INTEGRATION OF INDIGENOUS KNOWLEDGE WITH INFORMATION AND COMMUNICATION TECHNOLOGIES IN COPING WITH EFFECTS OF CLIMATE CHANGE AND VARIABILITY ON AGRICULTURE IN KAJIADO COUNTY, KENYA

BY MANEI NAANYU

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DECLARATION

This dissertation is my original work and has not been presented for a degree in any other university.

Signed.....Date.....

Manei Carolyne Naanyu

This dissertation has been submitted with our approval as University Supervisors

Signed…… Date…..

Dr. Laban Macopiyo

Lecturer

Department of Land Resource Management and Agricultural Technology (LARMAT)

University of Nairobi

Signed…….... Date……..

Dr. Geoffrey Kironchi

Senior lecturer

Department of Land Resource Management and Agricultural Technology (LARMAT)

DEDICATION

This dissertation is dedicated to my late father and best friend, Mr. **Eliud Manei Mpoke** and my mother **Sussy Nkuoh.**

My special gratitude goes to my family; more so my mother, Mrs. Sussy Manei for her entire support and sacrifice throughout the study, my sisters & brothers, Nosim, Tiampati, Soloi, Sation, Cindy and Felix who made sure my study was comfortable. My mother in-law Mrs. Anne Abubakar, for her encouragement and prayers that kept me going. The two year study needed someone to count on, shoulder to lean on and a lot of encouragement to overcome all the challenges; this could not have not been possible without the presence of my beloved spouse and best friend Mr. Faruk Abubakar. Thanks for being there and giving me time to pursue my dreams.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASAL_Arid and semi arid land

CC- Climate change

CV- Climate variability

FGD- Focus Group Discussions

GoK- Government of Kenya

ICTs- Information and Communication Technologies

IK- Indigenous Knowledge

IPCC- Intergovernmental panel for climate change

OCC- Olkejuado County Council

SMS- Short Messaging Services

SPSS- Statistical Package for Social Sciences

ABSTRACT

Climate change threatens production's stability and productivity. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is expected to reduce productivity to even lower levels and make production more erratic. To help cope with the negative impacts of anthropogenic climate change, local people employ traditional Indigenous-Knowledge based practices. This local based knowledge, which has evolved over several hundreds of thousands of years in tandem with the domestication of plants and animals, is critical for responding to climate change's related risks at the local level. ICTs have the potential improve access to this knowledge among other relevant information and social networking opportunities. The study was carried out in Kajiado County at Kumpa, Oloosuyian and Rombo locations. Data were collected through formal interviews using structured questionnaires, FGDs and Key informant interviews. A total of 200 questionnaires were administered, 100 practicing agro pastoralism and 100 pastoralists. The specific objectives of the research was to assess relevant Indigenous knowledge used by Indigenous people to cope and adapt to climate change and variability effects on agriculture as well as evaluate opportunities for utilizing ICTs to communicate and disseminate agricultural production related indigenous knowledge in Kajiado County of Kenya. Results indicated that farmers' are aware of the changing aspects of climate and their impacts especially prolonged droughts, leading to high crop failure, loss of animals, increase in pest and diseases and human wildlife conflict. These has led farmers shifting to farming historically known drought tolerant crops(green grams, sorghum, and cowpeas,) rain water harvesting, irrigation, use of organic manure, change in planting time, preservation of pastures, vaccination and migration. Among other things, farmers are also increasingly relying on their own indigenous knowledge in determining weather patterns compared to scientific knowledge. Various communication mechanisms taking advantage of ICTs

such as radios and mobile phones are emerging as viable avenues for acquisition and dissemination of agricultural production related information. They are the most preferred ICTs because they are affordable and use local languages to disseminate information. The study recommends increase in the level of awareness to farmers on the importance of environment conservation, drought tolerant crops, rain water harvesting techniques, preservation of pastures. Furthermore, the study recommends the use of radios to disseminate agricultural related information to farmers as well as documentation and dissemination of indigenous knowledge on climate change adoption strategies countrywide through use of the new ICTs.

DEFINITION OF TERMS

1. **Adaptation:** actions and adjustments undertaken to maintain the capacity to deal with stresses induced as a result of current and future external changes (Nelson et al. 2007:396, Alland 1975).
2. **Anthropogenic factors:** human activities that affect the climate. E.g. Increase in carbon dioxide levels due to emissions from fossil fuel combustion, aerosols and cement manufacture.
3. **Climate change** is a significant and lasting change in the statistical distribution of weather patterns over long periods, ranging from decades to millions of years. It may be a change in average weather conditions or distribution of events around those average e.g. more or fewer/extreme weather events.
4. **Climate variability** refers to the climatic parameter of a region varying from its long-term mean. Every year in a specific time period, the climate of a location is different. Some years have below average rainfall, some have average or above average rainfall.
5. **Community**: group of individuals united by commonality of purpose, characteristics, beliefs, and/or actions. Most communities are also internally differentiated (Agrawal and Gibson 1999)
6. **Coping:** use of existing resources to achieve various desired goals during and immediately after unusual, abnormal, and adverse conditions of a hazardous event or process.
7. **ICT (information and communications technology** - or technologies) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning.

8. **Integration**: to form, coordinate, or blend into a functioning or unified whole.
9. **Indigenous people** are a group of people practicing unique traditions; retain social, cultural, economic and political characteristics that are distinct from those of the dominant societies in which they live.
10. **Indigenous knowledge (IK)** is the local knowledge which is unique to a given culture or society. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities. (Warren 1991). Grenier (1998) and McGregor (2004) present traditional knowledge as a collective memory that is conveyed with speech from generation to generation through songs or tales and also through actions and observations.
11. **Mitigation**: actions and policies that reduce exposure to climate change, for example, through regulation and institutional changes, technological shifts, alterations in behaviours, or change in location (Nelson et al. 2007).

CHAPTER ONE

INTRODUCTION

Climate change and variability (CCV) and its impacts have been reported in various research studies carried out across the world (IPCC 2001, Hulme et al., 2002, Titus et al., 2009). The anticipated impacts of climate change will manifest in the form of; floods, storms, prolonged droughts and increased atmospheric temperature (IPCC 2007). The consequences will have far reaching adverse impacts on human health, food security, economic activities, physical infrastructure, natural resources, and the environment (UNDP 2007).

Climate change is caused by natural and anthropogenic factors. The natural causes include continental drift, mountain building, changes in green houses gases, deviations in the earth's orbit, and variation in solar radiation. The anthropogenic factors are human activities that affect the climate. For example the increase in carbon dioxide levels due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere) and cement manufacture. Other factors includes land use, ozone depletion, animal agriculture and deforestation, are also of concern in the roles they play either separately or in conjunction with other factors - in affecting climate, microclimate, and measures of climate variables.

Climate change threatens production's stability and productivity. In many areas of the world where agricultural productivity is already low and the means of coping with adverse events are limited, climate change is expected to reduce productivity to even lower levels and make production more erratic (Stern Review 2006; Cline 2007; Fisher *et al.* 2002; IPCC 2007).

According to Dewes (1993), two main categories of knowledge systems can be distinguished - Indigenous knowledge systems (IKS) and western knowledge systems (WKS). While western knowledge systems (WKS) are made universal through western education which is entrenched in many world cultures, indigenous knowledge systems (IKS) are confined to specific areas and are being suppressed in most parts of the world. The fundamental differences between the two knowledge paradigms are characterized by an old African proverb which states *"when a knowledgeable old person dies, a whole library disappears".* Indigenous knowledge can provide currently constrained research and extension with low-cost solutions (Akegbejo-Samsons, 2009). Indigenous knowledge can also be defined as the information base for a society, which facilitates communication and decision-making. Indigenous information systems are dynamic, and are continually influenced by internal creativity and experimentation as well as by contact with external systems. (Flavier et al. 1995: 479).The basic component of any country's knowledge system is its indigenous knowledge. It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihoods.

To help cope with the negative impacts of anthropogenic climate change, local people employ traditional indigenous-knowledge based practices. Local indigenous knowledge includes defined knowledge of indigenous plant and animal species, especially drought-tolerant and pest-resistant varieties; water harvesting technologies; water conservation techniques to improve water retention in fragile soils; food preservation techniques such as fermentation, sun drying, use of herbal plants, ash, honey, and smoke to ensure food security; seed selection to avoid the risks of drought; mixed- and or intercropping and diversification; soil conservation through no tillage and other techniques; use of early warning systems to predict short, medium and long term climate changes; transhumance to avoid draught and risk loss of livestock; herd accumulation; use of supplementary feed for livestock; reserving pasture for use by young, sick and lactating animals

in case of drought; disease control in livestock and grain preservation; use of indigenous techniques in the management of pests and diseases; culling of weak livestock for food; and multi-species composition of herds to survive climate extremes. This local based knowledge, which has evolved over the last 10,000 years with the domestication of plants and animals is critical for responding to climate change related risks at the local level (FAO, 2009; Agrawal, 2008; Thorne, 2008; United Nations Development Group, 2008; Arafa *et al*, 2007; Nyong *et al.*, 2007; Osman-Elasha and Downing, 2007; Republic of Kenya, 2007; Leautier, 2004 in Boko *et. al.*, 2007; and Otieno, 2002)

Climate change most marked impact is water scarcity, which is one of the vital natural resource that plays different roles from provision of basic services and sanitation, to irrigation and food production, ecosystems protection and hydropower generation. Water resources are important for socio-economic development as well as climate change adaptation. The use of mobile phones, the Internet, community radio and participatory video are increasingly part of climate change responses. Indeed, ICTs have the potential to foster inclusiveness and participation in the design and implementation of adaptation processes; in providing opportunities for capacity building, access to relevant information & social networking; technology transfer to strengthen local livelihoods and enhance natural resource management.

1.1 PROBLEM STATEMENT

Climatic change and variability will especially be pronounced and important in the dry land regions, roughly two-thirds, of the African continent with a population of approximately 50 million people (World Bank, 2000). It is further projected that under a range of climatic scenarios, there will be an increase of 5-8 percent of arid and semiarid land (IPCC 2007). These scenarios coupled with the relatively warmer climate (UNESCO 2007, Galvin et al., 2001), low per capita incomes, inadequate preparedness by most African governments and poor current information and slow technology change (Mendelssohn 2000), widespread poverty, recurrent droughts, inequitable land distribution and over dependence on rain-fed agriculture (IPCC, 1998; Hulme 1996) makes Africa the most vulnerable in terms of mitigation and adaptation to climate change.

In Kenya, temperatures have risen by 1°C over the past 50 years (GoK, 2009) and warming is expected to accelerate with temperatures rising by nearly 3°C by 2050 (IPCC, 2007). It had been established that rains used to fail every nine or ten years (UNEP/GoK, 2005). The cycle seemed to have reduced to five years (GoK, 2009). Most recently, the country is experiencing droughts every two or three years (according to The Economist on East Africa Drought, 2009).

Nationwide, Kenya is very sensitive to the described climatic change. Water as the primary resource affected by climate change is already stressed to scarce (FAO 2010a; World Resources Institute 2008). In addition, Kenya's economy is highly dependent on reliable rain for agriculture and electricity generation (FAO 2010b; KenGen 2011). The purely rain fed agricultural sector contributes 23% to the national GDP (World Bank 2010).

The recent droughts had severe impacts on the country's agriculture and food security (Economist 2009; GoK 2008a; Jha 2009). For example, the droughts of 1999/2000 resulted in 4.7 million Kenyans facing starvation (GoK 2010). The Government of Kenya citing "unofficial reports"

states that “the 2006-2009 successive drought episodes caused 10 million people - over a fourth of the country's population - to starve” (GoK 2010:101)

Besides droughts, floods pose a threat to food production, human and animal lives in Kenya. In early 2010 floods caused by heavy rainfall killed 15 to 20 people, aggravated the food situation and forced the Kenyan government to ask for international help (BBC 2010). In addition to the direct killing of people, floods also have medium to long term effects. As stagnant water serves as a breeding ground for mosquitoes, floods increase the spreading of diseases such as Malaria (Oluoko-Odingo 2010; Pascual et al. 2006; UNDP 2007; UNEP 2009) and hence it affects the health of the local populations.

Long term changes in the patterns of temperature and precipitation, that are part of climate change, are expected to shift production seasons, pest and disease patterns, and modify the set of feasible crops affecting production, prices, incomes and ultimately, livelihoods and lives.

Indigenous knowledge systems were altered and disrupted in Africa during the colonial period. This disruption is currently perpetuated by the inequitable north -south political and economic system where indigenous knowledge systems are often ignored, under -valued or replaced by colonial, state practices. Moreover, indigenous knowledge systems (IKS) content and development in Africa are not adequately researched and documented (Kolawole, 2001)

The oral and rural nature of IK in Africa has made them largely invisible to the development community and global science. Indigenous knowledge has often been dismissed as unsystematic and incapable of meeting rapid economic growth needs of modern world. Historically, modern societies have regarded indigenous people and tradition as less progressive, and as a result many groups of indigenous peoples, especially their younger generations, are influenced to devalue their native cultures and to adopt new lifestyles and technologies.

Indigenous peoples are the ones affected by the climate change the most, though having contributed least to its causes. This is largely as a result of their historic dependence on local biological diversity, ecosystem services and cultural landscapes as a source of their sustenance, wellbeing, and resilience. All around the world, indigenous populations have lived in perfect harmony with nature. Over long period of times these populations have acquired knowledge about the inner workings of their immediate surroundings or environment.

Moreover, indigenous knowledge provides a crucial foundation for community-based adaptation and mitigation actions that can sustain resilience of social-ecological systems at the interdependent local, regional, and global scales. However, this knowledge is highly held in tacit form making it difficult to access or even disseminate. Information and knowledge are now recognized as key components in climate mitigation and adaptation but discussions are still going on the role of ICT tools e.g. (community radios, mobile phones and social media) in climate change strategies. Currently, many indigenous knowledge systems are at risk of becoming extinct because of rapidly changing natural environments and cultural changes on a global scale. These practices vanish, as they become inappropriate for new challenges or because of adapting too slowly. Also, the intrusion of foreign technologies causes the disappearance of the rich indigenous knowledge. The loss of the rich indigenous knowledge is most obvious to the Indigenous people who have developed it and make a living through it. But the implication for others can be detrimental as well, when skills, technologies, artifacts, problem solving strategies and expertise are lost. That is why, coming up with a way of integrating the rich knowledge from the indigenous people into a form that can easily be accessed, disseminated, stored and retrieved can really help future generations in mitigating, coping and adapting to climate change and variability.

Lessons can be drawn from specific attributes of indigenous practices which include good social networking and sharing of new ideas, community participation, use of low-cost locally available materials in crop production and storage facilities, crop diversification and biodiversity conservation, caring abilities and high level of risk awareness. Climate change and variability impacts therefore calls for the need to redefine the way in which we understand and approach development challenges as well as identification of new ways of solving problems, making decisions, accessing and processing information, and of applying knowledge to agricultural practices in order to achieve more adaptive production systems.

1.2 JUSTIFICATION

While the importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, little has been done to incorporate this into formal climate change mitigation and adaptation strategies.

Although indigenous peoples constitute one of the largest vulnerable segments in contemporary society, they and their knowledge systems have been marginalized mainly because of the craze for modernity and globalization. The distinct culture of indigenous people and their identity, their economic activities, religious beliefs, notions, and traditional ways of managing natural resources are often regarded as backward and superstition. They are considered to be absolutely incompatible with modern society and development.

Indigenous knowledge systems have not to a very long extent been captured and stored in a systematic way and are therefore endangered with extinction. The lust for modernity and new technologies are threatening the loss of a great store of knowledge held by native people. A good number of indigenous groups in Africa and elsewhere in the world have suffered from long-term discrimination, inequity and exclusion from planning and execution of development

programs and projects. The main reason for IK not been captured and stored in a systematic way is that, it is handed down orally from generation to generation

The advancement of research on climate change and variability and its impacts on agriculture particularly in dry land areas has played a key role in development of both tactical and strategic means to buffering the impacts associated CCV. However less emphasis has been laid on indigenous knowledge, skills, experiences and adaptation strategies held by local people as a basis for informing development of sustainable approaches to minimize the risks imposed by climate change and variability (Suri 2009)

However, the existence of IK is threatened by the development process, and the World Bank states that indigenous knowledge systems are 'at risk of becoming extinct' (Ahmed, 1994). Kothari (1995) attributes this to the fact that oral paths are being blocked and people are no longer staying in homogenous community blocks. IK systems in rural communities are rarely documented. Thus, should the method of preservation and perpetuation be disrupted, there is a risk that within one generation, the knowledge could be lost forever (Warren, 1993). Given that Indigenous Knowledge is threatened with extinction, it is possible to justify the documentation. Development agents (CBOs, NGOs, governments, donors, local leaders, and private sector initiatives) need to recognize it, value it and appreciate it in their interaction with the local communities. Before incorporating it in their approaches, they need to understand it and critically validate it against the usefulness for their intended objectives. Moreover, indigenous knowledge forms part of the global knowledge. In this context, it has a value and relevance in itself. Indigenous knowledge can be preserved, transferred, or adopted and adapted elsewhere.

One of the best modern approaches to preservation of traditional knowledge is documentation in some permanent form and public accessibility. In addition to preservation, documentation and

dissemination of agricultural indigenous practices provides an effective tool for research and innovation. However, Lwoga et al (2010) observed that research libraries have not been particularly active in documenting Indigenous Knowledge. Nakata and Langton (2005) assert that libraries must consider indigenous knowledge not simply part of a historical archive, but a contemporary body of relevant knowledge.

Rational conclusions are based on determining whether Indigenous knowledge would contribute to solve existing problems of climate change and achieving the intended objectives. In most cases, a careful integration of indigenous and foreign knowledge would be most promising in solving the climate change crisis. On-going efforts to help communities adapt to the adverse effects of a changing climate are increasingly recognizing the role of ICTs and their potential in helping communities employ innovative approaches to prepare for, respond and adapt to climate change. ICTs are the most inclusive infrastructure on the planet, with 90% of the world population connected to mobile services and over one third connected to the Internet. ICTs play a pivotal role in monitoring, predicting and detecting natural disasters. There is an important body of traditional knowledge and emerging adaptation and mitigation experiences that developing countries communities can share and disseminate with the help of ICT tools.

1.3 RESEARCH OBJECTIVES

1.3.1 Broad Objective

To contribute to the integration of indigenous knowledge with ICTs in coping with effects of climate change and variability on agriculture in Kajiado County.

1.3.2. Specific Objectives

1. Evaluate farmers' perceptions on the effects of climate change and variability on agriculture in Kajiado County.

2. Determine the existing agricultural production related Indigenous Knowledge used to cope with and adapt to climate change and variability.

3. Evaluate the level of application of ICTs in agricultural information use and dissemination.

4. Establish farmers' perception on most effective channels and modes of communication for dissemination of agricultural production related Indigenous Knowledge.

5. Evaluate the most appropriate ICTs and Non-ICTs channels and modes of communication on climate change impacts and adaptation strategies on agriculture.

1.4. Research questions

1. What is the perception of most farmers regarding the causes of climate change and variability?

2. Which are the climate change and variability effects already experienced and felt by most farmers?

3. How can ICTs be used to convert Indigenous Knowledge into more appropriate forms for decision makers and other key stakeholders groups?

4. Which type of Indigenous knowledge do farmers in the study areas apply in coping and adapting to climate change and variability?

5. Which ICTs are most preferred and used by most farmers for dissemination of agricultural information?

6. How can ICTs be used to package information resources in different ways for different groups of people?

8. What targeted communication strategies are needed to improve adaptability to climate change?

9. How can ICTs be used to develop and support the implementation of such communication strategies?

CHAPTER TWO

LITERATURE REVIEW

2.1. Climate change and variability status in Kenya

Across Kenya, the effects of climate change are wreaking havoc" (MEMR 2009b). The prolonged droughts of the past decade have threatened food security and societal stability, especially in vulnerable pastoral areas (Economist 2009; GoK 2007b; Jha 2009; UNDP 2007). There is "a critical need for adaptive measures to be undertaken" (MEMR 2009a).

Kenya, located on the equator, has a mostly temperate climate in the inland, a semi arid to arid climate in the northern part and a tropical climate along the coast (Ambenje 2011). The average annual mean temperature (between 1970 and 1999) is 23.9 °C with little variation throughout the year. The highest temperatures of about 35 °C are reached in North Kenya, while the lowest values of 10 °C and below are mostly found in the central-western parts of the country. Most of the annual rainfall of about 687 mm falls during the long rains from March to May and the short rains from October to December (McSweeney et al. 2008).

According to the IPCC temperatures in Kenya have risen by 1°C over the past 50 years (Christensen et al. 2007). Looking particularly at highlands Pascual et al. (2006) find a significant warming trend of 0.5°C since the end of the 1970s. This trend is in line with on the ground measurements. The country is warming at a rate roughly 1.5 times the global average (Christensen et al. 2007).

As for precipitation no statistically significant trend can be observed since 1960. Yet, the proportion of rain falling in heavy rainfall events has increased. These events are projected to

occur more often, resulting in a higher total amount of rainfall and an increase of rainfall variability (Christensen et al. 2007; McSweeney et al. 2008).

Temperatures are projected to increase up to 2.8°C until 2060 and up to 4.5°C until 2090 (IPCC 2007). The projected trend of increasing temperatures and less reliable rainfall increases the likelihood of floods and droughts in Kenya (Few et al. 2006; WBGU 2007). In arid and semi arid lands (ASALs), which make up 80% of Kenya's land area, droughts are a common phenomenon (GoK 2007b).

Kajiado County is a semi arid district mostly inhabited by Maasai (Nyariki et al. 2009). The Maasai predominantly practice pastoralism and to some extend engage in subsistence farming (Osunga 2009). Sufficient availability of pasture and water is critical for the Maasai to sustain their livelihood.

Ensuring food security amidst a changing climate is at the top of developing countries agendas. But most importantly is a matter of survival for the millions of farmers, fishers, herders and foresters whose livelihoods are highly vulnerable to the occurrence of extreme events, changing temperatures and unpredictable seasonality, among other stressors.

2.2. Indigenous people and knowledge

Indigenous knowledge is often perceived as historical and ancient practices of the African peoples, which is a problematic perception. The word indigenous has often been used to refer to specific groups of people defined by ancestral territories, collective cultural configuration, and historical locations (Angioni, 2003; Dei, 2002; Purcell, 1998; Turay, 2002).

Thus, indigenous knowledge is a process of learning and sharing social life, histories, identities, economic, and political practices unique to each cultural group. This reflects the uniqueness of

ways that specific societies make meaning of the world and how such forms of knowledge address local problems and solutions that are context specific.

As stated by Dei, Hall, and Rosenberg (2002), knowledge cannot be perceived as fixed categories, experiences, and social practices. Wane (2002), reiterates this dynamic nature of indigenous knowledge by noting that indigenous forms of knowledge have accrued over time, which is a critical aspect of cultures. Wane has argued that in the process of learning the old knowledge, new knowledge is discovered and this is what makes indigenous knowledge more dynamic.

Indigenous knowledge is developed and sustained through traditional education, which provides skills, trade training, and socialization avenues for many youths in Kenya today who never attended or dropped out of the formal school system. Common features in the process of knowledge transmission among most ethnic communities in Kenya occur within the context of family, community, clan tribe, and cultural age groups. It is a lifelong learning process involving progression through age groupings, seniority, and wisdom of elders (Mudimbe, 1988; Mungazi, 1996; Wangoola, 2002).

Indigenous knowledge is handed down from one generation to another through symbols, art, oral narratives, proverbs, and performance such as songs, storytelling, wise sayings, riddles, and dances (Dei, 2002; Mudimbe, 1988; Semali, 1999; Turay, 2002). In most rural, arid, and semi-arid parts of Kenya, especially in communities where formal education has had insignificant impact, oral art remains the most important means of transmitting knowledge and skills as a way of maintaining societal continuity from one generation to the next.

Indigenous knowledge possesses chronological and landscape-specific precision and detail that is often lacking from scientific models developed by scientists at much broader spatial and temporal scale, including those used to understand the magnitude of climate change consequences. The last

IPCC Assessment (AR4, 2007) noted that indigenous knowledge is "*an invaluable basis for developing adaptation and natural resource management strategies in response to environmental and other forms of change.*" This was reaffirmed at the 32nd Session of the IPCC in 2010: *"indigenous or traditional knowledge may prove useful for understanding the potential of certain adaptation strategies that are cost-effective, participatory and sustainable."* Previous IPCC Assessments, however, were unable to access this type of information because, for the most part, traditional knowledge either appears in grey literature outside of peer-reviewed academic forums, or remains in oral form, thereby falling outside the scope of IPCC process.

Indigenous people are spread across the world from the Arctic to the South Pacific; they are the descendants of those who inhabited a country or a geographical region at the time when people of different cultures or ethnic origins arrived. The new arrivals later became dominant through conquest, occupation, settlement or other means. It is estimated that there are more than 370 million indigenous people spread across 70 countries worldwide. Unfortunately, valuable insights held by indigenous peoples worldwide about direct and indirect impacts of, as well as mitigation and adaptation approaches to climate change, remain largely unrecognized. This is particularly apparent in the Intergovernmental Panel on Climate Change (IPPC) Assessment Reports released every few years. There are still debates going on and conclusions regarding indigenous people and the knowledge they hold. They include;

1. Indigenous peoples and rural populations are keen observers of their natural environments.
2. Indigenous knowledge, although new to climate science, is a product of millennia of human co-evolution with environment. It has been long recognized as a key source of information and insight in disciplines such as

agro forestry, traditional medicine, biodiversity conservation, customary resource management, environmental impact assessment, and natural disaster preparedness and response.

3. Indigenous observations and interpretations of weather and climate are at a fine scale, have considerable temporal depth and highlight elements that may be marginal or even new to scientists. They focus on elements of significance for local livelihoods, security and well-being, and are therefore essential for climate change adaptation.
4. Indigenous peoples' observations contribute to advancing climate science by ensuring that assessments of climate change impacts and policies for climate change adaptation are meaningful and applicable at the local level.
5. Indigenous responses to climate variation typically involve changes to livelihood practices and other socio-economic adjustments. Strategies such as engaging in multiple livelihood activities and maintaining a diversity of plant varieties and animal races provide a low-risk buffer under uncertain weather and climate conditions. The ability to access multiple resources and rely on different ways of using the land, contributes to local capacities to manage for climate change.

Traditional systems of governance and social networks improve the ability of indigenous communities to collectively manage diversity and share resources, while dissipating shocks and reinforcing innovative capacities.

2.3. Information communication technology (ICT)

ICTs are a unique platform for progress that creates wealth, optimize the use of natural resources, enables a low carbon economy and give equitable access to basic public services, such as health

care and education. Integration of the indigenous knowledge with the modern ICT's will enable the following; advances understanding of climate change vulnerability, adaptation and mitigation related to indigenous peoples, collates, and makes it available to the global community, information important for understanding local-scale climate change impacts, adaptation and mitigation involving local and indigenous knowledge holders, engages indigenous peoples in international climate dialogues and debates, provides policymakers with relevant information on the vulnerabilities, knowledge and adaptive capacity of indigenous peoples.

For decades, "traditional" forms of ICTs have been used in advisory service provision. Radio and TV programs regularly feature weather and agricultural information in developing countries, and rural telecenters have provided information on price and quality (Goyal 2010).(Aker and Mbiti 2010).

Some of the ICT services used by farmers include;

1. Voice-based information delivery services primarily include telephone based information delivery services that provide advice on farming methods and market access. Some of these services use call in centres or hotlines for agricultural extension support. The mechanisms range from the use of a simple telephone – community fixed phone or mobile – to more complicated technology and computing applications for the provision of the requisite information service (FARA 2009).

2. Radio dial-up and broadcasts include regular radio broadcasts that provide market prices or other agricultural information, as well as dial up radio that feature a series of short segment audio programs. The radio system usually features a regularly updated menu of pre recorded agricultural content. In some cases, the systems allow farmers to ask questions via SMS and the responses are disseminated via the radio (FARA 2009).

3. SMS-based extension services essentially use message-based platforms to collect and disseminate information. This includes data collection via a simple SMS-based questionnaire; sending an SMS-based code to request potential information (on market prices or for simple agricultural questions) and receiving the response via SMS; and receiving mass SMS on agricultural topics.

4. E-learning programs typically include telecenters and internet kiosks that allow farmers to access computers and the internet for agriculture-related information.

The information provided via these different mechanisms includes market prices, weather, technical advice and suppliers and buyers in local markets. A majority of these services focus on market prices, weather and transport costs. Projects that provide information on agricultural practices and inputs are relatively rare, possibly because such information is more nuanced and difficult to convey.

Information and communication technologies (ICTs) not only help advance weather forecasting and climate monitoring, but are also essential in disseminating information to large audiences, for example via portals and mobile phones. This can help address major adaptation challenges, such as food and water shortages through providing early warning systems and better monitoring of soil conditions and water quality. In addition, ICTs could be used to inform decisions and to coordinate efforts during climate change events, and to strengthen social networks, inclusiveness, and processes of learning and self-organization. This could lead to new strategies and innovative policy approaches in the climate change field, especially with respect to the management of water resources. Ensuring that information and knowledge flows are bidirectional, with the development of mechanisms in which formal, rigorous, research-based data and information can be integrated with bottom-up, community-generated information.

ICT components can be used to achieve the following roles in the integration of Indigenous knowledge; Enables capturing, storing and sharing of indigenous knowledge, Support the incorporation of indigenous knowledge with modern scientific and technical knowledge, Create easily accessible indigenous knowledge information systems, Promote integration of indigenous knowledge in formal and non-formal training and Provide a platform for advocating for improved benefit of the poor from their intellectual property rights and indigenous creators. The following are the various ways in which ICT components can be used in the integration of Indigenous Knowledge;

(a) ICTs used to Archive and Disseminate Collective Memory

Maintaining and sharing a collective memory is an important component of cultural identity. By helping to record and disseminate local practices and traditional knowledge, ICT tools can contribute to the preservation of traditions and the inter-generational transference of cultural values.

(b) ICTs used to Produce, Access & Apply Relevant Knowledge

The ability to produce and disseminate local content, as well as to access information and knowledge that responds to local priorities contributes to strengthen cultural identity and decision-making processes in the face of climate change. ICT tools can facilitate the production of local content in creative, user-friendly formats an example of (photo-stories and audio blogs), as well as the translation of relevant scientific content into local languages, fostering the participation of communities in adaptation processes.

(c) ICTs used to Foster Diversity

Diversity is one of the main attributes of resilient systems, and also an important component of strong cultural identities. ICT tools –such as Web pages, online communities and radio programs- can be used to give a voice to local diversity, by sharing the adaptation needs and experiences of diverse members of the community. ICTs can also facilitate the sharing of new and traditional adaptation practices between communities at the regional, national and global level, fostering dialogue, learning and tolerance between diverse groups. ICTs can also be used in support of alternative adaptation practices that are linked to traditional customs (such as the diversification, protection and exchange of seeds).

(d) ICTs used to Strengthen Social Networks & Self-organization

The use of mobile phones, text messages, and e-mail and community radio can contribute to supplement and strengthen social networks, including the interaction and preservation of cultural links with migrant or geographically dispersed community members who play a key role in mobilizing support and helping locals to cope with the effects of climatic disturbances. Tools such as Geographic Information Systems (GIS) and Web-based mapping applications can contribute to the monitoring of local resources, facilitating the self-organization of community members around the protection of water sources, forests and other common interests.

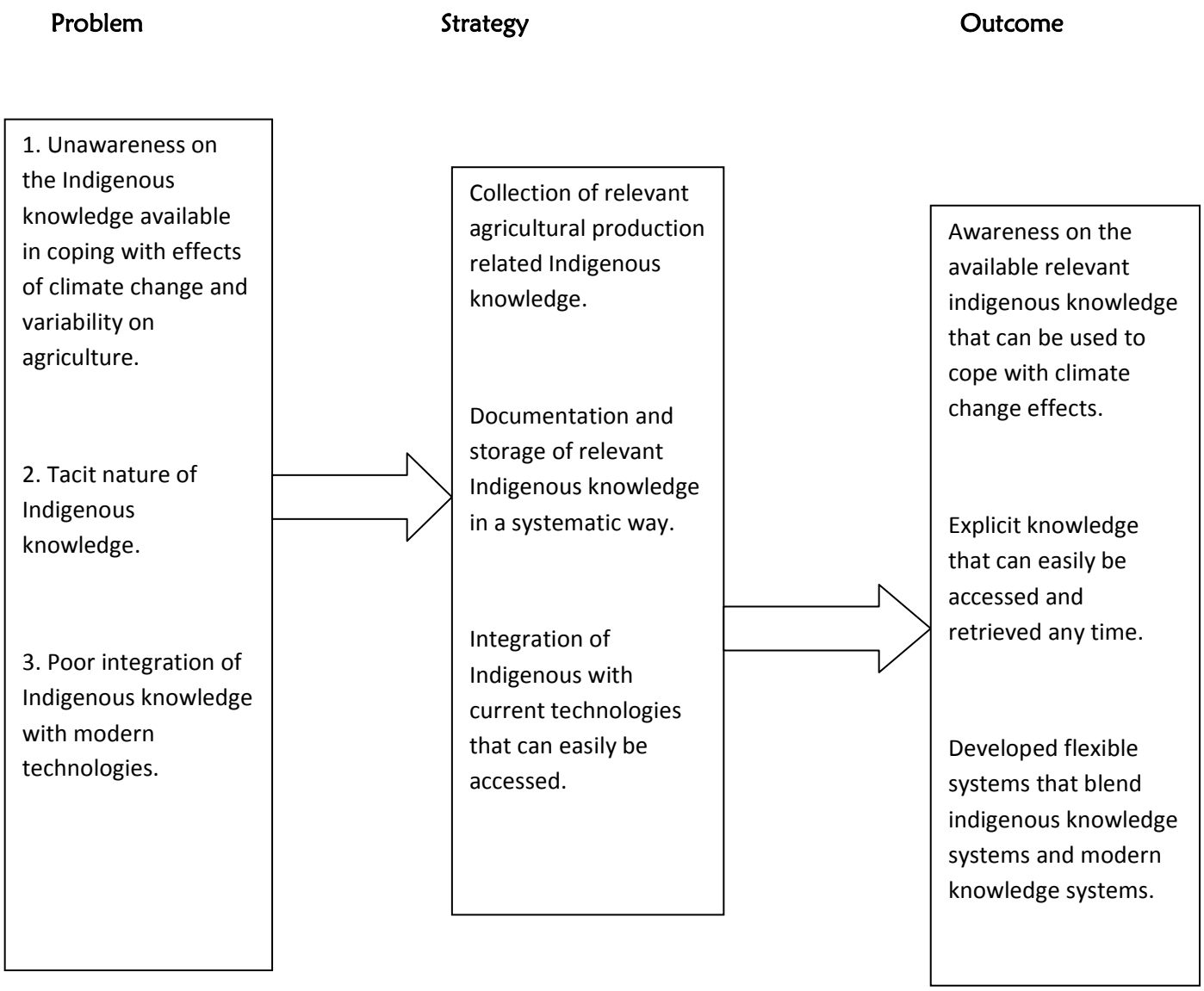
(e) ICTs used to Empower Youth

New generations play a pivotal role in the continuity, re-construction and renewal of cultural identities. ICT applications such as online training can help to strengthen the capacity and the confidence of local youths to adapt to the changing circumstances posed by climate change. ICTs tools can also provide access to relevant information about rights and responsibilities in the

management of natural resources, fostering youth leadership and pro-active engagement in these processes.

Ultimately, ICT-enabled information and knowledge should contribute to inform the decision-making processes of local actors, to strengthen their capacity to deal with uncertainty, and to build new bridges of collaboration and exchange towards more resilient, food-secure agricultural systems. Not only many of their native languages are in danger of extinction – if not already extinct, but also, a limited amount of their wisdom has been documented and too little has been done to preserve it. Indigenous peoples (e.g. nomadic herders) are often affected by climate change.

2.4. CONCEPTUAL FRAMEWORK



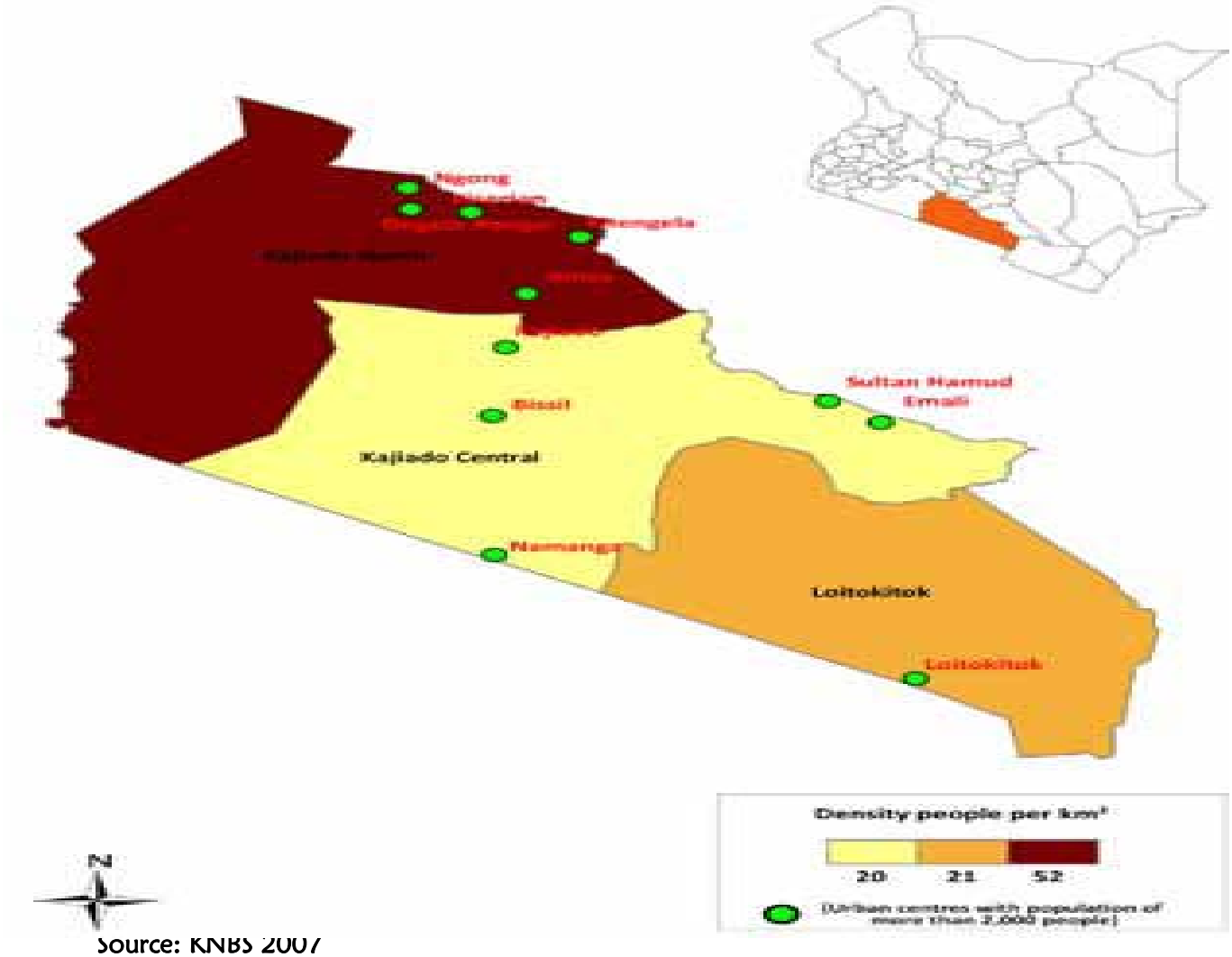
The diagram seeks to show the existing research problem, ways of tackling and finally what can be achieved at the end of tackling the problem.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study Area

3.1.1. Kajiado County Map



Source: KNBS 2007

3.1.2. Location and geo-physical characteristics

Kajiado County formally Kajiado District has an area of 19600 km^2 (CBS, 1981). It is roughly triangular, and is bordered by the Nairobi-Mombasa railway to the north-east, borders with Tanzania to the south, and the western wall of the Rift Valley to the west. The eastern boundary is formed by the Chyulu Range and western limit of Tsavo National Park. The county has been divided into four eco zones: the Rift Valley, the upland Athi Kapiti Plains, the Central Hills, and the Amboseli Plains (Republic of Kenya, 1982). Most of Kajiado county lies in the semi-arid and arid zones (zones V and VI) Only 8% of the county's land is classified as having some potential for rain fed cropping (zone IV): most of this is in the Athi-Kapiti Plains, close to Nairobi, and in the south of the county, along the Kilimanjaro foothills.

This study was conducted in Kajiado central district; Oloyiangalani and Kumpa location, and in Kajiado south district; Rombo Location. The study areas comprised of pure pastoralists and agro-pastoralists. Different economic activities are carried out in the selected areas which are largely impacted by climate change.

3.1.3. Climate

There are few permanent natural sources of surface water in Kajiado County. The main ones are the Ewuaso Nyiro River in the Rift Valley, two streams in the northern part of the Athi-Kapiti Plains, the Kiboko River which drains much of the Central Hills and the northern part of the Amboseli eco zone, and several springs in the southern part of the Amboseli zone. The Kiboko River is not strictly a permanent source of surface water, but water is available year-round from shallow wells in the river bed. Mean annual rainfall ranges from 300 to 800 mm. Rainfall is

bimodal, with short rains from October to December and long rains from March to May. The distribution of rainfall between the two seasons changes gradually from east to west across Kajiado County. In eastern Kajiado, more rain falls during the short rains than during the long rains. The temperatures in the county also vary according to altitude. Mean maximum temperatures of 34ºC around L. Magadi and a mean minimum of 10ºC on the foothills of Kilimanjaro have been recorded. Moisture deficit is also observed in the greater part of the year. This gives the county a dry season of between 7-9 months. The climate scenario in the county indicates that the bulk of the area (with annual rainfall of 700- 850mm), is suitable for ranching. Very small strips near Ngong, Sultan Hamud, Namanga and Chyulu Hills and a larger one on the foothills of Mt. Kilimanjaro, however, have potential for rain-fed agriculture.

3.1.4. Soils

The county consists of four geological regions: Quaternary Sediments, Quaternary Volcanics, Tertiary Volcanics and Basement System. There is a close relationship between the geological formation, topography and soils. The Quaternary Sediments consist mainly of alluvium associated with fluvial deposition. These occur mainly along river valleys and lake-beds, notably around Namanga/Amboseli area, Lake Magadi and Nguruman areas. The soils developed on these sediments are Fluvisols, Solonchaks, Solonetz, Cambisols and Vertisols (Soil Map Classification legend, FAO 1990). The Fluvisols are stratified soils and are fertile. The Solanchaks and Solonetz can only support grass and other vegetation species that are tolerant to high levels of salinity and sodicity. Vertisols are found in the low-lying areas which are subjected to seasonal water logging. As a whole these soils offer limited opportunities for both rain fed and irrigated agriculture.

The Quaternary Volcanics are found in Western side of the district, South-Eastern side (Loitokitok, Rombo, Mashuru and Kimana) and Chyulu hills. The Tertiary Volcanics are found around Ngong, Magadi and Kajiado town. The main rocks are olivine, pholonites, pyroclastics,

volcanic ash, tuffs and trachytes. The soils developed on these rocks vary widely in depth, colour, texture and drainage. These include Leptosols, Luvisols, Andosols, Nitisols, Vertisols, Cambisols and Phaeozems. Leptosols are shallow and have low water holding capacity and hence low productivity potential. The other soils are relatively fertile and of medium to high productivity potential for both crops and livestock.

The Basement System rock comprising various gneisses, schists, qurtzites and crystalline limestone are found mainly in Central part of the district and east of the Rift valley. These rocks give rise to a variety of soils such as Ferralsols, Luvisols, Arenosols, Regosols, Leptosols, Lixisols, Cambisols and Vertisols in low-lying areas. The Luvisols have a tendency to form a surface capping and hence are susceptible to soil erosion and high water run-off. The Cambisols and leptosols are shallow to moderately deep and their main limitation for crops and vegetation growth is shallow depth and low water holding capacity. Ferralsols are deeply weathered and are chemically poor, hence requires high input levels to improve their soil fertility for crop production. (Soil Map of the World – FAO, 1990.

3.1.5. Drainage

It is noted from the outset that the greater part of the county depends on ground water reserves. Limited surface water resources exist for livestock and domestic use. The major rivers in the district include; Athi, Ewuaso Ngiro, Olkejuado and Noolturesh. In this case construction of water dams and pans, boreholes and shallow wells are important means of accessing water in the district. Ground water yields vary throughout the district from 0.01 to 35.77 cubic metres per hour.

3.1.6. Vegetation

The main vegetation type in the county is determined by altitude, soil type and rainfall received in the different parts of the district. However, anthropogenic and animal causes have modified

the status significantly. Overgrazing, charcoal burning, extraction of fuel wood, forest fires and quarrying activities are some of the leading causes of this trend. Ground cover in the county varies according to seasons while the canopy cover ranges from 1% on the densely populated areas to 30% on the steep slopes. For grazers there is need to move over large areas in order to have enough grass for the animals while subdivision of land continue to restrict grazing capacity considerably. Browsers have more potential particularly in the northern part of the county.

Presence of invader species to vegetation has been noticed in Central division *(Ipomea Kituensis)* and in Namanga – Olkiramatian area (prosopis). These species not only colonises the vegetation but also reduce the grazing potential available to the livestock and wildlife. The main vegetation types in the county, comprises wooded grassland, open grassland, wooded bush land, bushed grassland and forest. Woody species include; *Acacia tortilis, Acacia xanthopholea, Acacia mellifera, Commifora schemperi, Balnites aegyptiaca, Balanites gabra, and Salvadora persica*. Grasses include; *Pennisetum mezianum, Pennisetum stramineum, Chroris roxburghiana* and *sporobulus angustifolia, Chloris guyana* and *Cenchrus ciliaris.*

3.1.7. Land Use

The total area in hectares for the county is 2,060,000ha which translates to 21,105 square kilometres and this is 3.5% of Kenya. Prior to the introduction of land adjudication in Kajiado, land in the county was trust land. Semi nomadic pastoralism has been the traditional Maasai mode of life carried out on land that was communally owned. Its use was closely and adequately regulated through communal rules and practices. Land tenure was vested in the local authority, the Olkejuado County Council (OCC) - which held it in trust for the local community.

Trends in land use change: Land and land use change over the years in the district, has been marked by turbulence as a result of both man-made and nature; events. The most important changes have been the loss of land and the loss of traditional mobility and flexibility characteristic

of pastoralism. The relationship between pastoralism, agriculture and hunting has been dynamic according to the environmental circumstances at any given time.

In the colonial era, Europeans occupied an area stretching along the Tanzanian border and divided the Maasai into the Northern and Southern reserves. The period between 1913 and 1950s, farming communities such as the Kamba and the Kikuyu moved in and started cropping in higher potential areas of Ngong and the foothills of Mt. Kilimanjaro. Although these areas were comparatively small, they were very important in providing the dry-season grazing and the opportunity for Pastoralist to go to agriculture during periods of drought.

Under the National Parks Ordinance of 1945, the Kajiado Maasai lost access to the Nairobi and Tsavo National Parks. It further established a game reserve in Amboseli (3248km. Sq.) restricting the use of these areas by the Maasai.

During the 1948-50 droughts, the County Council was allowed to restrict the cultivation of land through the Land Usage By-laws due to conflicts that arose between the Pastoralist and the farmers.

3.1.8. Water resources

Kajiado County entirely depends on groundwater reserves due to limited number of permanent rivers and reliable rainfall regimes. Boreholes and shallow wells remain the most widespread methods of accessing water in the district.

Water supplied to the county is far short of the estimated demand for the county. Provision of water for livestock is an important aspect in Kajiado County. There are limited surface water flows in the county. The major rivers in the county are; Athi, Ewuaso Ngiro, Olkejuado and Noolturesh. The greater part of the county depends on groundwater reserves in form of boreholes, dams, shallow wells and pans. Boreholes form the bulk of supply sources; however, most of the boreholes are broken down and are not in operation.

3.1.9. Crop farming

The total area of the county with arable potential is about 171,000 hectares (8.1% of the total area of the county). The actual area under cultivation is about 88,000 hectares (51.3% of total acreage of arable land). The main agricultural areas are found in laces with relatively high average annual rainfall (ACZ II-IV). This includes: Ngong hills area, Loitokitok area on the foot slopes of Mt. Kilimanjaro, Slopes of Nguruman escarpment (rain fed and irrigated), Slopes of Oldonyo Orok hill in Namanga, Western foot slopes of the Chyulu hills, Scattered patches in Central and Mashuru divisions, Scattered irrigation areas in parts of Loitokitok.

Farming is carried out mainly by immigrants (non-Maasai) but recently the Maasai are also taking up farming more seriously than in the past. The production systems range from subsistence to commercial. The commercial system is practiced in only 1.5% of total farmed land in the county. It is mainly for horticulture and is oriented towards the market. Under this system extensive use of inputs such as chemical fertilizer, certified seeds and pesticides are applied.

As for the trend, crop production has fluctuated over the past ten years due to weather uncertainties. In 1991, the production declined due to drought and in 1992-1995 the production improved and again declined due to unreliable rainfall.

The horticultural farming in the area between Kitengela and Isinya is becoming prominent and a major source of income and employment. The horticultural crops grown include onions, tomatoes and Asian vegetables.

In the recent past, there has been an increased interest in commercial farming especially of cupflowers in Isinya division. Production of Asian vegetables also has been increasing in Magadi as well as increase in production of vegetables in Loitokitok division. Drip irrigation is gaining popularity among small scale farmers who have sunk boreholes.

3.2.0. Population

Kajiado County is predominantly inhabited by the Maasai community but lately has a high influx of other communities in search of settlement and job opportunities. In reference to 2009 census the county has a population of 687,312 people.

3.2.1. Livestock

Traditionally, Kajiado county major economic activity is Semi-nomadic pastoralism. Over 75% of the population derives its livelihood from livestock production which account for about 60% of the total labour force. The lifestyle of the majority of the population depends on livestock and livestock products for subsistence.

Three livestock production systems are identified, namely: the group ranches, individual ranches and individual parcels, being the individual parcels that emerge from the dissolution of group ranches. The group ranches range from 3,000 to 15,000 hectares in size while individual ranches average 800 hectares. The main livestock reared are cattle and shoats (sheep and goats).

3.3. METHODOLOGY

3.3.1. Structuring of the survey

This study was conducted in Kajiado Central and South districts. During the initial stages, broad modalities of carrying out the study were discussed and agreed upon by the student and the supervisors. It entailed time allocation to various activities planned for carrying out the study, development of questionnaires, primary and secondary data collection, etc.

Primary data was collected through structured questionnaires. The enumerators were trained before being sent to the field for data collection. The data collected by enumerators were supplemented by the information collected through focus group discussions and key informants interviews.

From the questionnaires, the study generated the information on climate change and variability effects on agriculture which have been witnessed in the study areas, Indigenous skills and knowledge applied by the indigenous people in agricultural production, the available and most conversant ICTs and Non ICTs components in the study areas as well as most preferred communication channels.

Secondary data was collected from published sources such as books, journals and reports on previous studies.

3.3.2. Qualitative Information Collection

Main tools used to collect qualitative information were Focus Group (FGD) Discussion .FGD method which involved a group of 8-12 informants to freely discuss a subject with the guidance of a facilitator and a reporter. Key informant interviews were also undertaken. Purposive sampling was used to select the participants of the focus group to ensure well representation of the discussion.

3.3.3. Quantitative Information Collection

Face to face interviews were conducted with individual respondents in households. A structured questionnaire was used to guide the interviews. The questionnaire consisted of closed, partially categorised and open ended questions. All the questions were coded in order to simplify data entry and analysis. The questionnaire consisted of four (4) key sections for capturing (i) socio-economic information (ii) climate change and variability; based on past experiences,

perception/knowledge/awareness, impacts on agriculture, (iii) indigenous techniques, skills of coping with climate change effects on agriculture , indigenous early warning systems and (iv) the types of ICT available and the level of familiarity with the Indigenous people

3.3.4. Sample framework

There are various ways for determining the required sample size. This is based upon whether the data collected is to be of a categorical or quantitative nature (e.g. is to estimate a proportion or a mean). Other considerations include available resources in terms of funds and time. Generally there is consensus among scientists that any sample size larger than 30 sampling units is sufficient. A total of 100 questionnaires in Rombo Location and 100 questionnaires in Kumpa and Oloosuyian Locations were administered.

3.3.5. Sampling procedure

Stratified random sampling procedure was used to collect the Indigenous Knowledge data. The goal of stratified sampling was to achieve desired representation from various communities in the population. This was done by dividing the population in each location into two or more subpopulations using given criteria, and then a simple random sample was taken from each subpopulation. For Kajiado central, two locations namely Oloyiangalani and Kumpa Locations were sampled into smaller populations then obtained a random sample from the sub populations who were interviewed. For Oloyiangalani location, 50 household heads were randomly selected from the sub populations for the individual questionnaire. 50 respondents were also randomly selected from Kumpa location. In Kajiado South, Rombo location, 100 people were randomly selected.

3.3.6. Data entry and analysis

The collected data were analyzed using Statistical Package for Social Sciences (SPSS). Data collected through personal interviews were subjected to descriptive analysis. The information on changing aspects of climate, impacts of climate change on agriculture, Indigenous strategies used and the type of ICTs used as sources of information were summarized in terms of frequency tables, charts and graphs.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The chapter presents the study findings and interpretation. It mainly comprises of general descriptive statistics.

4.1. Results

4.1.1. Objective 1: Evaluate farmers perceptions on the effects of climate change and variability on agriculture in Kajiado County

This objective was undertaken to evaluate farmers' perception regarding climate change and variability effects. Farmers were asked if they have heard or experienced climate change in their localities, perceived causes of climate change and the most felt impacts of climate change on agriculture.

The results indicated that 100% of the respondents have heard and experienced effects of climate change and variability on their localities. Deforestation was thought by the farmers to be the highest contributor of climate change and variability, followed by pollution and global warming as the main causes of climate change having been reported by 112, 38, and 21 respondents respectively. Sand harvesting, soil erosion and overstocking were thought as least contributors of climate change having 3 respondents each while 20 of the households didn't know at all the causes of climate change and variability. (See fig 1). This implies that most farmers have felt the changing climatic conditions but don't understand or rather know the causes of such changes which could have been attributed by high illiteracy levels and poor sources of information leading to low awareness levels.

The farmers interviewed reported that, reduced crop yield, change in planting time, increase in crop pest and diseases, flooding of crop fields and reduced soil moisture were the highest climate

change impacts in agro pastoralists' as compared to the pastoral areas. High crop/pasture failure was reported to be very high in pastoral area than in the Agro pastoral which may be attributed by low mean rainfall compared to agro pastoral area which receives higher mean rainfall. (See fig 2) At the off-farm level, insufficient food, high food prices, human wildlife conflict and competition over resources were highly felt in agro pastoral areas compared to pastoral areas. This could have been attributed by high population rate in agro pastoral areas, reduced crop yield and nearness to the Tsavo national park leading to high human wildlife conflict. (See fig 3)

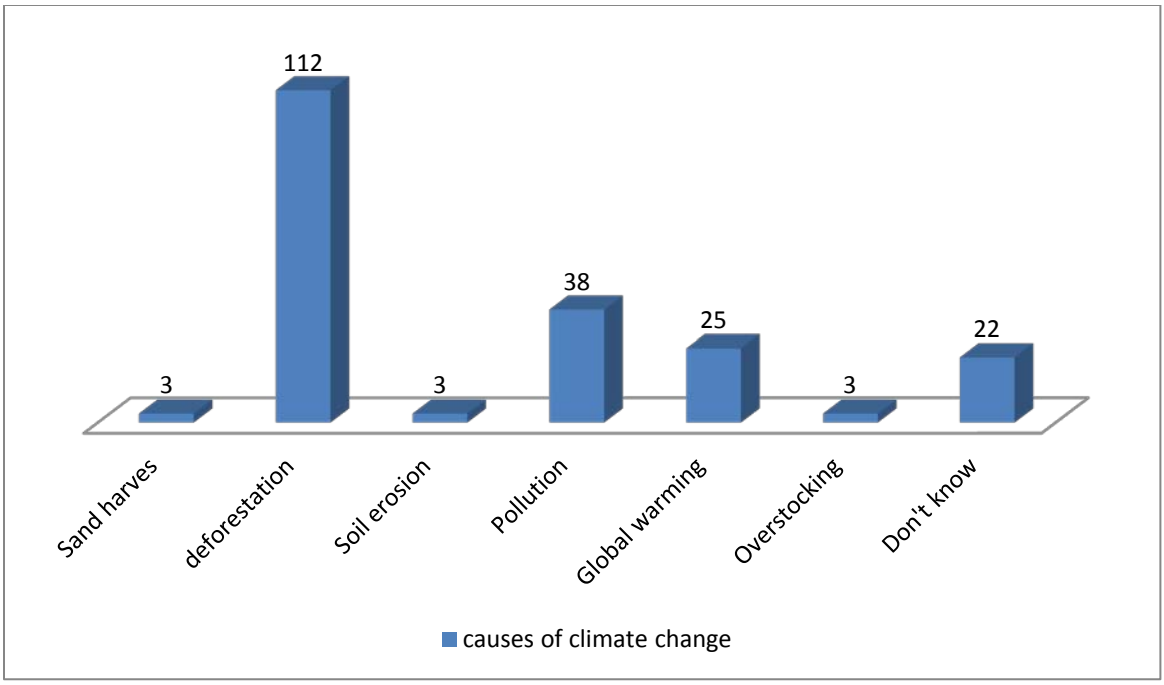


Fig.1 Perceived causes of climate change

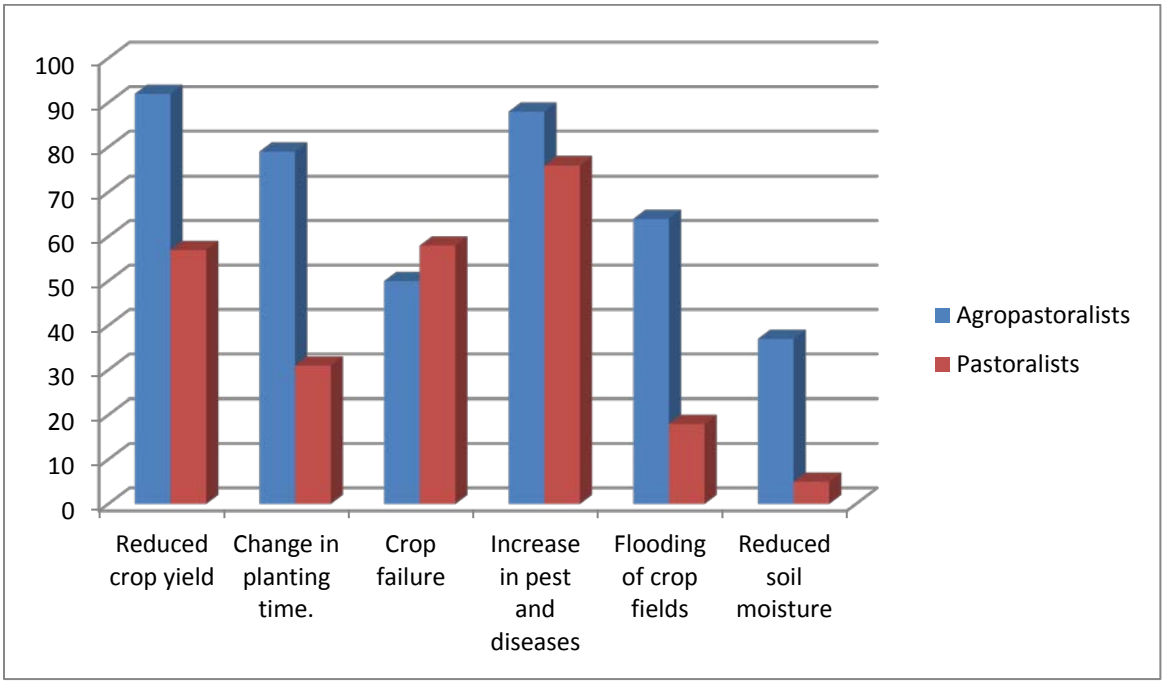


Fig. 2 Climate change and variability impacts at the farm level

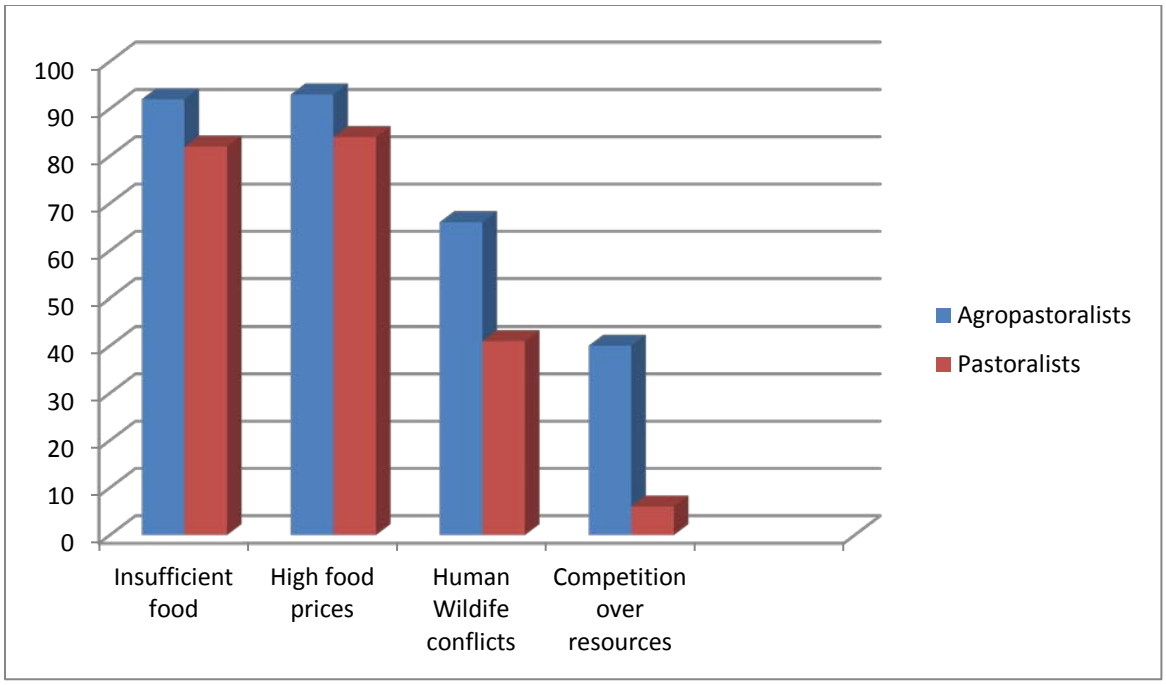


Fig. 3 Climate change and variability impacts at the off farm level

4.1.2. Objective 2: Determine the existing agricultural production related Indigenous Knowledge used to cope with and adapt to climate change and variability.

The objective was carried out to find the level of indigenous knowledge usage by farmers and why they prefer to use indigenous knowledge and specific agricultural indigenous knowledge strategies used by farmers in the management of their farms to address impacts of climate change and variability.

The results indicated that, 98% of farmers still apply Indigenous knowledge in the management of their farms while 2% don't use it all. The reason behind being traditional approach is 53% reliable, 19.5% accurate, 14% used to it and 13.5% cheaper. (See fig 4.)

In addition, indigenous strategies practiced by the agro pastoralists more than the pastoralists were agro forestry, irrigation, planting of appropriate crop varieties, preservation of pastures, application of organic and inorganic fertilizers and soil and water conservation. On the other hand, pastoralists practice more of migration, planting of drought tolerant crops, rain water harvesting, keeping of drought resistant animals and management of pest and diseases. (See the table 4.1.) During the Focus group discussions, it came out clearly that the agro pastoralists are no longer practicing migration as compared to ten years ago while the pastoralists are now practicing it more due to frequent prolonged droughts and lack of pasture preservation. The FGD results also indicated that women from pastoral areas prefer other strategies in coping with drought such as use of shallow wells to draw water, separation of livestock to control breeding as compared to the men who prefer migration of animals during drought in search of water and pastures. This could have been attributed by the facts that, during migration of livestock and people, women and children are left behind while men and boys move with the cattle. From the FGD also, it was clear that women from agro pastoralists' areas practice indigenous strategies such as traditional methods of food preservation. Use of organic manure in their farms, crop rotation and paddocking. This explains the different activities practiced in both areas. The agro

pastoralists produce their own agricultural food hence conversant with food preservation methods and with the few cattle they keep, they use the organic manure to enrich their soils for optimum food production. It was also clear that men from both areas are used to using traditional herbs to treat certain livestock diseases more than the women. This explains that men are the ones responsible for their cattle and they are the ones who also know specific traditional herbs to be used for treating specific diseases.

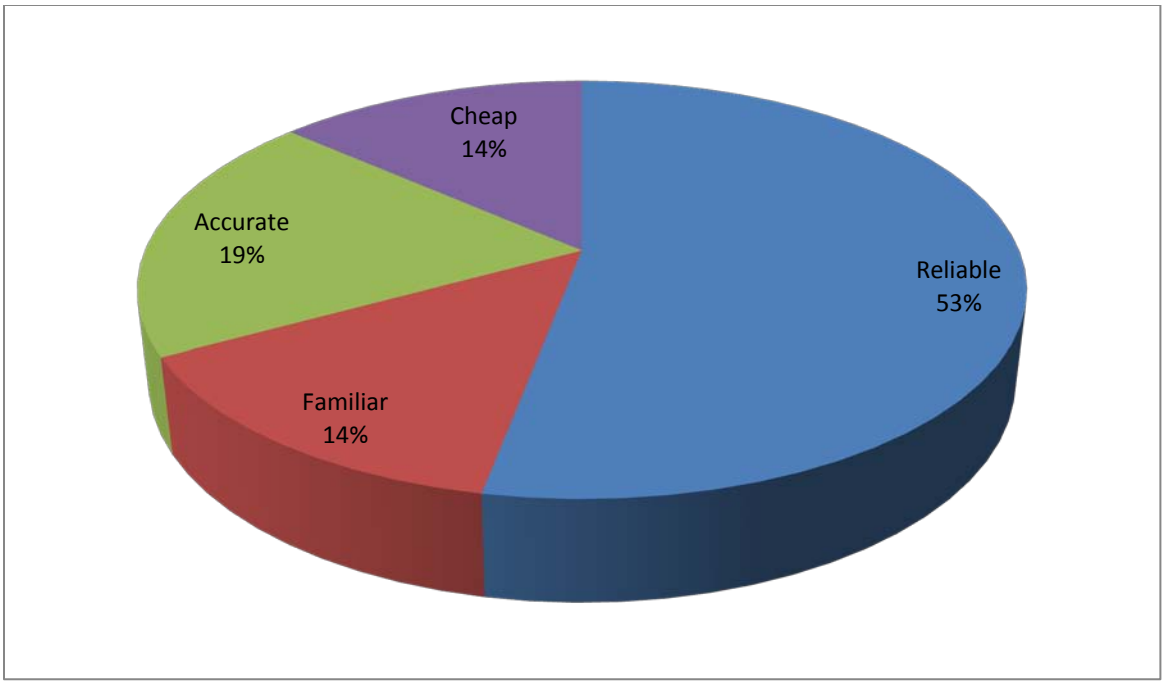


Fig. 4. Reasons for farmers preferring traditional approach of weather forecasting over the scientific approach

Table 4.1. Indigenous Strategies practiced by the respondents in adaptation of climate change and variability.

Variables	Agro pastoralists	Pastoralists
	Percentage	Percentage
Agro forestry	9.18 %	7.7%
Drought tolerant crops	11.6 %	12 %
Rain water harvesting	6.28 %	14.3%
Drought resistant animals	11.1%	17%
Irrigation	24.6%	2%
Management of pests &diseases	4.83 %	18 %
Application of fertilizers and inorganic input	1.96%	1 %
Planting appropriate crop varieties	14.0%	4 %
Use of different cropping systems	2.4%	3.7%
Preservation of pastures	4.4%	0%
Migration of livestock and people	4.34 %	19.3 %
Soil and water conservation	5.31 %	1%
Totals	100%	100%

4.1.3. Objective 3: Evaluate the level of application of ICTs in agricultural information use and dissemination.

This objective was to find out if famers are using ICTs as sources of agricultural information. The farmers were asked types of ICT used and the reasons for the most preferred ICT as source of information.

Out of all the farmers interviewed, 45% use radio, 30% use mobile phones, 5% use Tv, 3% use internet, 2% use newspaper and 10% didn't know the use of any ICT as a source of information. (See fig 5.) Radio was the most preferred ICT component as source of agricultural information because it is 50.5% user friendly. 31% cheap, 9.5% portable, 5% informative and 4% others (doesn't require power, uses local language). (See fig 6.)

In addition, FGD results from the men, women and youth, showed that the most relied ICT components as sources of information were the radio, mobile phone and TV in that order. It was also clear that, most youth are able to access the internet through their mobile phones but don't use it for any of agricultural related information but for other purposes such as entertainment.

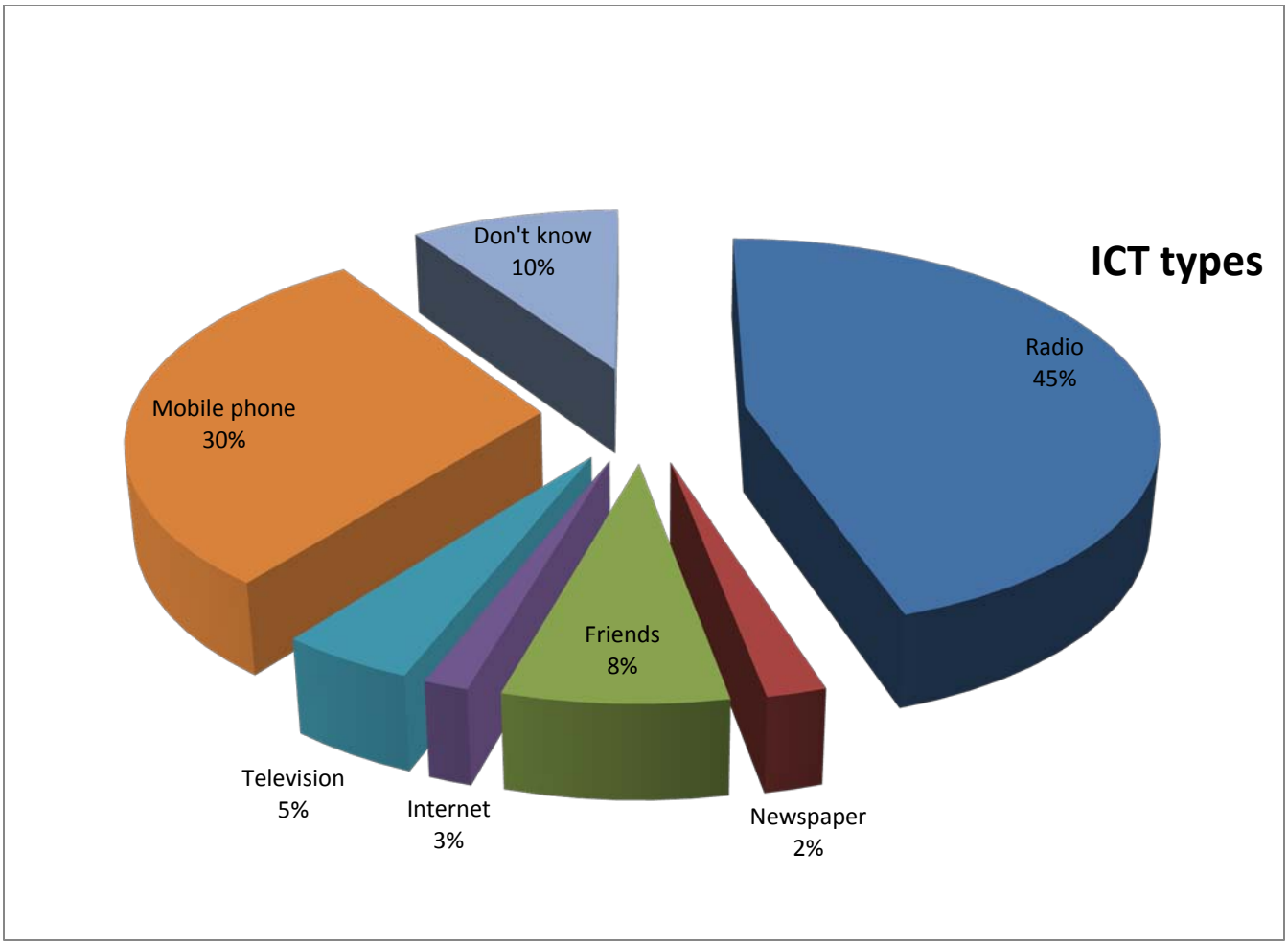


Fig. 5 ICT materials used by farmers as sources of information for the management of their farms

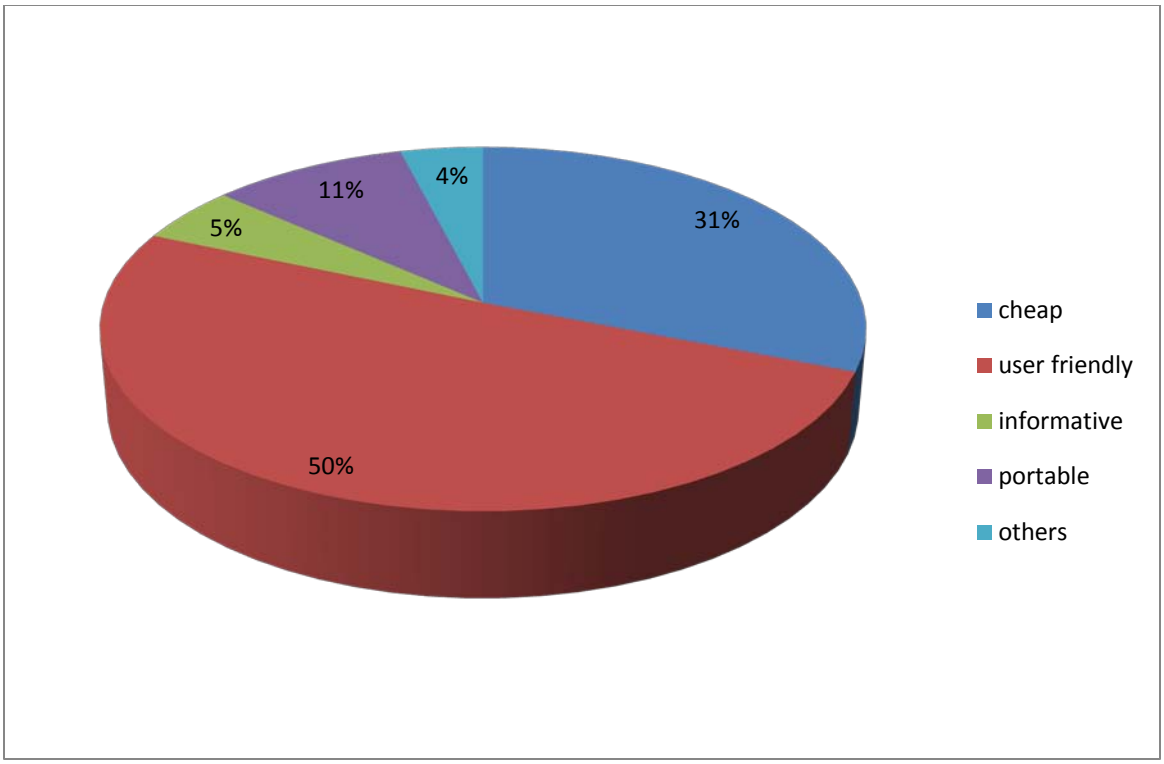


Fig. 6 Reasons why Radio is the most preferred source of information

4.1.4. Objective 4: Establish farmers' perception on most effective channels and modes of communication for dissemination of agricultural production related Indigenous Knowledge.

This objective was carried out to know how the farmers would like to disseminate IK to other people. The farmers interviewed were asked on how IK can be strengthened and adopted nationally.

From the results, 35% of the farmers suggested use of magazines, journals for publishing of IK to be disseminated countrywide, 26.5% thought use of programmes through Radio and TV to disseminate IK, 19% believed that IK knowledge can be disseminated though workshops/ seminars, 13% suggested use of community based group and 1.5% and 0.5% suggested use of internet and exchange farm visits to disseminate IK respectively. (See fig 7)

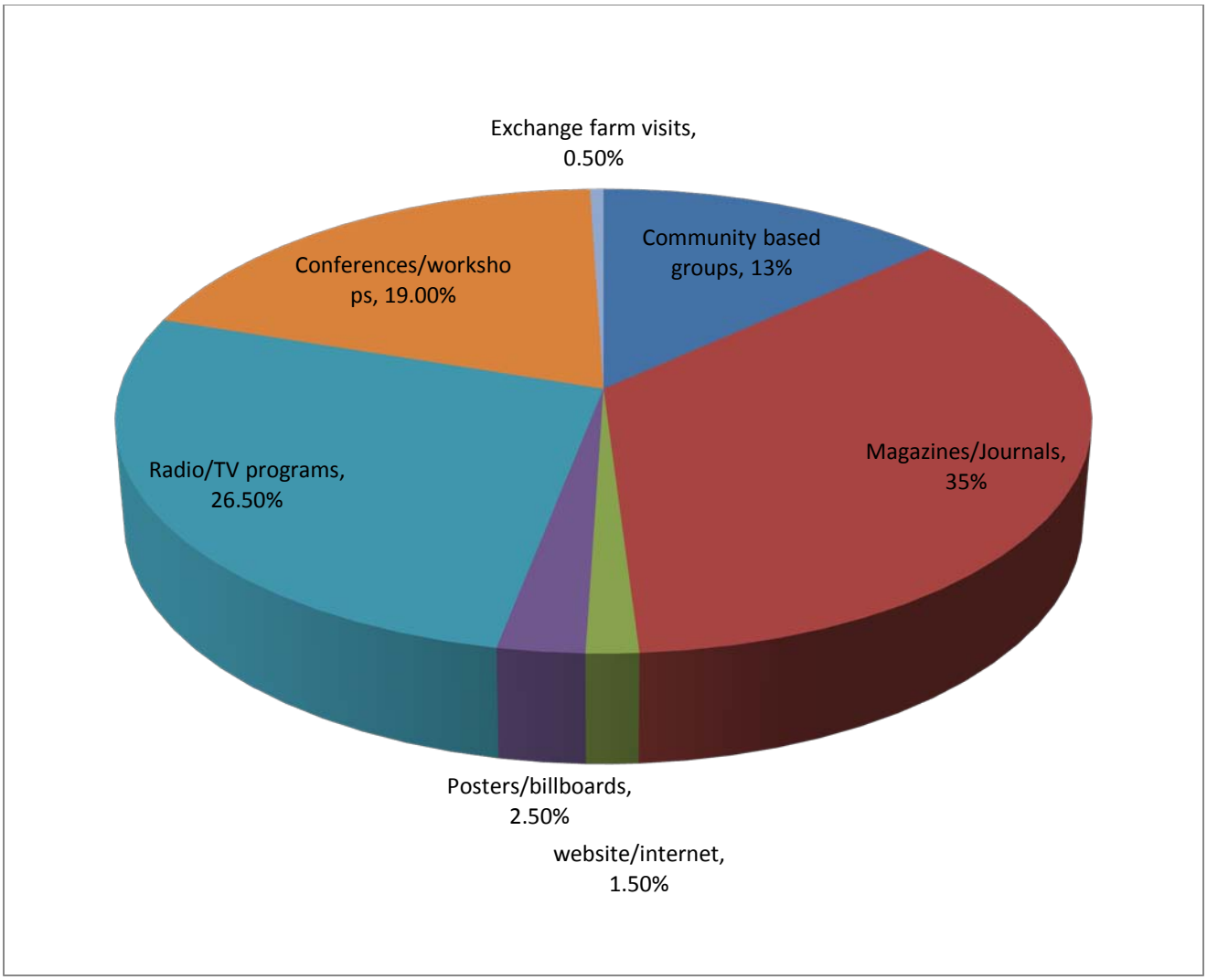


Fig.7 Suggested channels by farmers for dissemination of Indigenous Knowledge.

4.1.5. Objective 5: Evaluate the most appropriate ICTs and Non-ICTs channels and mode of communication on climate change impacts and adaptation strategies on agriculture.

The objective aims to identify appropriate communication pathways to farmers in communicating adaptation strategies needed to cope with impacts of climate change and variability on their farms. They were asked on other modes of communication preferred other than the ICTs and additional ICTs that are currently not in place but can be used to solve some of the agricultural issues they face in their farms.

As indicated by the results, 61% of the farmers preferred farm visits, 27.5% preferred barazas, 3.5% use of posters, 2% use of extension officers and 6% didn't know any non ICT mode they preferred. (See fig 8). From the FGD results, it was clearly noted that, the youth needed training on use of internet in agricultural related information and use of road shows to disseminate climate change impacts and adaptation strategies to the farmers.

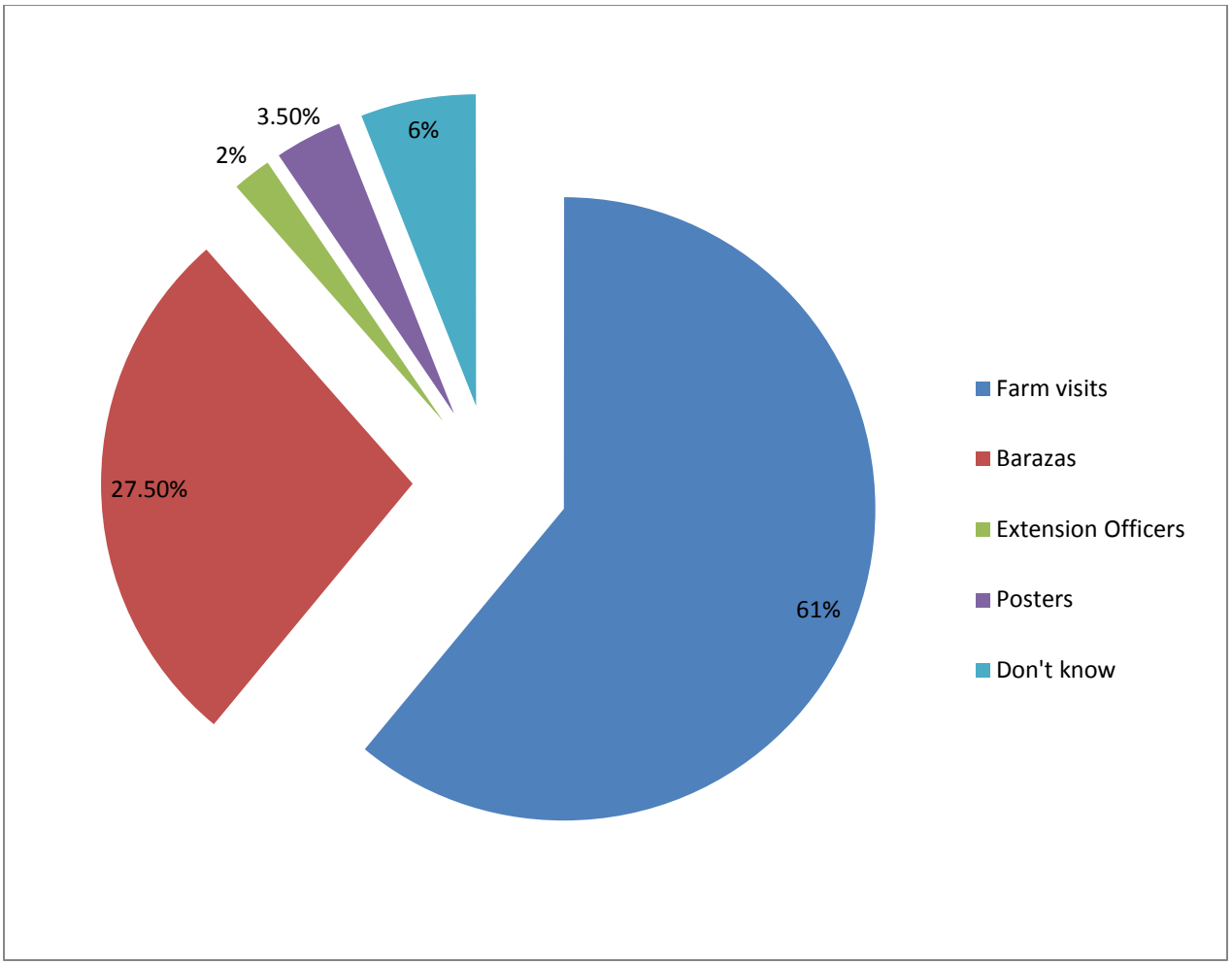


Fig. 8 Appropriate channels of communication for farmers on dissemination of climate change adaptation strategies

4.2. DISCUSSIONS

Climate change and variability has at least been heard and experienced by 100% of farmers. It was clear that some farmers reported deforestation and pollution from the industries as the main causes of climate change and variability. Although all the farmers interviewed have experienced climate change and variability, there are still 11% of the farmers who have no idea at all on contributors of climate change. This indicates the need of awareness for farmers on climate change mitigation, adaptation and coping strategies. Alternative sources of income especially for women in pastoral areas other than the informal milk business, is charcoal selling which has high demand in the nearing urban and peri urban areas. According to the Neighbours Initiative Alliance (NIA) report, the proximity of Kajiado to the city and having savannah woodlands that support a low smoke and high calorific value tree species (*Acacia – Commiphora-Balinites)*, makes it a potent market for the charcoal trade. Up to 91,300MT or more of charcoal is consumed in Nairobi annually and these dry woodlands within relatively short distances are one of the main sources. It is estimated that 60% of the charcoal consumed in Nairobi is from Kajiado County. (NIA report)

This therefore leads to desertification as so many people are engaged in cutting of trees without planting others. Alternative technologies for fuel should be taught to these women such as using agricultural wastes (sugarcane, coffee husks)converted into charcoal briquettes to provide much needed source of cheap fuel that is cleaner in burning. Moreover, Sand harvesting along rivers which is rampant in the Kajiado County; have degraded the environment by lowering the waterbeds hence diminishing the water availability potential. The activity also steepens and destabilizes riverbanks thereby causing erosion and river channel widening. Sediment bed loads also increase thus destroying the habitats of aquatic community.

Agro pastoralists have highly felt impacts of reduced crop yield due to low rainfall, change in normal planting time due to changing and unpredictable weather patterns, increase in pest and diseases especially in crops, flooding of crop fields due to high amount of rainfall at certain times, reduced soil moisture enough to support optimal growth of crops. The pastoralists have experienced high pasture and crop failure in their areas compared to the agro pastoralists due to the very low rainfall received in the area compared to Oloitokitok area where crop farming does very well.

Based on the results from the various discussions held, the most remarkable drought that had highest impact on farmers was in the year 2004 and 2009 which led to loss of livelihoods especially pastoralists who entirely depended on livestock. Crop failure and lack of adequate water for both animal and human consumption was also highly felt in the Agro pastoralists' areas.

Indigenous knowledge on agriculture/livestock keeping, prediction of different weather patterns and food preservation techniques are still being used by 98% of the farmers for management of their farms. The main reason for relying on IK more than scientific knowledge, being that they are used to, it's reliable, accurate and more affordable. The study area being predominantly occupied by the Maasai community, the indigenous signs and strategies used by farmers for coping with climate change and variability were similar between the pastoralists and agro pastoralists. Migration of animals and people was a very common strategy and still practiced by the pastoralists more than the agro pastoralists which could be attributed by the fact that agro pastoralists are now practicing preservation of pastures to be used during drought seasons unlike the pastoralists who reported to practice no pasture preservation at all hence the need to move in search of pastures in times of drought.

Positive indigenous strategies practiced included; use of organic manure to increase crop production, crop rotation, traditional food preservation methods like smoking of meat, use of

ash to preserve the seedlings, separation of livestock to control breeding, use of traditional herbs to treat some of the animal diseases and migration of livestock during drought.

ICTs have long been perceived to be for the literate and farmers are still sticking to their old ICTs components for communication. Radio which has always been used by farmers is still the most preferred mode of communication due to its affordability, reliability, use of local languages to communicate and its easiness to operate as compared to other modes of communication. The only new ICT component that has been widely adopted by farmers is the mobile phone, because of its direct communication, portability and having features important to the farmers such as money transfer services. However, use of SMS is still very low mainly because of high illiteracy levels of most farmers. With the majority of farmers lacking formal education, use of internet has the lowest adoption rate among the farmers with very few who have attended colleges and universities using it as a source of information. Farmers perceive internet use to be for the youth, not user friendly and expensive when it comes to buying computers and installing internet or even accessing the services at the cyber cafes. The youth on the other hand don't know how to utilize internet as mode of communication for agricultural related information but showed interest on learning to use in solving some of the agricultural related issues to assist their folks in the management of their farms.

Other than use of ICT for communication, farmers still prefer their oldest forms of communication such as use of barazas and farm visits to pass information, mainly because, the non ICT methods do not require buying of any equipment and there is direct contact when communicating hence effectiveness of the information passed.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Climate change impacts have already been experienced by farmers and more profound changes are still expected. To reduce these impacts, farmers need to be taught, mitigation, coping and adaptation strategies as it was noted in the research that, there is still a good number of farmers who actually don't know the actual causes of climate change and variability as well as how to respond to some of the changes. A bottom up approach should be used in coming up with adaptation strategies. Indigenous people have rich knowledge which is highly held in tacit form. Indigenous knowledge has long been ignored leading to loss of traditional strategies, values and practices. Ways of integrating the rich indigenous knowledge with formal knowledge should be the new way to go for adaptation of climate change and variability.

For the indigenous knowledge to be useful in future generations, a way of communicating, disseminating, storing and retrieving using Information and communication technologies should be devised. The study reported high usage of some ICTs such as Radio and mobile phones as the main sources of information for farmers. Integration of Indigenous knowledge with such ICTs can really help in the dissemination of indigenous strategies useful for coping and adapting to climate change impacts. Moreover, the Indigenous knowledge can be captured and disseminated by the new technologies such as use of internet making it easy to access globally. In addition, new emerging adaptation strategies important for the farmers can be communicated back through communication modes effective for the farmers such as the Radios, farm visits among others, hence creating an effective feedback mechanism between the farmers and the scientists. However, it should be noted that Indigenous knowledge should not be documented to compete with scientific knowledge but rather should be used to compliment the modern/formal knowledge.

5.2. Recommendations

From the study findings and conclusion, the following is recommended:

1) There is need of awareness for farmers on detrimental effects on environment caused by their daily normal activities such as deforestation, sand harvesting, overstocking and over use of inorganic chemicals.
2) An alternative business or source of fuel should be devised for farmers so as to reduce the rate of deforestation for fuel and charcoal business which is highly practiced as a source of income more so in pastoral areas.
3) Extension services should be enhanced to give information on types of drought tolerant crops/animals, importance of organic manure, rain water harvesting techniques, use of ICTs to disseminate information, treatment of different pests and diseases, credit facilities available for farmers, preservation of pastures/hay especially in worst hit drought areas.
4) Agricultural related information should be integrated in Radios in form of local programmes through the local radio stations to have a wide coverage.
5) Researchers should be able to document all indigenous strategies useful for adaptation of climate change as well as disseminate the information using the new emerging ICTs.

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APPENDIXES

QUESTIONNAIRE

1.0. Households' questionnaire for farmers in Kajiado County

House Hold ID ____

INTEGRATION OF INDIGENOUS KNOWLEDGE WITH INFORMATION AND COMMUNICATION TECHNOLOGIES [ICTs] IN COPING WITH CLIMATE CHANGE AND VARIABILITY EFFECTS ON AGRICULTURE IN KAJIADO COUNTY

Date of interview: Day: …… Month …… Year: ……

Interviewed by: ……..

Start time …… End time……

Interviewee name……..Phone Number…… .....

County …… Constituency…… Village……

Immigrant …… Non- Immigrant……

Distance to the nearest town (KM)……

1.0 Household composition and characteristics

HH member identification (start with respondent)	Gender **Codes A**	Marital status **Codes B**	Age (yrs)	Number of years of formal schooling	Highest level of education attained **Codes C**	Relation to HH **Codes D**	Main occupation **Codes E**	Experience (Years of farming)
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								

9.								

Codes A

1. Male

0.Female

Codes B

1 Single, never married nor in a consensual union

2 Married

3 Consensual union

4 Widowed

5 Divorced

6 Separated

Code C

1. Primary school
2. Secondary school
3. College
4. University
5. PhD or equivalent

Codes D

1. Household head
2. Spouse
3. Son / daughter
4. Stepson/stepdaught
5. Son / daughter in la
6. Grandchild
7. Parent
8. Parent in-law
9. Brother /sister
10. Brother/sister in- law
11. Other family member
12. Other, non-family member
13. Domestic worker /employee

Codes E

1. Full-time employee
2. Part-time employee
3. Self-employed
4. Student
5. Retired
6. On benefit
7. Unemployed
8. Other (*specify)*……

HH member: includes the people who habitually eat and sleep in the home (including those who have been absent less than six months and have not established another residence).

Age: in years (if less than one year, write zero (0); don't know (999)

2.0. **Climate Change and Indigenous Knowledge and skills**

2.1. Have you ever heard of climate change or climate variability? (1) Yes (2) No

2.2. If Yes in 2.1 above, what aspects of climate change or variability have you heard of?

(a) Rising temperature

(b) Droughts

(c) Floods

(d) Erratic rainfall

(e) Low rainfall

(f) Strong wind

(g) Cold spells

(h) Water stress

(i) Others (specify)_____

2.3. How and where do you get information on climate change and variability from?

(i) Radio (ii) Newspaper (iii) Friends (iv) Extension officers

(v) Internet (vi) Television (vii) others (specify) _____

2.4. What in your opinion are the possible causes of climate change and variability?_____

_____

_____

_____

2.5. Have you ever experienced or/noticed any climatic changes and variability in your locality?

(1) Yes (2) No

2.6. If yes in 2.5 above, what changes have you experienced/noticed and since when?

Climate change and climate variability	**From when (Give years e.g. 1991 or range of years e.g. from 1990 to 2012)**
Erratic rainfall [ ]	
Low rainfall [ ]	
Flooding due to heavy rains [ ]	
Prolonged droughts [ ]	
Increasing temperatures [ ]	
Others (specify) ……	

2.7. To what extent have the changes identified in 2.6 above impacted on agricultural activities? (please tick as appropriate)

At your farm/local level	**At the national/regional level**
Reduced crop yield [ ]	Insufficient food [ ]

Change in planting time [ ]	High food prices [ ]
Crop failure [ ]	Human wildlife conflicts [ ]
Increased pest and disease infestation [ ]	Competition over resources [ ]
Flooding of crop fields [ ]	Others (specify) ……..
Reduced soil moisture [ ]	
Others (specify) ……..	

2.8. How are you responding to these changes in 2.7 above?

2.9. Do you anticipate further changes and variability in climate in the near future?

(1) Yes (2) No

2.10. If Yes in 2.9 above, in what timescale do you expect these changes to occur?

(1) 0 – 5 years (2) 5 – 10 years (3) 10 – 20 years (4) over 30 years

Give reasons for choice of your time scale in 2.10 above.

2.11. What aspects of climate change and variability do you anticipate to notice profound changes and why? E.g. rainfall, floods, temperatures e.t.c.

Aspect/Change	Why

2.12. How will you respond to the changes identified in 2.11 above?

_____

_____

2.13. Which of the practices listed below are used in your locality in response to climate change?

Strategy	**Approximate % of farmers using**
Agro forestry [ ]	
Drought tolerant crops [ ]	
Rain water harvesting [ ]	
Drought resistant animals [ ]	
Irrigation [ ]	

Management of Pests and diseases in crops and animals [ ]	
Soil and water conservation [ ]	
Application of fertilizers and organic inputs [ ]	
Planting appropriate crop varieties [ ]	
Use of different cropping systems [ ]	
Preservation of pastures [ ]	
Movement of livestock and people [ ]	
Others (specify)	

2.14. Which strategies of the ones mentioned in 2.13 above do you use?_____

_____

_____

2.15. Are you aware of other strategies that can be used in response to current and/or anticipated climate change? (1) yes (2) no

2.16. If yes, which are they?

_____

_____

2.17. What would you require (techniques/information) to implement some of these strategies on your farm and/or in your locality?

_____

_____

_____

2.18. Why do you think knowledge on climate trends and projected changes is important to a farmer?

_____

_____

_____

2.19. Do you use indigenous knowledge in your agricultural farms/livestock to cope and adapt to climate change and variability? Yes No

2.20. If yes to 2.19. which indigenous strategies do you employ in agricultural production/livestock to adapt to climate change and variability?_____

_____

_____

_____

_____

2.21. In what ways do you think the indigenous knowledge related to adaptation of climate change can be strengthened to be adopted in other various part of the world?_____

_____

_____

_____

2.22. From your point of view would you recommend adoption of indigenous knowledge in agricultural production as a way of coping and adapting to climate change and variability? Yes No

2.23. Using the indigenous techniques above, are you able to forecast weather changes accurately? (1) yes (2) No

2.24. In a scale of 1 (low) to 5 (high), how do you rate the accuracy of scientific weather forecasting 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ]

2.25. Between the traditional approach and the scientific approach, which one do you rely on most when making your farm management decisions?

(1) Traditional approach (2) scientific approach

2.26. Why would you go for the approach in 2.25 above?

_____

_____

_____

2.27. How do you rate the significance of climate change as an issue?

1 [ ] Rated least 2 [ ] 3 [ ] 4 [ ] 5 [ ] Rated high

2.28. Who do you think should play a bigger role in the mitigation of the effects of climate change?

(1)Researchers [ ] (2) NGOs [ ]

(3)Farmers [ ] (4) Developed countries [ ]

(5)Government [ ] (6) Private companies [ ]

(7)Research institutions [ ] (8) others (specify_____

3.0. Awareness and use of ICT technologies and services.

3.1. From which ICT components below do you mostly get information to assist in the management of your farm?

(1) Radio (2) Newspaper (3) Friends (4) Extension Officers

(5) Internet (6) Television (7) Others (specify)_____

3.2. Among the ones mentioned above, which one are you more conversant with?_____

_____

3.3. From the one mentioned above, explain the reasons for the most preferred one._____

_____

_____

3.2. What is the level of penetration and usage of the following types of ICT to disseminate information to farmers regarding issues like rainfall seasons, current market prices, new seed varieties, pest and diseases? (please tick on the level of usage)

a. Radio [high], [medium] [low]
b. Mobile phones [high] [medium] [low]
c. Internet [high] [medium] [low]
d. Ministry of Agriculture (extension Officers) [high] [medium] [low]
e. Others [high] [medium] [low]

3.3. Other than use of ICT used to disseminate information, which other modes of communication do you think are most practical in disseminating information on coping and adaptation strategies to climate change and variability?

_____

_____

_____

_____

3.4. As a farmer with Indigenous knowledge on coping and adaptation strategies, which mode will you prefer to communicate that information?

3.5. Do you have any project/service provider in your area that provides information useful to farmers? Yes No.

3.6. If yes what is the name of project and which type of information does it provide?

_____

3.7. Which mode of communication does it use to disseminate the information?

_____

_____

3.8. Are you a member of the project? (1) Yes (2) No

3.9. If No ,why_____

3.10. Please complete the table below for each of the ICT-based information sources you have used in the past *[Record only for ICT information used]*

	Is the information timely? (1)Yes (2)No	Is the information reliable? (1)Yes (2)No	Is the information easy to use? (1)Yes (2)No	Initial cost of buying the equipment (Ksh)	Cost of getting information from this source (Ksh)	How does the cost of using this information source compare to your usual source of information? (Codes A)
Type of media						
1. Radio programme						
2. Television						
3. Mobile call-up						
4. Mobile SMS						

5. Radio call-in						
6. CD Rom						
7.Video						
8.Internet/ email						
9. Other						

Codes A: (1) Same (2) Lower (3) Higher

4.0. Communication channels.

4.1. How would you prefer to receive information on weather/Climate Change?

[a] Booklets/leaflets, [b] Radio, [c] TV, [d] Farm Visits, [e] Barazas/Field days,

[f]Mobile phone, [g] other (specify)

4.2. Do you have access to a mobile phone? Yes No

4.3. Are you able to access the internet for information? Yes No.

4.4. If yes to 4.3. Where? Mobile phone,[ ] Local cyber café,[ ] Own computer,[ ] Other (specify)