *International Journal of Disaster Risk Reduction*, 65. 102562. ISSN 2212-4209 doi: https://doi.org/10.1016/j.ijdrr.2021.102562 Available at https://centaur.reading.ac.uk/104235/
Saunders, M. (2009). *Understanding research philosophies and approaches.* ResearchGate. Available at: https://www.researchgate.net/publication/309102603_Understanding_research_philosophies_and_approaches. (Accessed: 07/06/2019).
Schlenker, W., & Lobell, D. B. (2010). Robust negative impacts of climate change on African agriculture. *Environmental Research Letters, 5*(1), 014010.

Schrader, P.G. and Lawless, K. A. (2004). The knowledge, attitudes, & behaviors approach how to evaluate performance and learning in complex environments. *Performance Improvement* 43(9):8 - 15 · DOI: 10.1002/pfi.4140430905.

Sharma, S., Hooda, K. S. and Goswami, P. (2019) Scenario of Plant Diseases Under Changing Climate. *Journal of Pharmacognosy and Phytochemistry*, Volume 8 No. 1, 2490-2495.

Shaw, R., Noralene, U., and Baumwoll, J. (2008). *Indigenous Knowledge for Disaster Risk Reduction: Good Practices and Lessons Learned From Experiences in The Asia-Pacific Region*. Bangkok: United Nations International Strategy for Disaster Risk Reduction (UNISDR). Available at: http://dpanther.fiu.edu/sobek/FI13022760/00001. (Accessed: 05/08/2020).

Shiferaw, B. A., Okello, J. and Reddy, R. V. (2009). Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. *Environment, Development and Sustainability* volume 11, pages601–619 (2009)

Shingirai S. M. (2018) Adaptation measures to sustain indigenous practices and the use of indigenous knowledge systems to adapt to climate change in Mutoko rural district of Zimbabwe. *Journal of Disaster Risk Studies (JAMBA). Jamba. 2018; 10(1)*: 388. doi: 10.4102/jamba.v10i1.388

Shizha, E. (2011*). Indigenous knowledge and science education in Zimbabwe: Perspectives of rural primary school teachers*. Saarbrücken, Germany: Lambert Academic.

Singh, S. L. and Sahoo, U. K. (2019). Socio-Economic and Demographic Factors Influencing Farmers' Decision on Homegarden management Practices and Carbon Storage in Mizoram, Northeast India. *International Journal of Ecology and Environmental Sciences* 45 (1): 59-69, 2019 ISSN: 2320-5199

Slingo, J.M., Challinor, A. J., Hoskins, B. J. and Wheeler, T. R. (2005). Introduction: food crops in a changing climate. *Philosophical transactions of the royal society B-biological sciences*, 360 (1463), 1983–1989.

Songok, C. K., Kipkorir, E. C., Mugalavai, E. M. (2011) *Integration of indigenous knowledge systems into climate change adaptation and enhancing food security in Nandi and Keiyo districts, Kenya*. In: Filho WL (ed) Experiences of climate change adaptation in Africa. Springer, Hamburg, pp 69–95.

Stammler, F. M. and Ivanova, A. (2020). From spirits to conspiracy? Nomadic perceptions of climate change, pandemics and disease. *Anthropology Today* Vol. 36 No. 4, August 2020 https://rai.onlinelibrary.wiley.com/doi/full/10.1111/1467-8322.12589

Stefanović, J. (2015) *Smallholder Farming Systems in Kenya: Climate Change Perception, Adaptation and Determinants.* Universität Basel. Syngenta Foundation. Available at: http://www.syngentafoundation.org/sites/g/files/zhg576/f/masterthesis_juliastefanovic_final.pdf

Stehr, N. and Storch, H.V. (1995). The social construct of climate and climate change. *Climate Research* 5: 99–105.
Stern, P.C. (2000). New environmental theories: toward a coherent theory of environmentally significant behavior. *Journal of Social Issues* 56:407–424. https://doi.org/10.1111/0022-4537.00175
Studley, J. F. (1998). Dominant Knowledge Systems & Local Knowledge. *Community Based Mountain Tourism: Practices for Linking Conservation with Enterprise*. Mountain Forum, the Mountain Institute. Available at: https://www.researchgate.net/publication/263657323.
Sunny, A. F., Huang, Z. and Karimanzira, T. T. P. (2018). Investigating Key Factors Influencing Farming Decisions Based on Soil Testing and Fertilizer Recommendation Facilities (STFRF)— A Case Study on Rural Bangladesh. *Sustainability* 2018, 10, 4331; doi:10.3390/su10114331
Taber, K. S. (2018) The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, Volume 48, Issue 6, pp 1273–1296. Available at: https://link.springer.com/article/10.1007/s11165-016-9602-2
Talanow, K., Topp. E. N., Loos, J., Martín-Lópezaurnal, B. (2021) Farmers' perceptions of climate change and adaptation strategies in South Africa's Western Cape. *Journal of Rural Studies*, Volume 81, January 2021, Pages 203-219. https://doi.org/10.1016/j.jrurstud.2020.10.026.
Tanyanyiwa, V. I. (2019). Indigenous Knowledge Systems and the Teaching of Climate Change in Zimbabwean Secondary Schools. *SAGE Open*. October-December 2019: 1–11 DOI: 10.1177/2158244019885149. journals.sagepub.com/home/sgo
Tanyanyiwa, V. I., & Chikwanha, M. (2011). The role of indigenous knowledge systems in the management of forest resources in Mugabe area, Masvingo, Zimbabwe. *Journal of Sustainable Development in Africa*, *3*, 132-149.

Tatira, L. (2000). The role of Zviera in socialisation. In E. Chiwome, Z. Mguni, & M. Furusa (Eds.), *Indigenous knowledge in Africa and Diaspora communities* (pp. 146-151). Harare, Zimbabwe: University of Zimbabwe.
Thapa, M. B., Luintel, Y. R., Gauchan, B. and Amatya, K. (2008). Indigenous Knowledge on Disaster Mitigation: Towards Creating Complementarity between Communities' and Scientists' Knowledge. *Indigenous Knowledge for Disaster Risk Reduction*. United Nations International Strategy for Disaster Reduction. Secretariat Asia and the Pacific, Bangkok, Thailand.
Theodory, T. F. (2016). *Dealing with Change: Indigenous Knowledge and Adaptation to Climate Change in the Ngono River Basin, Tanzania*. Dissertation Submitted to Obtain the Degree of Doctor (Dr. rer. Nat.) at the Faculty of Mathematics and Natural Sciences of the Rheinische Friedrich-Wilhelms-University of Bonn. Available at: https://d-nb.info/1119888557/34.
Thuo, M., Bell, A. A., Ureta, B. E. B., Lachaud, M. A., Okello, D. K., Okoko, E. N., Kidula, N. L. Deom, C. M. and Puppala, N. (2014). Effects of social network

factors on information acquisition and adoption of improved groundnut varieties: the case of Uganda and Kenya. *Agriculture and Human Values,* Volume 31, pages339–353(2014)

Thurstone, L.L. (1967). Attitudes can be measured. In M.Fishbein (Ed.), *Readings in attitude theory and measurement* (pp. 77-89). New York: John Wiley & Sons.

Tiruneh, S. Yigezu, A. and Zewdie, B. (2015). Measuring the effectiveness of extension innovations for out-scaling agricultural technologies. *African Journal of Agriculture Science and Technology* (AJAST), Vol. 3, Issue 7, pp. 316 -326, ISSN 2311-5882.

Toma, L., Barnes, A. P., Sutherland, L.-A., Thomson, S., Burnett, F. and Mathews, V. (2018). Impact of information transfer on farmers' uptake of innovative crop technologies: a structural equation model applied to survey data. *The Journal of Technology Transfer* volume 43, pages864–881(2018). https://doi.org/10.1007/s10961-016-9520-5

Trenberth, K. E. (2011). Changes in Precipitation with Climate Change. *Climate Research.* Vol. 47: 123–138, 2011 doi: 10.3354/cr00953

Tripathi, A. and Mishra, A.K. (2017). Knowledge and passive adaptation to climate change: An example from Indian farmers. *Climate Risk Management*. Volume 16, 2017, Pages 195-207.

Trisos, C.H., I.O. Adelekan, E. Totin, A. Ayanlade, J. Efitre, A. Gemeda, K. Kalaba, C. Lennard, C. Masao, Y. Mgaya, G. Ngaruiya, D. Olago, N.P. Simpson, and S. Zakieldeen, (2022): *Africa. In: Climate Change 2022*: *Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 1285–1455, doi:10.1017/9781009325844.011.

Twarog, S. and Kapoor, P. (2004). Protecting and Promoting Traditional Knowledge: Systems, National Experiences and International Dimensions. UNCTAD. ISSN: 1812-7061

Uddin, M.N.; Bokelmann, W.; Entsminger, J.S. (2014). Factors Affecting Farmers' Adaptation Strategies to Environmental Degradation and Climate Change Effects: A Farm Level Study in Bangladesh. *Climate* 2014, 2, 223–241.

UNESCO (2017) *Local and Indigenous Knowledge Systems (PDF)*. Available at: http://unesco.org/new/en/naturalsciences/ priority-areas/links/related-information/what-islocal-and-indigenous-knowledge (Accessed 16/04/2021). United Nations Educational, Scientific and Cultural Organization (UNESCO), 7 Place de Fontenoy, 75007, Paris, France.

UNESCO (2019). *UNESCO's Commitment to Biodiversity: Local, indigenous and scientific knowledge.* Available at: https://en.unesco.org/themes/biodiversity/knowledge. (Accessed on 17/04/2021).

United Nations (1992). *United Nations Framework Convention on Climate Change*. Available at: http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf. (Accessed: 15/07/2019)

UNFCCC (2018). *National Adaptation Plans 2018: Progress in the process to formulate and implement National Adaptation Plans.* The LDC Expert Group, UNFCCC. United Nations Climate Change Secretariat, UN Campus, Platz der Vereinten Nationen 53113 Bonn, Germany.

UNFCCC (2019). *What do Adaptation to Climate Change and Climate Resilience Mean?* United Nations Framework Convention on Climate Change. Available at: https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean (Accessed : 04/12/2019).

United Nations (2011). *Canberra Group on Household Income Statistics.* Canberra Group Handbook on Household Income Statistics. UN.

UNISDR (2008) *Climate Change and Disaster Risk Reduction*. United Nations International Strategy for Disaster Reduction. International Environment. Geneva, Switzerland. Available at: https://www.wmo.int/pages/prog/dra/vcp/documents/7607_Climate-Change-DRR.pdf.

United Nations (1992). *Convention on Biological Diversity* (with Annexes). No 30619. Rio de Janeiro, Brazil: United Nations.

Venugopal, S., Gau, R., Appau, S., Sample, K. L. and Pereira, R. C. F. (2019). Adapting traditional livelihood practices in the face of environmental disruptions in subsistence communities. *Journal of Business Research* Volume 100, July 2019, Pages 400-409

Vilakazi, B.S., Zengeni, R. and Mafongoya, P. (2019). Indigenous strategies used by selected farming communities in KwaZulu Natal, South Africa, to manage soil, water, and climate extremes and to make weather predictions. *Land Degradation and Development*, 2019;1–10.

Vygotsky, L. S. (1978): Mind in Society: The Development of Higher Psychological Process. In Cole, M., John-Steiner, V., Scibner, S. and Souberman, E (Ed.). Cambridge, MA: Harvard University Press.*Mind in Society: The Development of Higher Psychological Process*. In Cole, M., John-Steiner, V., Scibner, S. and Souberman, E (Ed.). Cambridge, MA: Harvard University Press.

Wanjohi, B. K., Njenga, E. W., Sudoi, V., Kipkore, W. K., Moore, H. L. and Davies, M. I. J. (2020). Ecological Knowledge of indigenous plants among the Marakwet Community (Embobut Basin), Elgeyo Marakwet County (Kenya). *Ethnobotany Research & Applications*, Volume 20 No.1

Weber, E. (1997). *Perception and Expectation of Climate Change: Precondition for Economic and Technological Adaptation*. Edited by Max Bazerman, David

Messick, David Messick, Ann Tenbrusel and Kimberly Wade-Benzoni. San Francisco: Psychological Perspectives to Environmental and Ethical Issues in Management, pp. 314–41.

Wiseman, V. (2016). *The UNFCCC National Adaptation Planning Model: A Foundation for Fulfilling Post-2015 Commitments? Part I*. International Institute of Sustainable Development (IISD). Available at: http://sdg.iisd.org/commentary/policy-briefs/the-unfccc-national-adaptation-planning-model-a-foundation-for-fulfilling-post-2015-commitments/. (Accessed: 26/12/2019)

Worku, A. A. (2019). Factors Affecting Diffusion and Adoption of Agricultural Innovations among Farmers in Journal of Medicine and Biology Ethiopia: Case Study of Oromia Regional State Western Shewa. *Journal of Medicine and Biology*. Review Issue Med Biol 1(2): 54-66.

Wossen, T., Abdoulaye, T., Alene A., Haile, M.G., Feleke, S., Adetunji Olanrewaju, A. and Victor Manyong, V. (2017). Impacts of extension access and cooperative membership on technology adoption and household welfare. *Journal of Rural Studies* 54 (2017) 223e233.

Yaron, D., Voet, H. and Dinar, A. (1992). Innovations on Family Farms: The Nazareth Region in Israel. *Am. J. Agric. Econ*. 1992, 74, 361–370.

Yazdanpanah, M., Tajeri Moghadam, M., Savari, M., Zobeidi, T., Sieber, S. and Löhr, K. (2021). The Impact of Livelihood Assets on the Food Security of Farmers in Southern Iran during the COVID-19 Pandemic. *Int. J. Environ. Res. Public Health* 2021, 18, 5310.

Zefeiti, S.M.B.A. and Mohamad, N.A. (2015). Methodological Considerations in Studying Transformational Leadership and its Outcomes. *International Journal of Engineering Business Management.* DOI: 10.5772/60429. Available at: https://journals.sagepub.com/doi/pdf/10.5772/60429

Zurba, M., Petriello, M. A., Madge, C., McCarney, P., Bishop, B., McBeth, M., Denniston, M., Bodwitch, H. and Bailey, M. (2022). Learning from knowledge co-production research and practice in the twenty-first century: global lessons and what they mean for collaborative research in Nunatsiavut. *Sustainability Science* (2022) 17:449–467. https://doi.org/10.1007/s11625-021-00996-x

APPENDICES

INTRODUCTION

Dear Respondent,

I am a postgraduate PHD student in Emergency Management Studies at Masinde Muliro University of Science and Technology. I am currently undertaking a study namely: **FARMERS' INDIGENOUS KNOWLEDGE PRACTICES INFLUENCING FARMERS' UPTAKE OF CLIMATE CHANGE ADAPTATION STRATEGIES IN KAJIADO COUNTY, KENYA**

. For purposes of collecting data, I have an attached questionnaire and interview schedules. I therefore kindly request you to fill the questionnaire, providing as honest response as you can so as to obtain accurate information of the study. The information provided shall be treated with utmost confidentiality and will not be used for any other purposes.

Thank you for your willingness to participate.

Stephen Muchaki Mudekhere

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Location of interview site:
Interview Number:
District: ____________
Location (ward, village and sub-village): ____________

SECTION 1: General information of the respondents

Please answer the following questions openly and circle the correct answer

1. Sex (a) Male (b) Female
2. Age (a) 18-25 (b) 26-33 (c) 34-41 (d) 42-49 (e) 50-57 (f) 58 and above
3. Education level of the respondents
(a) Illiterate (b) Adult education (c) Primary education (d) Secondary education

(e) Others specify………………………………………………..

4. PPI Index {1} Poorest {2} Poor {3} Medium {4} High

5. Household size (a) 1-3 (b) 4-7 (c) 8-11 (d) 11 and above
6. Are you originally from this village? (a) Yes (b) No
7. Land ownership {1} Yes {2} No
8. If no, where were you living before coming to this village?.......................
9. What is your monthly average income in KES?...
10. Source of income of the respondent (multiple response allowed)
(a) Selling agriculture products (b) Employment salary (c) Remittances (d) Fishing

(e) Hunting (f) others specify……………………………………………………
11. What is your farm size in hectare? (a) 1-5 (b) 5-10 (c) 10-15 (d) 15 and above
12. a.) What kind of crops do you grow?...
b.) How much was your yield in the last season? Specify per crop

Type of Crop	**Yields/specify units**

c.) Which type of livestock/animal do you keep?

i. …………………………..
ii. …………………………..
iii. ………………………….
iv. ………………………….
v. …………………………..

d.) Animal products in the last season

Type of product	Yield/specify units

SECTION 2: Knowledge and perceptions of changes of climate

13. Reflect on the past year and tell me whether you have experienced any of the following extreme weather events and which have negatively affected you.

Extreme Events	Tick	Extreme Events	Tick
Very heavy rain		Wild fires	
Storm		Floods	
Drought		Landslide	
Pest invasion on crops		Thunder	
Very high temperatures		Very low temperatures	

Other
(specify)…………………………………………………………………………………….
…………………………………………………………………………….

14. Specify whether you received any information about the event you mentioned above
{1} Yes {2} No {99}

15. When did you hear about these extreme events
{1} Before the events {2} During the events {3} After the events {99} Don't know

16. Sources of information on extreme weather events

Sources	Tick	Sources	Tick
TV		Family member	
Radio		Weather report	
Neighbor		School	
Newspaper		Provincial administration/chief	

Other
/specify……………………………………………………………………………
………….

17. Are you aware of climate change?
{1} Know a lot {2} Know {3} Know little {4} Don't know

18. How do you perceive the status of climate variables in your village? (Tick as appropriate)

Local perceptions	Tick
Increasing rainfall amount during rainy season	

Decreasing rainfall amount during rainy season	
Increasing length of rain season	
Decreasing length of rain season	
Early onset of rain days	
Late onset of rain days	
Increase of strong winds events	
Increasing temperature of the area	
Decreasing temperature of the area	
Increasing rainfall amount during rain season	
Decreasing rainfall amount during rain season	

19. What are the causes of climate change in your area? (Tick as appropriate)
    1) Environmental degradation
    2) Pollution
    3) Deforestation
    4) Modernization
    5) Other/specify……………………………...

20. What are the impacts of climate change which affects your livelihood activities?
……………………………………………………………………………………..

21. What are the common response mechanisms by farmers to these extreme weather events in your locality?

Response mechanisms	**Tick**
Resign to our fate and do nothing	
Appeal to government for help through local administration	
Wait for Humanitarian assistance from NGOs, civil societies etc.	
Use traditional IK to survive	
Seek help within social networks; relatives, clan, neighbors	
Migration	
Others………………………………………………………………… ‘’’ ……………………………………………………………………….	

SECTION 3: Learning indigenous knowledge on climate change adaptation

22. Please mention different sources of indigenous knowledge concerning climate change adaptation? (Tick as appropriate)

Sources of knowledge	**Tick**
Personal experience	
Parents/Family	
Friends/Neighbours	
Social groups	
Church/mosques	

Community gathering	
Village leaders	
Media	
Extension staffs	
NGOs	
Others specify……………………………………	

23. For how long you have been using this knowledge in your everyday farming and livestock keeping activities?..

SECTION 4: Use of modern agricultural technologies towards building community climate change adaptive capacity.

24. Have you ever heard about modern agricultural technologies/practices that address challenges related to climate change? {1} Yes {2} No {99} Don't know

25. Which of these are farming practices that you have carried out on your farm?

Farming practices	**Tick**
Proportion acreage of land under irrigation farming.	
Proportional numbers of animal breeds that include the superior breed among livestock farmers.	
Involvement in agricultural development planning at village, ward or constituency committees	
Practicing artificial insemination for livestock.	
Fenced off and reseeded natural pasture	
Better pasture establishment by using more than one grass species to spread the risks.	
Increased cultivation of drought resistant crops	
Water resource management practices (e.g. water harvesting)	
Others/Specify……………………………………………………………… ……………………………………………………………………………… ………………………………………………………………………………… …………………………………………………………………………………… ……… ………………….	

26. Please mention different sources of scientific knowledge concerning climate change adaptation? (Tick as appropriate)

Sources of knowledge	Tick
Parents/Family	
Friends/Neighbors	
Social groups	
Church/mosques	
Community gathering	
Village leaders/Elders	
Media	
Government Extension staffs	
NGOs	
Others specify…………………………………	

27. From your experience, how effective are the modern agricultural practices in solving climate change challenges? (tick as appropriate)

{1} Very effective {2} Effective {3} Somehow effective {4} ineffective {5} very ineffective

28. Challenges of applying scientific knowledge and its practices on climate change adaptation

a) Adherence to indigenous knowledge
b) Expensive
c) Lack of reliable sources or financial income
d) Lack of IK integration
e) Inadequate government support
f) Shortage of Labour
g) Others ………

SECTION 5: Challenges of indigenous knowledge and practices on climate change adaptation

29. What are the challenges of applying indigenous knowledge and practices on climate change adaptation (rank them as above in terms of importance)
(a) Intrusion of western knowledge
(b) Inception of government-based adaptation strategies
(c) Lack of government support
(d) Disappearance of traditional farming system

(e) Death of IK custodians
(f) Lack of reliable sources or financial income
(g) lack of information on weather
(h) Disappearance of traditional seeds
(i) Shortage of Labor
(j) Extension advice
(k) Less effective
(l) Forgotten them
(m) Elders do not pass them on
(n) New generation refuse their use
(o) There is no hindrance to adaptation
(p) Others please specify……………………………………………………..

30. What are your suggestions which you think will enhance indigenous knowledge practice to effectively adaptation to climate change? Comment freely …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… ………………………

31. What are your suggestions which you think will enhance modern scientific agricultural practice to effectively adaptation to climate change? Comment freely
……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
………………………
3. Do you have any other opinion that you think will be beneficial to this study?
………………………………………………………………………………………
………………………………………………………………………………………
………………………………………………………………………………………

APPENDIX II: GUIDING QUESTIONS FOR INTERVIEWS AND FOCUS GROUP DISCUSSIONS

(This interview guide will be used only for local leaders, elders, experienced farmers, famous leaders in the community and religious leaders)

Different on-going changes observed within the community

1 What kind of changes you have observed in recent years in your village?

2 How do local communities explain those changes?

3 Please can you explain the causes of these observed changes?

4 What are the main disasters caused by these changes experienced by local communities in the past 30 years in this village?

Climate change perceptions

5 Please explain the changes of local climate which you have observed in this village for the last 30 years.

6 On average, how many times/years have you observed unexpected frequent precipitation in the past 30 years?

7 On average, how many times/years have you observed frequent drought in the past 30 years?

8 On average, how many times/years have you observed unexpected strong winds in the past 30 years?

9 Please explain the causes of changes of the status of local climate in this village.

10 What are the impacts of climate change you have experienced in recent years?

Indigenous knowledge adaptation practices to climate change

11 What are the sources of knowledge regarding climate change adaptation in your community?

12 How did you learn about indigenous knowledge that you in climate change adaptation?

13 Please explain indigenous adaptation practices used by local communities to withstand drought condition.

14 Please explain indigenous adaptation practices used by local communities to withstand reduced precipitation.

15 Please explain indigenous adaptation practices used by local communities to control strong wind events.

16 Please explain strategies used by local communities to control pests and diseases caused by climate change to both crop and livestock.

17 Please explain indigenous knowledge practices on water resources management.

18 What are the sources of indigenous knowledge adaptation practices used by the local communities to adapt to climate change?

Challenges of indigenous knowledge in climate change adaptation

19 Do you think indigenous knowledge practices are helpful to adapt to climate change? If yes how?

20 Do you think it is relevant to integrate indigenous knowledge with western knowledge to adapt to climate change? If yes why?
21 Do you think it is relevant to integrate indigenous knowledge with existing government policies and programs to adapt to climate change? If yes why?
22 What are the underlying challenges of using indigenous knowledge practices on climate change adaptation?
23 How these challenges can be solved?
24 What are your suggestions on how to promote indigenous knowledge for effectively climate change adaptation at local level?

APPENDIX III: GUIDING QUESTIONS FOR GOVERNMENT OFFICIALS EXTENSION STAFFS, NGOS EXPERTS AND RESEARCH SCIENTISTS

Perceptions of climate change

1. What are the indicators of climate changes observed in this country in recent years?
2. What are the causes of climate change in Kenya?
3. How climate change affects agricultural and livestock keeping communities in Kenya?
4. How the incidences of human disease relates to climate change?
5. How the incidences of pests and disease to crops and livestock relate to these changes?
6. How climate change affects water resources management in Kenya?

Indigenous knowledge and practices on climate change adaptation

7. What are the indigenous knowledge adaptation practices applied by the local communities to control pests and disease caused by climate changes to both crops and livestock?
8. What are the indigenous knowledge adaptation practices used by the local communities on water resources management?
9. Explain indigenous knowledge adaptation practices used by the local communities to adapt to strong wind events.
10. What kind of support do you provide to local communities for effectively adaptation to climate change impacts?
11. Do you think it is important to integrate indigenous knowledge with western knowledge in adapting to climate change? If yes, please explain the relevance of indigenous knowledge on climate change adaptation?
12. Explain the contribution made by your organization/section on adapting to climate change in the community.
13. To what extent is the use of indigenous knowledge in adapting to climate change is effectively integrated into national climate change adaptation policies and strategies?
14. In your opinion, what challenges are associated with uptake (slow or none at all) of conventional climate change adaptation strategies by local farmers?

List of Key Informant Interviewees

Key Informants	No. of participants	Locations	Interviewer
Department of Agriculture	2	Kajiado Town	Researcher
Department of livestock	1	Kajiado Town	Research Assistant
Department of fisheries	1	Kajiado town	Research Assistant
Climate Smart	2	Kajiado town	Researcher

Agriculture project			
Kenya Agricultural & Livestock Research Organization - KALRO	1	Kajiado Town	Researcher
Agricultural Extension officers	3	1 in Loitokitok, 1 in Olepolos 1 in Kajiado town	Researcher
Chiefs/Assistant Chiefs	3	Emukutan, Imbirikani, Isilale	Research Assistants
Kenya Meteorological Department	1	Kajiado town	Researcher
Department of Environment and Natural resources	1	Kajiado town	Researcher
Kenya Red Cross Society	1	Kajiado Town	Researcher
Action Aid International	1	Kajiado Town	Researcher
Village elders	2	Olepolos and Kimana	Researcher/research assistants
Total	**19**		

APPENDIX IV: OBSERVATION CHECKLIST

Characteristic Features	Detailed Information
Livelihood Activities	
- Crop farming	
- Horticulture	
- Pastoralism	
- dairy farming	
- quarrying & sand harvesting	
- casual labour	
- Small scale trading (shop keeping, hawking etc)	
- formal employment	
- others	
Land Use	
- Land ownership	
- Settlement patterns	
- Proportion under crop farming	
- Proportion under grazing	
- Proportion under irrigation farming	
Natural resources	
- Range lands	
- Water	
- Forests	
- Crop fields	
- Mountains/hills	
- Others	
Social services	
- Health	
- Schools	
- Local administration	
- Traditional authorities	
- NGO/CBOs	
- Government extension offices	
- Others	
Infrastructure	
- Road networks/bridges	
- Settlements	
- Commodity Markets	
- Others	

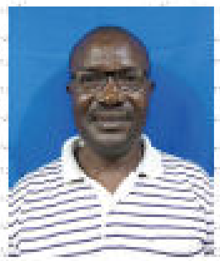
Appendix V: NACOSTI PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 485050 Date of Issue: 09/January/2020

RESEARCH LICENSE



This is to Certify that Mr.. Stephen Mudekhere of Masinde Muliro University of Science and Technology, has been licensed to conduct research in Kajiado on the topic: FARMERS' INDIGENOUS KNOWLEDGE PRACTICES INFLUENCING UPTAKE OF CLIMATE CHANGE ADAPTATION STRATEGIES IN KAJIADO COUNTY, KENYA for the period ending : 09/January/2021.

License No: NACOSTI/P/20/3428

485050

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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APPENDIX VI: PERMIT FROM KAJIADO COUNTY COMMISSIONER

OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT
COUNTY COMMISSIONER, KAJIADO

Telephone: 0203570295
Fax: 020206[illegible]16
Email: [illegible]2012@gmail.com
When replying please quote

County Commissioner
Kajiado County
P.O. Box [illegible]-01100
KAJIADO

Ref. KJD/CC/ADM/45 VOL. III (27)

4th February, 2020

Mr. Stephen Mudekhere
Masinde Muliro University of Science & Technology
P.O. BOX 190 - 50100
KAKAMEGA

RE: RESEARCH AUTHORIZATION: MR. STEPHEN MUDEKHERE

Following the request made on your behalf by National Commission for Science, Technology and Innovation vide letter **Ref. No. NACOSTI/P/20/3428** dated 9th January 2020.

You are hereby granted authority to carry out research on ***"Farmers Indigenous Knowledge Practices Influencing Uptake of Climate Change Adaptation Strategies ",in Kajiado West Sub – Cournty, Kajiado Central Sub – County and Loitokitok Sub – County in Kajiado County,*** for the period ending 9th January 2021.

It is expected that you adhere to research ethics in doing your study.

CHERONO RORIAN
FOR: COUNTY COMMISSIONER
KAJIADO COUNTY.

CC:

County Director of Education,
KAJIADO COUNTY

Deputy County Commissioners,
Kajiado West Sub – County
Kajiado Central Sub – County
Kajiado South Sub - County

APPENDIX VII: PERMIT FROM COUNTY MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

State Department of Early Learning & Basic Education

Email: kajiadocde@gmail.com
When replying please quote

COUNTY DIRECTOR OF EDUCATION
KAJIADO COUNTY
P.O. BOX 33-01100
KAJIADO

4TH FEBRUARY, 2020

Ref: KJD/C/R.3/VOL.II/180

Mr. Stephen Mudekhere
Masinde Muliro University of Science & Technology
P.O. Box 190-50100
KAKAMEGA

RE: AUTHORITY TO CONDUCT RESEARCH

Reference is made to a letter from National Commission for Science, Technology and Innovation **Ref. NACOSTI/P/20/3428** dated 9th January, 2020.

Authority is hereby granted to you to conduct your research on **"Farmers Indigenous Knowledge Practices Influencing Uptake of Climate Change Adaptation Strategies in Kajiado West, Kajiado Central and Loitokitok Sub-Counties in Kajiado County"** for the period ending **9th January, 2021.**

On completion of the research, you are expected to submit **a copy** of the research report/thesis to our office.

JOB KAIKAI
FOR: COUNTY DIRECTOR OF EDUCATION
KAJIADO COUNTY