FARMERS' KNOWLEDGE AND ADAPTATION PRACTICES TO CLIMATE CHANGE IN LOWER NYAKACH DIVISION OF KISUMU COUNTY, KENYA

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ABSTRACT

Agricultural production all over the world has been affected by continuous climatic changes. Although most developed nations constantly update their farmers with current climate change information that enables them to device appropriate adaptive strategies, farmers in developing countries only learn about the same after its effects have been noticed. Most households in rural areas of Kenya still face food insecurity. However, there is no evidence on whether Kenyan farmers have reliable information necessary for adoption of appropriate farming practices to cope with climate change effects. Equally, challenges that face Kenyan local farmers in adapting to climate change remain unknown. The general objective of the study was to investigate farmers' knowledge and adaptation practices to climate change in Lower Nyakach Division. Specific objectives were to: examine the level of awareness; explore the indigenous adaptation practices, and to identify challenges faced by farmers in adapting to climate change. Capability theory (Sen, 1992) which focus upon the significance of individuals' capability of achieving the kind of lives that they value, guided the study. Descriptive cross sectional design was used on a target population of 2504 households stratified in 4 sub locations. The sample size comprised 10% of the target population as recommended by Gay & Diehl (1992), representing 250 households. Data was collected using structured questionnaire from household heads; Key Informants Interview from three agricultural officers and five CBO officials; and one focus group discussion from each of the 4 sub locations. Instrument validity and reliability were checked through expert consultation and split half during pilot study. Descriptive statistics were used to analyse quantitative data using Statistical Package for Social sciences (SPSS) version 20. Thematic analysis was used to analyse qualitative data. It was found that farmers were aware of common short and inconsistent patterns of rainfall, and floods in the recent past accompanied with strange diseases like *Miguna Miguna* and invasion of army worms. Radio is the main source of weather information, implying that radio broadcast is a better avenue for passing weather information. Multi cropping, intensive weeding, planting early maturing crops, and applying manure on the farms are some of the indigenous adaptation practices. However, there are inadequate extension services, lack of financial resources, lack of government subsidies, poor farming practices, small sizes of land, and late preparation of farms. This implies that adapting to climate change depends upon individual capabilities. It is recommended that extension officers should use village *barazas* to disseminate climate change information, and that capital support be availed to farmers to enhance their capabilities. Further studies should be done on contribution of radio broadcasts on adaptation to climate change, and effect of climate information flow on adaptation practices to climate change.

CHAPTER ONE
INTRODUCTION

1.1Background to the Study

Globally, food provision is dominated by subsistence agriculture (World Bank, 2011). An estimated 70 per cent of the global population (nearly 4.7 billion people) is fed with food produced locally, mostly by small-scale farming, fishing or herding (ETC Group, 2009). In Latin America the contribution of traditional small-scale (peasant) farming to food supply is significant, with data from Brazil, Bolivia and Ecuador showing that 60 to 80 per cent of staple foods and over 50 per cent of dairy and meat products originate from family farms (Schejtman, 2010;Clements, et al., 2013). Small-scale farmers produce almost 80 per cent of food on regional markets in Africa and Asia (Vermeulen, 2010). Moreover, eighty-five per cent of the world's farms are less than 2 hectares, worked by families and indigenous peoples. Strengthening the livelihoods of rural populations is therefore intrinsically linked to poverty reduction efforts and is a key area to focus climate change adaptation strategies in the agriculture sector.

There is, however, limited scope for expansion of arable land, and the emerging threat to agriculture from climate change in the form of unpredictable weather, floods, and other disastrous events makes the task of providing enough food for the global population more challenging (Clements, Haggar, Quezada, and Torres, 2011). Mabe, et al. (2012) suggests that the activities of man have gradually destroyed the environment, thus affecting its suitability for habitation for natural creatures due to extreme climatic conditions. According to Mabe, et al. (2012), climate change is a significant shift in the average weather condition especially average temperature and precipitation of an area, and it is predicted that most land areas will have warmer and fewer cold days and nights. Similarly, Intergovernmental Panel on Climate Change Working Group (IPCCWG II, 2007: 30) defines climate change as a change in the climate that persists for decades or longer, arising from either natural causes or human activity.

Scientists attribute climate change to the emission of greenhouse gases (GHGs), such as carbon dioxide, methane and nitrous oxide (IPCC, 2007). There is evidence that human activities such as electricity production and transportation are adding to the concentration of greenhouse gases that are already naturally present in the atmosphere (Oduniyi, 2013). Moreover, energy and chemical intensive farming leads to increased levels of GHG emissions, primarily as a result of

over-use of fertilizers, land clearance, soil degradation and wastes from intensive animal farming (Smith, 2008).

Most scientists have attributed climate change to emissions of GHGs, land use, livestock farming, and aerosols. According to Walsh, et al (2013), carbon dioxide (CO_2) is the primary greenhouse gas that that has contributed to recent climate change. CO_2 is absorbed and emitted naturally as part of the carbon cycle, through animal and plant respiration, volcanic eruptions, and ocean-atmosphere exchange. Human activities, such as the burning of fossil fuels and changes in land use (see below), release large amounts of carbon to the atmosphere, causing CO_2concentrations in the atmosphere to rise. Along with CO_2, methane and nitrous oxide are also major contributors to the greenhouse effect. The Kyoto Protocol (EPA, 2012) lists a number of gases emitted through human activities which also contribute to changes in atmospheric conditions, although it is hardly known whether most farmers in rural areas are aware of the same. Recommending a means of dissemination of such information to farmers in rural areas thus remains an essential step in equipping them with knowledge regarding climate change.

In Africa, many studies have revealed changes in climate without indicating adaptation strategies which have been employed by local farmers in those areas. For instance, Ziervogel, et al (2014) affirms that climate change poses a significant threat to South Africa's water resources, food security, health, infrastructure, as well as its ecosystem services and biodiversity, and considering South Africa's high levels of poverty and inequality, these impacts pose critical challenge for national development. Mabe, et al. (2012), in a study aimed at estimating the adaptive capacities of farmers and their effects on rice production in the Northern Region of Ghana, found that high adaptive farmers obtain nine more bags of 50 kg bag of paddy rice than farmers with low adaptive capacities. Mary and Majule (2009) also examined the impacts of climate change and variability on agricultural systems in Manyoni District in Singida Region, Tanzania. They found that amounts of rainfall have been inconsistent, thereby negatively affecting the production and management of different crops. Changes in rainfall patterns have been identified to include shrinking of rainy season by one month due to late onset of the rainfall period (ibid). However, Mabe, et al (2012) and Mary and Majule (2009) have not stated adaptation strategies employed by farmers, and what informed such adaptation practices.

Kalungu, et al. (2013) contended that climate change has had negative effects on agricultural production in Kenya. This is because the country experiences major droughts every decade and minor ones every three to four years. There is also a predicted significant reduction of cropping area because of climate change, and farmers perceive that crop productivity has been decreasing due to erratic rainfall patterns coupled with extreme temperature conditions. However, awareness of local farmers on climate change patterns specific to each area and to particular subsistence farmer groups seem to be limited, particularly in the developing world.

Although farmers have embraced some farming practices geared at enhancing food production, hardly are there studies which attribute these practices to awareness of climate change. Juana, Kahaka & Okurut (2013) pointed out that most farmers have adopted crop diversification, planting different crop varieties, changing planting and harvesting dates to correspond to the changing pattern of precipitation, irrigation, planting tree crops, water and soil conservation techniques, and switching to non-farm income activities. Juana, et al. (2013) further stated that years of farming experience, household size, years of education, access to credit facilities, access to extension services and off-farm income are among the significant determinants of adaptation capacity of a farmer. Nonetheless, it is not stated whether or not the aforementioned factors determine adaptation practices among households in the rural areas, although there is evidence of low production of food crop in most developing countries. It is however important to assess whether the same factors determine adaptation capacities of farmers in other regions.

It is significant to note that awareness of particular situations like changing climatic conditions is essential for developing adaptation strategies. As asserted by Pelham (2009), adequate knowledge and awareness of causes and effect of climate change can enable communities to join forces and adopt measures to reduce risks associated with the same. A study by the BBC World Service Trust (2010) in Tanzania revealed that most farmers are unfamiliar with the concepts of climate change and global warming. Moreover, Kiswahili translations of climate change terminology do not convey the concept accurately to the farmers. A similar study was therefore necessary in other regions in developing countries to determine awareness of climate change concepts among households. Thus, in order to establish perceptions of local farmers on climate change and hence adaption strategies for addressing the same, it was vital to investigate the level of awareness of the same.

In most developed countries, communities have been able to take steps that have enabled them to survive with the state of climate shifts. The Intergovernmental Panel on Climate Change Working Group (IPCCWG II) has considered this initiative by the developed world to be adaptation strategy to climate change. According to Clements, et al. (2011), adaptation has the potential to prevent future risks, reduce present adverse effects. This process can be initiated through individual or collective action. Although successful adaptation to climate change depends on the adaptive capacity of a system, there is scant information on indigenous adaptation strategies employed in different rural set ups based on awareness of particular climatic changes.

Studies across Africa, though, have demonstrated that there are challenges faced by farmers in gaining knowledge and adaptation strategies to cope with climate change. For instance, Antwi-Agyei, Dougill, and Stringer (2013) used case studies from northeast Ghana and a systematic literature review to assess the barriers that restrict effective implementation of climate adaptations in sub-Saharan Africa. They found that households are constrained by a range of barriers, the most important of which included financial barriers, institutional barriers and a lack of information on climate change characteristics. In the Niger Delta, Nzeadibe, Egbule, Chukwuone, and Agu (2011) assessed farmers' perception of climate change governance and adaptation constraints. Challenges revealed were: lack of information, low awareness level, irregularities of extension services, poor government attention to climate problems, inability to access available information, lack of access to improved crop varieties, ineffectiveness of indigenous methods, no subsidies on planting materials, limited knowledge on adaptation measures, low institutional capacity, and absence of government policy on climate change. Nevertheless, climate change awareness and adaptation poses unique challenges to each region, and there is need to investigate these constraints in places like Lower Nyakach Division, where the same has not been established.

In Kenya, farmers have continued to link reduction in agricultural production to climate shifts for the last 3 decades. Voluntary Service Overseas Evaluation Report (VSO, 2012) estimated that 53.4% of people in Kisumu County (Kenya) live below the food poverty line, compared to 8.4% in Nairobi. In Lower Nyakach Division in Kisumu County, households rely on maize crop as staple food. However, there are often poor harvests every season, with an approximate two to

three bags yields to feed a household of five persons annually. According to Obuoyo, Ochola & Ogindo (2016), the area has witnessed gradual food insecurity over the last three decades that has recently intensified due to, poverty, rapid population increase, overgrazing, over-cropping and coupled with serious deforestation on the upper catchments and constant flooding during rainy seasons. Ochieng (2014) asserts that 65.0 percent of the residents of the study area are food insecure due to infestation of maize farms by striga, declining soil fertility due to overuse and soil erosion. This further questions adaptation strategies employed by the farming households in addressing changes in climatic conditions. Records from Nyakach Sub County Agricultural Office (2016) indicate that between 2012 and 2015, Lower Nyakach Division with four administrative locations has realised a steady decline in maize crop production. Table 1.1 presents the trend of maize crop production in the area.

Table 1.1: Trends of Maize Crop Production in Lower Nyakach Division

	2012	2013	2014	2015	No of Households
Jimo East	4585	4467	4412	4362	917
Rarieda	2120	2052	1992	1968	424
Gem Nam	2155	2064	2008	1987	431
Moro	3670	3567	3501	3484	734
Total	**12530**	**12150**	**11913**	**11801**	**2504**

Source: Nyakach Sub County Agricultural Office (2016)

Table 1.1 illustrates that between 2012 and 2015, there was a decline of 712 bags in maize production in Lower Nyakach Division. Between 2012 and 2013, the production declined by 380 bags; 220 bags between 2013 and 2014; and 112 bags between 2014 and 2015. With a population of 2504 households (Kenya Population Census Report, 2009), each household received approximately five bags of maize from their farms to feed an average of five persons per household (KPC, 2009). Similarly in 2013, 2504 households were to feed on 12150 bags obtained from the farms: this translates to 4.9 bags per household; in 2014, the amount reduced to approximately 4.8 bags per household, while in 2015, it declined to approximately 4.7 bags. This therefore implied that in a household of five persons, each person consumed 0.94 bags (or 37.6 two kilograms tins) of maize in 2015. This is far below an average of 91 two kilogram tins per year as recommended by the World Food Organization (FAO), International Fund for

Agricultural Development (IFAD) and the World Food Programme (WFP) (FAO, IFAD & WFP, 2014).

The statistics provided in Table 1.1 begs an answer as to whether farmers in this area have had prior knowledge of the oncoming climatic conditions and whether they have been adopting farming practices to enable them adapt to changes in the climate. Studies that have been done have tended to overlook the farmers' knowledge and adaptation practices to climate change in Lower Nyakach Division. Obuoyo et al (2016), in their investigation on whether livestock keeping lead to household food security in Lower Nyakach Division, established food insecurity in the area had intensified due to, poverty, rapid population increase, overgrazing, over-cropping and coupled with serious deforestation on the upper catchments and flooding on the Kano plain. Oluoko-Odingo (2006) assessed food security and poverty issues with special reference to small-scale farmers in Nyando District of Kenya. It revealed that that although drought episodes frequently occur in the study area, they were not severe enough to result into total crop failures as opposed to floods, where six months of flooding resulted into total crop failure.

Another study by Ochieng (2014) sought to establish the factors that limit the adoption of Striga weed control mechanisms in Nyakach district. It found that in access to credit by the farmers increases their adoption of control methods of striga by 31%. An increase in the level of income of the respondents decreases their adoption of striga control methods by 0.0084%. Increase in the level of education increases the level of adoption of striga control methods by 68%. Increase in access to the extension services increases the adoption by 13%. It is there imperative to note that in wake of decline in food security, limited focus has been given to knowledge and adaptation practices to climate change among the farming households. There is therefore need to investigate the awareness of farmers on climate change, indigenous adaptation strategies used by farmers, and the challenges facing subsistence farmers in mitigating climate change by embracing adaptation practices.

1.2 Statement of the Problem

Climate change is a major stumbling block to ensuring food security in developing countries including Kenya, yet little is known on awareness of farmers as well as adaptation strategies to such changes in climatic conditions. In Kisumu County, it is estimated that 53.4% of households

live below the food poverty line, compared to 8.4% in Nairobi. In places like Lower Nyakach Divisions, households comprising five persons seem to be relying on farm harvests of between four and five bags of maize annually. This is an indication of food deficiency. Owing to the fact that climate change is unique to each region, means of conveying climate information is often unique; adaptation practices are hardly known; and challenges faced in adapting to climate changes are not known. It is therefore important to focus upon each region in investigating this phenomenon. In Kenya, little evidence is available concerning the level to which awareness and adaptation strategies to climate change have been investigated and challenges faced in crafting coping methods identified and overcome. This is because several households in areas like Kisumu County have been facing reduced food crop production, ostensibly due to climate change effects. Little is known concerning awareness and adaptation strategies to climate change amongst the farmers. Equally, information concerning challenges that farmers in this area face in adapting to climate change has remained scanty. This study therefore sought to answer the following research questions:

1.3 Research Questions

i. What is the level of awareness among local farmers on climate change information in Lower Nyakach Division?

ii. Which indigenous farming practices are used by local farmers for adaptation to climate change in Lower Nyakach Division?

iii. What challenges do farmers face in adapting to climate change in Lower Nyakach Division?

1.4 Study Objectives

The general objective of the study was to investigate farmers' awareness of, and adaptation strategies towards climate change in lower Nyakach Division, Kisumu County-Kenya.

1.4.1 Specific Objectives

The specific objectives were to:

i. Examine the level of awareness among local farmers of climate change information in Lower Nyakach Division

ii. Explore the indigenous farming practices used by local farmers for adaptation to climate change in Lower Nyakach Division

iii. Identify challenges faced by farmers in adapting to climate change in Lower Nyakach Division

1.5 Significance of the Study

This study set out to establish farmers' knowledge of climate change and how they adopt to these changes. This would enable subsistence farmers to get prepared with alternative strategies to ensure continuous food production to alleviate household/family poverty and hunger. Similarly, should farmers simulate adaptation strategies and realise improved agricultural production, the general poverty level in the country would be reduced to a reasonable index. This study might therefore be of much importance to the national government.

There are normally other key players engaged in poverty mitigation and livelihood interventions among poor and rural households across the country, such as churches, Non Governmental Organizations (NGOs), Community Based Organizations (CBOs), and other resource based organizations. The findings from this study would go a long way in providing information to these organizations on what the rural communities are doing to adapt their agricultural production practices properly in order to avoid losses associated with climate variability, since their livelihood depend on agriculture.

Finally, this study would also add value in the academic knowledge on farmers' awareness of, and adaptation practices to climate change, and would also open up room for further research in the field of perception of farmers on climate change and adaptation strategies in other parts of Kenya.

1.6 Scope of the Study

This study covered farmers' knowledge of climate change and the strategies they adapt towards mitigating these changes. It was conducted in Lower Nyakach Division of Nyakach Sub County. Key areas examined included level of awareness of climate change, indigenous adaptation strategies, and challenges faced by farmers in adapting strategies to mitigate climate change.

1.7 Theory of the Study

This study was informed by the capabilities theory advanced by Sen (1992, 1999, and 2004). Sen argued that the focus in social evaluations and policy design should be on what people are able to do and be, on the quality of their life, and on removing obstacles in their lives so that they have more freedom to live the kind of life which, upon reflection, they find valuable. Capability theory emphasizes on the distinction between the means and the ends of well-being and development, and that only the ends have intrinsic importance, whereas means are only instrumental in the achievement of well-being and development.

According to Sen (1992), major constituents of the capability approach are functionings and capabilities. Functionings are the "beings and doings" of a person, whereas a person's capability is "the various combinations of functionings that a person can achieve. Capability is thus a set of vectors of functionings, reflecting the person's freedom to lead one type of life or another." Capability theory examines capacities necessary for people to lead functioning lives. In the view of Goerne (2010), functioning lives reflects the collection of 'beings' and 'doings' that can be viewed in various outcomes in one's achievements. A capability approach focuses on whether or not people possess capacities necessary to construct a fully functioning life. On the other hand, Nussbaum, (2011) considers capacities as natural systems that directly depend on a stable climate system.

Since changes in climatic conditions will affect what individuals are able to achieve with the resources that they have, capability theory was found suitable for the present study. Schlosberg (2011) asserts that capability approach provides a concept that can encompass the current framing of climate change in a way that is more applicable to the development of adaptation strategy. Since this approach addresses the basic requirements that are necessary for human life to function and flourish; it is important to align adaptation strategies with climate change for the purpose of protecting basic functioning of human communities. If climate change impedes agricultural practices, or/and undermines local infrastructure, then functioning will be limited. In that case, climate change is a barrier to functioning lives of individuals (Schlosberg, 2011: 19). Additionally, Nussbaum (2011) considered the potential mental health impacts, such as the increased stress of farmers who have been affected by climate change, and the overall anxiety of rapid climate change, as a barrier to capability of emotional health.

A capabilities-based approach to adaptation, in other words, offers a way to assess vulnerability as it varies across location, benchmark adaptation needs and goals, and include the affected public in the development of adaptation strategy. Thus the approach offers a way of analyzing the particular knowledge needs of communities with regard to climate change, understanding local adaptation strategies in adapting to climate change, and of identifying challenges which hinder people to adapt to climate change.

The Capability Approach attempts to address various aspects of well-being of an individual, based on different contexts, regions, or environments. This informed the choice of this approach to guide investigation into farmers' awareness of and indigenous adaptation practices to climate change in Lower Nyakach Division based on the following reasons. Farmers need to employ the resources they have to enhance crop production under prevailing climatic conditions. On the other hand, individuals often differ greatly in their abilities to convert the same resources into valuable functioning ('beings' and 'doings'). For example, those with physical disabilities may need specific goods to achieve mobility, and pregnant women have specific nutritional requirements to achieve good health. Capability theory analyses what particular people can do with the resources they have under specific circumstances. Thus, farmers may be able to adapt to climate change and be able to enhance food crop production (consequently leading to nutrition and good health) using the resources they have, and based upon prior knowledge of on-coming climatic conditions.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section presents a review of literature. The review is presented in the sequence of the study objectives.

2.2 Awareness of Climate Change Information by Local Farmers

Adopting effective adaptation strategies to combat climate change can only be possible if small scale farmers are aware and understand the consequences of climate variability (Clements, et al., 2011). Several studies have attested to awareness and understandings (of climate change and adaptation strategies) as the first step in mitigating vulnerability caused by variations in weather over time. Pidgeon and Lorenzoni (2006) reviewed major studies to analyse how climate is conceptualized among the public in Europe and the United States of America (USA). This was a comparative analysis using study finding from Europe (25 studies) and USA (30 studies). They found some shared perspectives among publics across the Atlantic (although not strictly comparable, general US findings are broadly in the range of the EU ones), supported by fifteen years of climate change perceptions research. Specifically, the analysis established widespread awareness and concern about environmental issues and climate change. Nonetheless, Pidgeon and Lorenzoni (2006) did not find out the adaptation strategies used to address vulnerabilities to climate change in their review. The need to address these areas necessitated the present study.

Further concerns over awareness of climate change and adaptation strategies can also be found in some studies within the Lake Region of Eastern Africa. The BBC World Service Trust (2010) conducted research to explore public awareness and understanding of climate change in Tanzania. The findings were that Tanzanians have noticed changes in the weather, seasons and drought but most have little understanding of the relationship between these issues and climate change; are unfamiliar with the concepts of climate change and global warming; believe that humans are to blame but point to local deforestation and local pollution as the primary causes of the drought and environmental degradation and hold themselves individually or collectively responsible for local changes.

Much as BBC World Service Trust (2010) sought to explore public awareness of climate change, it did not link awareness to climate change. Furthermore, they did not indicate whether or not the local Tanzanians have failed to adapt to climate change due to lack of awareness, and the challenges that they face owing to awareness or lack of it.

Another study done in Tanzania to established people's indigenous knowledge on Climate Change & Variability and their adaptive capacity was by Mary and Majule (2009). This was done in two villages of Kamenyanga and Kintinku of Manyoni District, central Tanzania. Findings showed that local people perceived changes in rainfall and temperature to have affected crops and livestock in a number of ways resulting in reduced productivity. Nonetheless, Mary and Majule (2009) did not indicate whether this knowledge that farmers have concerning climate change have helped them in adapting strategies to address the same.

In Kenya, Ndambiri, Ritho, and Mbogoh (2012) carried out a study to evaluate how farmers in Kyuso District in Kitui County (Kenya) have perceived and adapted to climate change. The analysis revealed that 94% of farmers in Kyuso District had a perception that climate was changing and as a result, 85% of these farmers had responded by adapting farming practices that mitigate climate change effects. In this regard, demographic variables, distance to the nearest market, access to irrigation water, local agro-ecology, on and off farm income, access to information on climate change through extension services, access to credit, changes in temperature and precipitation were found to have significant influence on the probability of farmers to perceive and/or adapt to climate change. Still, this study (Ndambiri, et al, 2012) has not indicated the adaptation strategies adopted by the farmers in their study based on their perception on climate change. These were the areas covered by the present study.

Kalungu, Filho, and Harris (2013) assessed smallholder farmers' perception of the impacts of climate change and variability on rain-fed agricultural practices in semi-arid and sub-humid regions of Kenya. Data from household interviews at four sites in Kenya was selected using a temperature analogue approach. It was found that more farmers at the drier sites reported having perceived more changes in the past 30 years than in the past 10 years in nearly all the selected agricultural practices. In addition, there was a strong association between the perceived changes and the regions (semi-arid and sub-humid) for the last 30 years. The study also showed that there

was significant association between the observed changes in agricultural practices and household. However, Kalungu, et al (2013) did not highlight on the adaptation strategies used by the farmers based on the knowledge they have concerning changes in climate. The present study assessed adaptation methods used by the farmers based on the climate change information that the sampled farmers had.

2.2.2 Indigenous Adaptation Practices

Although farmers have resorted to different farming practices like crop diversification, planting different crop varieties, changing planting and harvesting dates (among others), limited studies in the developing countries have established whether these are adaptation practices to climate change. Studies done in the USA, Europe, and other developed countries have however attested to this. Jackson, et al., (2011) examined adaptation strategies for agricultural sustainability in Yolo County in California, USA. They found that farmers concerned about climate change were more likely to implement water conservation practices, and adopt voluntary Green House Gas (GHG) mitigation practices. Evidently Jackson, et al. (2011) examined adaptation strategies for agricultural sustainability, the study was carried out in a developed country where farmers are able to obtain water conservation facilities. The need to examine adaptation practices in low income countries where the capabilities of farmers are low therefore necessitated the present study.

Ramsey and Tarleton (2008) assessed farm-level adaptation to multiple risks in climate change and other concerns among farmers in the Parkland region of Manitoba, Canada. A change in crop hybrids was the only adaptation made by farmers that was related almost exclusively to climate. Of the total responses made by farmers in both areas in regard to climate change, the majority said there had been no average change in the climate, with the exception of an increase in erratic weather events. Their study, however, differs from my own study in one way: it was done among farmers who were able to buy crop hybrids in the wake of changes in climatic conditions. It was therefore prudent to conduct a similar study among farmers in a resource constrained country like Kenya.

Another study by Below, Artner, Siebert and Sieber (2010) explored micro-level practices for adapting to climate change that are available to small-scale farmers of African origin all over the

World. The analysis was based on a review of 17 studies about practices that boost small-scale farmers' resilience or reduce their vulnerability to observed or expected changes in climate; it included data from more than 16 countries in Africa, the Americas, Europe, and Asia. The review showed that African smallholders are already using a wide variety of creative practices to deal with climate risks; these can be further adjusted to the challenge of climate change by planned adaptation programs. The study found 104 different practices relevant to climate change adaptation and organized them in five categories: farm management and technology; farm financial management; diversification on and beyond the farm; government interventions in infrastructure, health, and risk reduction; and knowledge management, networks, and governance.

While Below, et al (2010) drew a sample of their study from all over the World, contextual economic differences between countries were not considered. Given that contextual considerations come in hand with capabilities to adapt to changes in climatic conditions, there is need to identify a specific context in which to carry out a similar study. Thus, Lower Nyakach Division in Kenya was selected to assess adaptation strategies to climate change,

Enete, Madu, Onyekuru, Onwubuya, and Eze (2011) aimed at promoting understanding of the most cost-effective and sustainable indigenous climate change adaptation practices in southeast Nigeria, by conducting a study in two randomly selected states of the region namely Imo and Enugu, and in four randomly selected agricultural zones, two from each state. They found that in the face of extreme weather events occasioned by climate change, and apparently because of its tolerance to these conditions, cassava, has become the dominant food crop in the area. Virtually all the respondents reported that extreme weather events and uncertainties in the onset of farming season have been on the increase. In addition, they were also aware of the effect of climate change on agriculture, but were not aware that some agricultural practices could ameliorate climate change effects.

While Enete, et al (2011) revealed that farmers in their sample were aware of the effect of climate change on agriculture and were unaware of farming practices necessary to improve farm production, the need to carry out a similar study in the Kenyan context necessitated the present study. As illustrated in capabilities approach, adaptation to climate change is individual based, hence there is need to assess the same in each community. Therefore, the researcher used a

sample drawn from Lower Nyakach Division in Kenya to assess adaptation strategies to climate change.

In Lesotho, African Technology Policy Studies, (ATPS, 2013) assessed the response of farmers to climate change and its impact to their livelihoods and the potential of the agricultural systems in Ts'akholo and Kolo communities in Mafeteng District. The results revealed that farmers in Ts'akholo and Kolo reported experiencing drought, sporadic and heavy rainfall periods, soil erosion, declining yield, pests and disease infestation, and short growing season and this has led to them developing their own adaptation/coping strategies to climate change. Some of the adaptation strategies include water harvesting technologies, conservation tillage, use of keyhole and trench gardens, agro-forestry and application of traditional medicine to control pests and diseases. The results indicated that soil fertility was found to be more in Conservation Agriculture than in Agroforestry and least in Conventional Agriculture.

Nonetheless, owing to the fact that climate change effects are based on unique contexts and the capabilities of particular communities to adapt, there was need therefore to assess adaptation practices in another area away from Ts'akholo and Kolo communities. Moreover, strategies that were found to be used by the two communities might not be viable elsewhere, like in some parts of Kenya, where the present study took place.

A study done in Kenya by Oremo (2013) sought to identify small scale farmers' perception and adaptation measures to climate change in Kitui County. It was found that extension service, educational attainment, membership to social and economic group, and access to water were the major factors influencing adaptation uptake. Improving these factors will be important to enhance adaptive capacity at the household level. However, findings in Oremo's (2013) study did not reveal the level of knowledge farmers in in the study had so as to inform their adaptation to climate change. Moreover, the study did not reveal the individual adaptation capabilities to climate change which is important in informing adaptation strategies to changes in climate. The present study therefore analysed the awareness to climate change, and consequently adaptation strategies to climate change among farmers in Lower Nyakach Division in Kenya.

Ochieng (2014) sought to establish the factors that limit the adoption of Striga weed control mechanisms in Nyakach district in Kisumu County. A multistage sampling procedure was used

to purposively select two divisions (upper Nyakach and west Nyakach divisions) and one location from each division was selected based on the production levels of maize and severity of Striga. A sample of 30 respondents who were maize farmer was selected for face to face interview using survey questionnaire. Increase in access to credit by farmers increases their adoption of control methods of striga by 31%. An increase in the level of income of the respondents decreases their adoption of striga control methods by 0.0084%. Increase in the level of education increases the level of adoption of striga control methods by 68%. Increase in access to the extension services increases the adoption by 13%. A unitary increase in age of the farmer increases adoption increases by 2.4%. There is a positive relationship between gender and adoption: with every male farmer, adoption of striga control methods is likely to increase by 14%. However, this study was silent on adaptation practices to address climate change.

2.2.3 Challenges Faced by Farmers in Adapting to Climate Change

Although climate change is a global phenomenon, its effects are seldom uniform. Effects and challenges faced in adapting to climate change are unevenly distributed, both between and within countries, according to O'Brien & Leichenko (2008). Moreover, the differential impacts and challenges associated with climate change on the livelihoods of human populations vary and are largely determined by the location of settlement, and levels of income, education and awareness (Oremo, 2013). Therefore, as Adger, et al (2007) assert, vulnerability, impact, and challenges to climate change adaptation are functions not just of geography and dependence on natural resources, but also of socio-political and economic factors. However, Eriksen et al (2008) assert that the most vulnerable are often the poor, politically disenfranchised and marginalised communities, who are among the first to experience the impacts and least equipped to diversify their livelihoods. Low income populations dependent on subsistence farming will increasingly face severe hardships because they have little flexibility to buffer potentially large shifts in their production bases, as opposed to farmers with stable capital bases and supported by strong economies (Ribot, 2010).

Adaptation to climate change by small scale farmers has faced several barriers which range from lack of information about climate change, lack of adaptive capacity, lack of resources, and inadequate preparedness, among other issues. Sterrett (2011) used data from 5 countries in South Asia to analyse good adaptation practices to mitigate climate change in Asia. Focusing on five

countries in the region (Bangladesh, India, Nepal, Pakistan, and Sri Lanka), data was collected from internet sources, reports, and materials gathered from a variety of organizations, as well as from field work in Bangladesh and Nepal. In this study, 64 adaptation projects and programmes were analysed. Out of these, 14 were found to be examples of good practice. These were: participatory assessment and analysis of vulnerability and capacity; focus on poor, vulnerable, and marginalised beneficiaries; local ownership; diversity of stakeholders; flexible and responsive design and implementation: future-looking, and practices that build adaptive capacity at multiple levels and within existing institutions, among others.

Nonetheless, vulnerability to climate change is based on the capabilities of an individual to adapt appropriate strategies to enhance agricultural production. Similarly, challenges faced in adaptation to climate change are also individual based, and are dependent upon the capabilities of an individual. Therefore the importance of establishing challenges faced by individual farmers in adapting to climate change was the part of the main concern of the present study.

In another study, Antwi-Agyei, Dougill and Stringer (2013) used case studies from northeast Ghana and a systematic literature review to assess the barriers that restrict effective implementation of climate adaptations in sub-Saharan Africa. Results showed that households are constrained by a range of barriers, the most important of which included financial barriers, institutional barriers and a lack of information on climate change characteristics. These findings highlight that the provision of credit facilities, development of early warning systems, effective communication of climate information and an understanding of the local context within which adaptations take place, are necessary pre-requisites to enhance climate adaptations and rural livelihoods in sub-Saharan Africa.

In as much as Antwi-Agyei, et al (2013) established the barriers restricting effective implementation of climate change in Sub Saharan Africa, it is important to note that capabilities of individual as well as communities in adapting to climate change vary, hence its effects on individual communities vary. It was thus necessary to investigate the same on another community. This was why the present study focused upon farmers who are household heads in Lower Nyakach Division in Kenya where food insecurity status is low.

Nzeadibe, et al (2011) assessed farmers' perception of climate change governance and adaptation constraints in Niger delta region of Nigeria, with a special focus on the grassroots communities' perception of constraints to adaptation to changing climate in the Niger Delta region of Nigeria. They found that the major constraints to climate change adaptation by farmers were lack of information, low awareness level, irregularities of extension services, poor government attention to climate problems, inability to access available information, lack of access to improved crop varieties, ineffectiveness of indigenous methods, no subsidies on planting materials, limited knowledge on adaptation measures, low institutional capacity, and absence of government policy on climate change. The results further showed that farmers in the Niger Delta generally have a low level of awareness of government policies/programmes on climate change. Furthermore, the study indicates that farmers of the region also have a poor perception of effectiveness of the policies/programmes and low awareness of the existence and impact of Committees on Climate Change in the National Assembly.

Findings provided by Nzeadibe, et al.'s study (2011) is illustrative enough to the situation in developing countries with regard to awareness and adaptation strategies to climate change. While information to forthcoming changes in climate are disseminated in advance to farmers in developed countries (Pidgeon & Lorenzoni, 2006), farmers in developed countries often learn of changes in climate after catastrophes like prolonged droughts or floods have destroyed their farms. However, owing to the fact that challenges faced in adaptation to climate change are contextual, the researcher saw the need to assess the same in Lower Nyakach Division in Kenya. Thus, a sample of household heads who engage in small scale farming activities were used to provide their opinion with regard to challenges they have been experiencing in adapting to climate change.

Another study by Macharia, Thuranira, Ng'ang'a, Lugadiru and Wakori (2012)was carried out in Kenya to evaluate farmer perceptions and adaptation to climate change in Naro Moru and Nairutia areas(both in Nyeri North District) and Matanya in Lamuria Division in Laikipia East District, areas that are typically semi-arid in nature. The farmers identified environmental destruction as the major contributor to the visible effects of climate change and variability in the region. The main indicators are erratic and low rainfalls, frequent droughts and dust storms, low crop yields and high day and low night time temperatures. The effects of climate change resulted

into increased levels of poverty, food insecurity, change in biodiversity and scarcity of resources such as water and indigenous trees which are sources of medicine, nectar, fuel wood, timber and fodder. Changes in biodiversity entail disappearance of wild animals and insects such as safari ants and an upsurge of pests (e.g. centipedes, millipedes and birds). The reduced availability of resources has changed the people's attitudes towards the need to conserve the natural resources and enhance food security through self and group initiatives. The biggest efforts have been towards tree planting and husbandry and adoption of appropriate technologies and farming methods.

Oluoko-Odingo (2006) assessed food security and poverty issues with special reference to small-scale farmers in Nyando District of Kenya. The District suffers from problems of drought and frequent flooding, which negatively impact on agricultural activities. Low food crop production and inadequate cash among various households, make it incapable of benefiting from available food, which could be purchased from neighbouring districts like Kisumu and Kericho. Random sampling was used to obtain a sample size of 279 households, the first household was chosen randomly, and systematic random sampling used to select other households. Regressions and factor analyses were used to analyse the data. It was found that although drought episodes frequently occur in the study area, they were not severe enough to result into total crop failures as opposed to floods, where six months of flooding resulted into total crop failure. Equally, land availability (farm size and land cultivated), household size and labour, hired labour and, distance to the nearest market centre, all impact upon household food security.

In as much as Macharia, et al (2012) revealed that poverty and changes in biodiversity have contributed to constraints in adaptation to climate change, they did not provide adaptation strategies that have been employed (albeit to a little success) by the local farmers in their study. Moreover, the capabilities of the local farmers in their study to adapt to climate change were not highlighted in their findings. Due to the fact that adaptation to climate change, besides being contextual, is dependent upon capabilities of individuals and communities, the present study used a sample from Lower Nyakach Division to assess the challenges faced by farming households in adapting to climate change.

The reviewed studies have demonstrated that although level of awareness of information and adaptation practices to climate change has been studied by various authors across the globe, there is limited information of the same in Kenya, particularly in Lower Nyakach Division. This is one area where persistent drought has resulted into poor harvest, hence reduced food security among households.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This section provides a description of how the study was carried out to achieve the stated objectives. It consists of research design, study location, population and sampling procedures, data sources, data collection instruments, data collection procedure, data analysis, and ethical considerations.

3.1 Research Design

This was a descriptive cross sectional survey design. This study employed a mixed method research design involving qualitative and quantitative data collection methods and analysis. According to Easterby-Smith, Thorpe Jackson and Lowe (2008), this design involves the study of a particular phenomenon (climate change knowledge and adaptation strategies) during a particular time. This design also allows the employment of mixed method (quantitative and qualitative) of data collection and analysis (Sounders, Lewis & Thornhill, 2009; p. 155).

3.2 Study Area

Lower Nyakach is one of the three divisions that make up Nyakach Sub County in Kisumu County. It is bound to the north by Nyando division in Nyando Sub County, to the South by Upper Nyakach division, to the West by West Nyakach division and Lake Victoria to the North West. The divisions forming the Nyakach Sub County are Lower Nyakach, Upper Nyakach and west Nyakach divisions. The Division's total area is 182.6 Km^2 and total population of 58,789 according to Kenya Population Census Report (Republic of Kenya, 2009).

The area is typically dry, with single season of rainfall (March – May) and relies on leguminous cropping (Jimo East); rice farming (Gem Nam); mixed cropping (Rarieda); and mixed cropping and goat keeping (Moro) as the main type of farming. However, those living at the far North near Nyando Floodplains often capitalize on the wet lands to cultivate green vegetables and rice. The rest of lower Nyakach rely on single rainfall season to cultivate (albeit in small scale) maize, groundnuts, sorghum, cassava, and Millet besides goat and sheep keeping.

The rivers that run through the area are River Awach and River Nyando, which often flood adjacent farms and villages during heavy downpour of rainfall, at times making it difficult for cultivation. The rest of the area, however remains dry and are non productive agriculturally. Maize and sorghum are the staple foods in the area. However, each household of five persons is only able to obtain approximately two bags of such produce to be consumed each year. Households in Lower Nyakach therefore rely on supplies from Upper Nyakach Division and Kericho County, although this is a stressor to household income. Appendix V shows a map of study location (Republic of Kenya, 2014).

The area was deemed suitable for this study because the residents were seemingly unable to cope with extreme weather variability and were unable to obtain meaningful agricultural production to improve household food stability:.

3.3 Study Population

Study population comprised of household heads from four sub-locations in Lower Nyakach Division, namely Jimo East, Moro, Gem-Nam, and Rarieda, totalling 2504 in number, as well as 3 agricultural officers, 3 Community Based Organization (CBOs) and 2 NGO officials. This resulted into a target population of 2512. The household heads were targeted because, being members of households responsible for providing food, they are the ones who engage in farming activities for food production. They were therefore considered to be better placed to respond to issues concerning changes in climate in the area. Similarly, Agricultural and CBOs officers were chosen because they have continuously been assisting households in the Division in adopting strategies of enhancing food security.

3.4 Sample Procedure and Sampling Size

This refers to the actual proportion of the study population from which actual data collection will be done (Kombo, 2006).According to Gay & Diehl (1992; cited in Mungure, 2015: 21), the number of respondents acceptable for study depends upon the type of research involved - descriptive, correlational or experimental. Gay and Diehl (1992) contend that for descriptive research, the sample should be 10% for a large (more than 2000) population, and 20% for a small (less than 1500) population (Hill, 1998: 6; Akyina & Alubokin, 2016: 42). Therefore 10% of the targeted heads of households were selected as the sample size, making up 250 households.

To ensure proportional representation of each sub location according to the population of each unit, proportional stratified random sampling technique was employed, where each individual sub location served as a stratum. This enabled the researcher to select a sample in accordance with proportional percentage of the population of each sub group (stratum) or each sub location (Paton, 2002). For example, Jimo East, with a population of 917 households, had a proportional representation calculated as:

$$\frac{917}{2504} \text{x } 100 = 36.6\%$$

Therefore, 36.6% of 250 households equal 92 households from Jimo East sub location. The same proportional calculation was applied to other sub groups. The sample size and sampling procedure is as shown in Table 3.1.

Table 3.1: Sample Size

Sub location	Target Population	Sample size	Percent
Jimo East	917	92	36.6
Rarieda	424	42	16.9
Gem Nam	431	43	17.2
Moro	734	73	29.3
TOTAL	**2504**	**250**	**100**

Source; adopted from Kenya Population Census Report (KPC, 2009)

Further, purposive sampling method was used to select 3 Divisional agricultural officers, 3 CBO officials, and 2 NGO officials to be used as Key Informants from whom interviews were conducted using interview schedule. Community Based Organizations (CBOs) and Non Governmental Organizations (NGOs) officials were selected as key informants in this study because they have been assisting household farmers to secure drought resistant seeds, preparation and securing of organic manure used in farms, and provision of other services like provision of animal feeds, treatment and other professional advice. The information that they provided was essential in supporting data obtained from the local small scale farmers through the use of questionnaires.

Similarly, the Divisional Agricultural Officer was essential in this study owing to the fact that all climate change mitigation endeavors to the farmers in this region are channelled through the Divisional office, and therefore an officer from this office understands the views of farmers concerning climate change and adaptation strategies.

3.5 Data Collection Methods

Three data collection methods were employed in this study: questionnaire for house hold heads, key informant interview schedule, and Focus Group Discussions guide.

3.5.1 Questionnaire

The study used questionnaire method to collect data from randomly selected 250 household heads from the 4 locations sampled by the researcher. The questionnaire was administered in person by the researcher. The significance of this method is that it enabled the researcher to draw short simple questions, which were closed ended, and which also required short and precise answers from the respondents, (Tsai, Lin, & Sai, 2001). The questionnaire used for data collection is found in Appendix I.

3.5.2 Focus Group Discussions

A total of 4 discussions were conducted, 1 in each administrative unit. The first discussion was held in Gem Nam involving 12 rice farmers (5 men and 7 women). The second discussion was in Jimo East, and it involved 10 (women only) farmers who cultivate leguminous crops. The third session was held in Moro location with 11 mixed crop farmers and goat keepers (6 men and 5 women). The last discussion took place in Rarieda with 12 discussants who were mixed crop farmers. In selecting participants for discussions, the researcher considered homogeneity of farming activities engaged in by the farmers. After the 4 sessions of discussions, it was realised that no new information was emerging. Thus, there seemed no point in proceeding with the sessions since a point of saturation had been reached.

3.5.3 Key Informant Interviews

The study also interviewed 3 agricultural officers, 3 CBO officials, and 2 NGO officials (one from Care and another from AMREF) as key informants. These people were selected owing to their wide knowledge on farming practices that mitigates impacts of climate change in the area. The researcher therefore sought their consent first for the interviews, thereafter formal

arrangements were made for the same. The interview schedule that was used to collect data from key informants is presented in Appendix III.

3.6 Pilot Test

To ensure instrument validity and reliability, the researcher carried out a pilot study using purposively selected 24 household heads or 10% of the sampled household heads per administrative unit in the area. These household heads were subsequently excluded from the main study.

3.6.1 Reliability Test

Reliability is a measure of the degree to which a research instrument yields consistent results after repeated trials (Amin, 2005). Split – half test method was used to measure reliability of the questionnaires obtained from pre-test done on 24 purposively selected respondents (3.6). The questionnaire items were divided into two parts of even numbers and Spearman-Brown's coefficient of correlation (r) between the two halves calculated. A reliability co efficient of 0.760 and 0.820 was obtained for the first and second parts respectively. This was an indication that the study instruments were capable of yielding consistent responses from the sampled respondents.

3.6.2 Validity Test

According to Mugenda and Mugenda (2005), instrument validity represents the extent to which the instrument measures what it purports to measure; it is the degree to which the analyzed data actually represents the phenomenon under study. To ensure instrument validity, instruments were counter checked by the research supervisors and peers in order to improve their contents and to ensure their content validity. The inadequate items were modified and others discarded in order to improve the quality of the instrument. Additionally, the principle of triangulation was employed, whereby two different research instruments were used in this study: questionnaires and interview guide. The results from both instruments were thereafter corroborated.

3.7 Data Analysis and Presentation

This study used both qualitative and quantitative data analysis methods. Qualitative data obtained from FGDs and KII was analyzed qualitatively through Thematic Analysis and organized into themes and patterns corresponding to the research questions. This helped the researcher to detect and establish various categories in the data which are distinct from each

other. The analysed qualitative data was presented in excerpts representing outstanding themes as captured from the discussants and informants.

Qualitative data obtained from KII and FGDs were recorded and later transcribed by the researcher. Agricultural officers were coded as A1 – A3; CBO officials were coded as C1 – C3; and NGO officials were coded as N1 – N2. Focus Group Discussions (FGDs) were coded as F1 to F4, with regard to sub locations where the discussions were held. Quantitative data such as statistical information on biographical backgrounds of the respondents, level of awareness of climate change information, indigenous adaptation practices, and the challenges faced in adaptation practices to mitigate effects of climate change generated percentages representing opinions and views of the respondents.

3.8 Ethical Considerations

These are the moral principles guiding research from its inception through to completion and publication of results. In this regard, the researcher observed the following: Respect for the autonomy and dignity of persons was ensured through seeking informed consent of respondents to participate in the study. Social responsibility was followed by ensuring that the data collection process caused unwarranted disruption to day to day activities of the households who participated in the study. Rights to privacy and confidentiality were achieved by concealing the identities of participants through assigning them pseudonyms instead of their true names. Finally, experts from Maseno University were constantly consulted during formulation of the study objectives and design. This ensured that scientific value of the study is achieved.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND DISCUSSIONS

4.1 Introduction

The purpose of the study was to examine farmers' awareness of, and adaptation strategies towards climate change in Lower Nyakach Division, Nyakach Sub County, Kenya. This chapter presents the findings of this study along the specific objectives.

The first section of the study instrument sought to establish demographic characteristics of the sampled household heads.

4. 2 Demographic Characteristics of Respondents

The first part of demographic characteristics of the sampled household heads assessed the gender of the respondents. Table 4.1 presents the distribution of respondents by gender.

Table 4.1: Distribution of respondents by gender

	Frequency	Percent
Male	96	38.4
Female	154	61.6
Total	**250**	**100.0**

Table 4.1 illustrates that most (61.6%) of the sampled household heads were females, while 38.4% were males. This suggests that among rural households which commonly engage in small scale or subsistence farming, women form the majority. This finding seems to indicate that most rural households engaging in small scale farming activities are headed by females. The onus to look for daily meals therefore seem to rest upon women in these set ups.

The second part of demographic characteristics of the sampled households assessed the ages of the respondents. Table 4.2 presents the distribution of respondents by age.

Table 4.2: Distribution of respondents by age

Age (in years)	Frequency	Percent
Below 30	23	9.2
31 - 35	51	20.4
36 -40	35	14.0
41 - 45	28	11.2
46 - 50	37	14.8
51 and above	76	30.4
Total	**250**	**100.0**

Table 4.2 indicates that most (30.4%) of the sampled household heads were aging 51 years and above, while 20.4% of the household heads were between 31 and 35 years of age. On the other hand, 14.8% of the respondents were of between 46 – 50 years of age; 14% of the sampled household heads aged between 36 and 40 years; 11.2% of the respondents being between 41 and 45 years old; and the remaining 9.2% of the respondents were of below 30 years of age. Findings in Table 4.2 indicate that over 50% of the sampled household heads were 45 years and above, suggesting that they were adults who have been participating in food production for the benefit of households which they head. Thus, this age group was expected to possess experience in issues related to shifts in climatic conditions and adaptation practices as well as challenges faced in adapting to changes in climate.

The third part of the demographic characteristics of the sampled household heads assessed the education level of the respondents. Table 4.3 presents the distribution of respondents by education level.

Table 4.3: Distribution of respondents by education level

	Frequency	Percent
None	11	4.4
Primary Level	123	49.2
Secondary Level	105	42.0
Tertiary Level	10	4.0
Total	249	99.6
Missing	1	.4
Total	**250**	**100.0**

Table 4.3 illustrates that the highest number (49.2%) of the sampled household heads had primary level of education, while 42% of them had secondary level of education. Furthermore,

4.4% of the sampled respondents did not attend school entirely, and the remaining 0.4% of the respondents failed to indicate their education level. It has been revealed by Table 4.3 that the highest numbers of households were headed by adults whose education levels are up to primary schooling only. This suggests that awareness to climate change might prove difficult to these household heads, because most of climate change information is seldom relayed through local vernacular languages. This result seem to concur with what the BBC World Service Trust (2010) established in Tanzania, that most local farmers in rural areas have little knowledge of climate change concepts.

The fourth section of demographic characteristics assessed appropriate farm size owned by the sampled household heads. Table 4.4 presents distribution of respondents by approximate farm size.

Table 4.4: Distribution of respondents by approximate farm size

		Frequency	Percent
	Less than 1 ha	46	18.4
	1 -2 ha	121	48.4
	2 -3 ha	58	23.2
	More than 3 ha	23	9.2
	Total	248	99.2
	Missing	2	0.8
Total		**250**	**100.0**

Table 4.4 illustrates that the highest number (48.4%) of the sampled households own between 1 and 2 hectares of land, while 23.2% of them own between 2 and 3 hectares of land. On the other hand, 18.4% of the households whose heads participated in the study own less than 1 hectare of land and 9.2% of them were found to own more than 3 hectares of farm size. However, 0.8% of the sampled household heads did not provide the information regarding the size of farm owned by their households. This finding indicates that more than 66% of the respondents own below 2 hectares of land. This suggests that farmers in Lower Nyakach Division have limited options for crop diversification owing to farm size.

The last part of demographic characteristics assessed was the size of family among the sampled households. This was important in this study because size of family correlates with food demand,

and subsequently calls for high capabilities required to meet the same. Table 4.5 presents distribution of respondents by family size.

Table 4.5: Distribution of respondents by family size

No. of family members	Frequency	Percent
1 - 3	49	19.6
4 - 6	125	50
7 - 9	58	23.2
10 - 12	12	4.8
13 and Above	3	1.2
Total	247	98.8
Missing	3	1.2
Total	**250**	**100.0**

Table 4.5 shows that the largest number (50%) of the sampled households had between 4 and 6 members, while 23.2% had between 7 and 9 members. Equally, 19.6% of the sampled households had between 1 and 3 members; 4.8% had between 10 and 12 members, and the remaining 1.2% of the sampled households had 13 and above members. However, 1.2% of the sampled household heads did not indicate the size of their families.

This finding suggests that the average size of families in the study area is 5 members. Thus, households composed of 5 members and with less than 2 hectares of land would be expected to employ intensive farming inputs to adapt to climate change (Ndambiri, et al, 2012). This would call for high adaptive capacity or capability. Thus it was deemed necessary to assess adaptation strategies employed by these households to climate change.

4.3 Awareness and Adaptation Strategies to Climate Change

Having presented biographical information of respondents, this section now focuses on the main issues in order to achieve the study objectives and realize its purpose. This has been done in the sequence of the objectives of the study and the results of quantitative data presented in percentages.

4.3.1 Level of Awareness of Local Farmers on Climate Change

The first objective of the study sought to assess the level of awareness of local farmers on climate change. Using translated language to suit local dialect, the researcher presented statements related to the level of awareness in regard to shifts in climatic conditions, whereby the

sampled household heads were requested to express their agreements as: **1**- Strongly Disagree; **2**- Disagree; **3**- Neither Agree nor Disagree; **4**- Agree **5**- Strongly Agree to the statements presented by the researcher. Table 4.6 presents the distribution of respondents by level of awareness of local farmers to climate change.

Table 4.6: Distribution by Level of Awareness of Local Farmers

No	Items	1	2	3	4	5
1	We often receive weather information through *barazas*	9.6	29.6	28.4	32	4
2	Radio has been a common source of weather information	0.4	1.2	0.8	76.0	21.6
3	We've experienced decreased rainfall in recent past	00	11.2	0.8	87.6	0.4
4	We have received intense rainfall in recent past	00	30.4	6.4	62.4	0.8
5.	Prolonged draught has become common in the village	00	7.6	4.8	74.0	13.6
6	Floods have become common on arrival of rainy seasons	00	22.0	1.6	63.6	12.8
7.	Short and inconsistent patterns of rainfall are common	00	4.4	2.0	92.4	1.2
8.	Heavy rainfall have caused delay of land preparation	00	38.8	5.2	38.8	17.2
9	We receive weather information via extension officers	7.6	68.0	0.8	22.8	0.8
10	We rely on internet for weather information	18.8	78.4	0.8	1.6	0.4

Table 4.6 illustrates that, with regard to level of awareness of shifts in climate change, 92.4% agreed that they were aware of common short and inconsistent patterns of rainfall; 87.6% agreed that there has been decreased rainfall in recent past; 76% of the sampled household heads also agreed that radio is a common source of weather information in the area; another 74% also agreed that there has been prolonged droughts in the village; while 63.6% of the sampled household heads agreed that there has been floods during rainy seasons. Equally, 62.4% of the sampled household heads agreed that instances of intense amounts of rainfall had been some shifts in climatic conditions in the area. On the other hand, the respondents disagreed that: they rely on internet for weather information (78.4%); and that they receive weather information from extension officers (68.0%). This therefore implies that rainfall patterns have become short, inconsistent and decreased in amount in Lower Nyakach Sub County. Moreover, radio has remained a common source of weather information in the area, while internet seems to be inaccessible due to low level of education and location of the area, being far away from urban centres.

Interviews held with the agricultural officers also produced an outstanding theme pointing to lack of information seeking from the side of the farmers, with the following statement emerging from one of the two Agricultural Officers:

> *Only a few farmers from this division do seek necessary weather information from the agricultural extension officers* (A1).

Without seeking weather information from sources like agricultural officers (also referred to as extension officers), it is likely that by the virtue of being a common mass communication gadget, radio stands as a common source of information, including weather information, in the division. Additionally, owing to the fact that majority of the household heads who participate in small scale farming in the area are females with primary level of education, limitation in language of communication might suggest that vernacular radio stations are the only optional source of information. This finding resonates with that of The BBC World Service Trust (2010) when it conducted a research to explore public awareness and understanding of climate change in Tanzania. It found that although Tanzanians have noticed changes in the weather, seasons and drought, most of them have little understanding of the relationship between these issues and climate change due to lack of weather information from experts. It is therefore important to note that the capability of these farmers to access appropriate weather information seems to be limited in terms of lack adequate language for communication and knowledge of where to get such information.

With regard to weather information as held by farmers in the division, an outstanding themes emerging from two FGDs was soil degradation as well as emergence of pest and strange crop diseases such as *Miguna Miguna* (the yellowing of the entire maize crop) that have taken place in the recent past. A common theme derived by the researcher was:

> *There has been increase in land degradation, and soil erosion leading to formation of gullies There has also been emergence of pests and diseases like "Miguna Miguna", yellowing of maize plants, affecting maize crops in the region; unpredictable weather patterns, and prolonged drought and floods* (F3).

This excerpt from FGDs implies that the sampled farming household heads are aware of climate changes and the effects that this has had on crop production. Plate 4.1 presents a picture of a maize disease invasion in the study area.

Plate 4.1: Picture of strange disease invasion on Maize Crop

Plate 4.1 and 4.2 presents pictures of maize crop that have suffered from invasion of strange diseases. According to the farmers who participated in the FGDs, the developing cob is first attacked during flowering stage, and then the entire crop turns yellow. The type of attack shown in the second picture is the outcome of the stalk yellowing. This was another statement that emerged from the discussants:

> *(Ochondo mako bando te, ma gima inyalo ka en man nus mar bando) ..... the entire cob is consumed by the disease such that one can only get half of what was expected from the field* (F5).

This statement indicates that the farmers lose almost half of what they were expected to harvest due to this invasion. This finding seem to concur with Mary and Majule's (2009) results in a study which established that changes in rainfall and temperature have affected crops and livestock production in a number of ways resulting in reduced productivity in Tanzania. Nevertheless, Pidgeon and Lorenzoni (2006) did not find any perceived negativity as well as threat attributable to changes in climate in a study among the public in Europe and the United States of America. This might have been due to contextual differences and individual capabilities in developed and developing countries. Perhaps the capabilities of farmers in Europe to adapt

measures that mitigate effects of climate change enable them to realize uninterrupted crop production throughout farming periods. This is in line with Schlosberg (2009) assertion that changes in climate affects what individuals are able to do with the resources that they have. For instance, if climate change impedes agricultural practices, then functioning of lives becomes limited. In that case, climate change is a barrier to functioning of lives. Capabilities of farmers in places like Tanzania and Lower Nyakach Division to own sufficient resources to mitigate effects of climate change has therefore led to low production of food crops hence affecting functioning of lives of households.

Another outstanding theme which emerged from the FGDs was the pronounced changes in weather patterns. Outstanding statements emerging from 4 discussants clearly outlined these changes as:

> *There have been instances of unprecedented harsh temperature, depreciation of water catchment areas, and dwindling water levels in the rivers as well as Lake Victoria. Weather patterns in the area have been unpredictable, with both prolonged drought and floods* (F4).

Findings from the statement made in F4 imply that floods and persistent draughts are extreme conditions that the farmers are faced with each year. Floods wash away crops in the farms and all plants plus organic deposits, leaving behind bare grounds exposed to extreme heat during dry spells. Plates 4.2; and 4.3 present pictures of such extreme weather conditions.

Plate 4.2: Picture of flooded farms in the study areas

Plate 4.2 presents a picture of flooded farms: farms that have been entirely submerged in flood water during unexpected flash rains. Entire farms are washed away with the floods, including crops and organic substance on the farms. This leave the farmlands exposed to the scotch of the sun in the proceeding period as shown in plate 4.3.

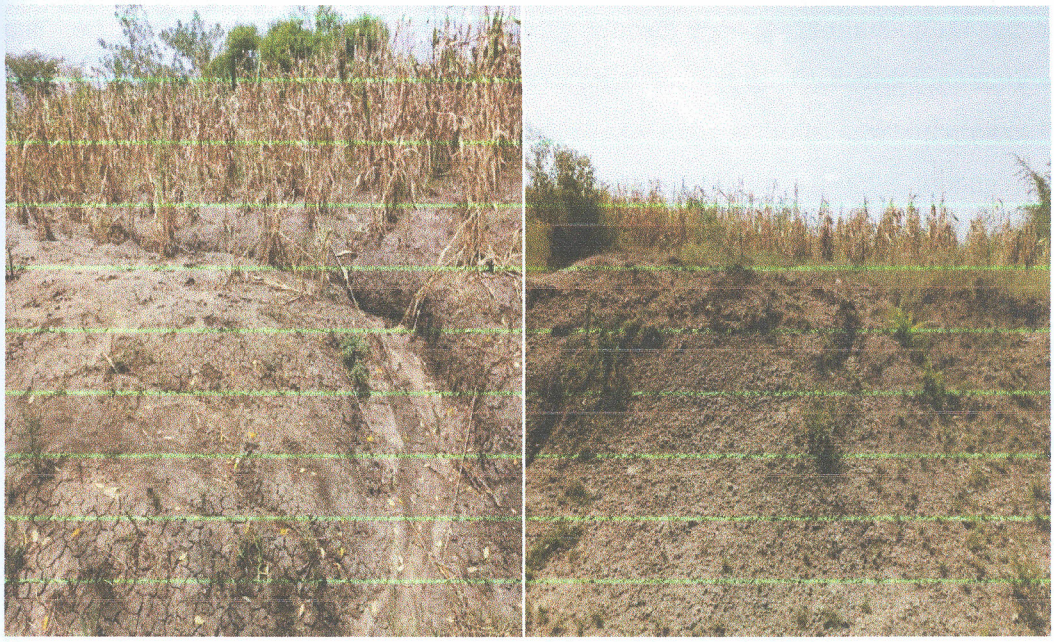

Plate 4.3: Pictures of dry farms that have been heavily eroded during floods

Plate 4.3 presents dried farmlands that have been washed bare by the floods during unexpected rains. Statements from the FGDs suggested that it takes time for such farms to regain their nutrients. One statement attributed to one of the discussants was that:

> *(Koth pore bang'e ka cham dwa chako golo wino seche moko mathoth matamo wang'. Pi yweyo puodho ma weyo ka owango cham te) ..... the rains at times come unexpectedly just when the crops are about to flower. Such rains cause floods that consequently wash away everything* (F2).

This finding implies that most farms are damaged by unexpected rains to an extent that crops are lost, and the cultivated farms are left bare. However, the sampled household heads (38.8%) could neither agree nor disagree that heavy rainfall has caused delay of land preparations in the area. This implies that while heavy rainfall interferes with land preparation of some farmers, other farmers have adapted to it (heavy rains). Moreover, the sampled respondents could not also clearly accept or deny whether or not they receive weather information through *barazas*. This is because; while 32% of them agreed that they receive such information through *barazas*, 29.6% disagreed; 28.4% neither agreed nor disagreed; 9.6% strongly disagreed, and 4% strongly agreed. This implies that attendance of these *barazas* by household heads could be irregular or low on one hand, or people responsible for providing climate change information do not adequately make use of such *barazas*. Thus, it remains evident that sources of weather information for these farming household heads are limited to broadcasts by radio stations. It was therefore interesting to establish what might have informed adaptation strategies (if any) among the farming household heads under study.

4.3.2 Indigenous Adaptation Practices and Climate Change

The second objective of the study sought to establish the indigenous adaptation strategies used by local farmers in addressing climate change and to enhance crop production. To this end, the researcher presented statements related to indigenous farming practices adapted to combat shifts in climatic conditions, whereby the sampled household heads were requested to express their opinion to the presented statements as: **1**- Strongly Disagree; **2**- Disagree; **3**- Neither Agree nor Disagree; **4**- Agree**5**- Strongly Agree. Table 4.7 presents the distribution of respondents by level of awareness of local farmers to climate change.

Table 4.7: Distribution by Indigenous Adaptation Strategies

No	Items	1	2	3	4	5
1	We often plant drought resistant hybrid seeds	1.2	23.2	11.2	64	00
2	We use tractors to plough our farms	6.4	71.6	2.8	19.2	00
3	Most of us plant early	2.0	64.4	2.0	31.6	00
4	We apply manure intensively in our farms	0.8	40.4	8.4	49.2	1.2
5.	Most of us use crop rotation in our farms	00	57.2	1.2	39.2	2.4
6	Multi cropping has become our only alternative	0.4	1.6	00	89.2	8.8
7.	Weeding is done more than once	00	0.4	00	83.6	16.0
8.	We normally plant early maturing crops	3.6	10.4	8.4	76.0	1.6

Findings presented in Table 4.7 reveal that the sampled respondents agreed that: Multi cropping had become their only alternative (89.2%); weeding is done more than once (83.6%); they normally plant early maturing crops (76.0%); they often plant drought resistant hybrid seeds (64.0%); and that they apply manure intensively in their farms (49.2%) as some indigenous adaptation strategies that they have used to mitigate the effects of climate change. This implies that, to minimise risks associated with crop losses, farming household heads resort to planting more than one type of crops as well as weeding intensively, although this may require large parcels of farm sizes. Perhaps due to the small sizes of farms revealed in this study, food deficit has been rampant among most households in this area. The capability of the farming households to own large farms is low, hence limiting their choice for crop rotation among other practices.

Interviews conducted with KII alongside discussions held with discussants from the four sub locations revealed outstanding themes, one of which was related to improvement in soil fertility. Four key informants stated thus:

> *Farmers have adopted use of green manure and farmyard manure in the farms instead of commercial fertilizers* (C2).

Some other KII stated that:

> *There has been a tendency of mulching and terracing to reduce flooding and soil erosion, while some farmers also plant short or fast – maturing seeds, as well as the use of disease-tolerant seeds* (N1).

Results obtained from KII suggest that farmers in this area are more concerned with soil degradation as caused by changing climatic conditions. The African Technology Policy Studies, (ATPS, 2013) also established similar adaptation practices in its study on farmers responses to climate change in Lesotho. It established that farmers consider soil fertility to be more in conservation agriculture than other practices.

Similarly, discussants who participated in FGDs gave out statements which the researchers deciphered to an outstanding theme the use of composite manure for soil fertility conservation. For instance, some 5 discussants in two of the FGDs made the following statements:

We have resorted to the use of farmyard manure in the farms instead of commercial fertilizers for soil enrichments in our farms (F1).

Another 1 discussant in one of the FGDs asserted that:

> *We have decided to increase the usage of agro forestry practices, with seasonal crop patterns and rotation for soil enrichment in our farms* (F3).

Another statement from 2 discussants in two of the FGDs was:

> *We have made a tendency of mulching and terracing to reduce flooding and soil erosion, as well as planting short or fast – maturing seeds* (F2).

The farmers under study seem to be incapable of acquiring suitable resources to combat changes in climatic conditions, as explained by capability theory: their functionings are limited to the mentioned practices. This therefore implies that the need to control soil erosion and enhancing of soil fertility is a major concern of farmers in Lower Nyakach Division. Prevalence of soil erosion thus seems to drive the need to plant fast maturing crops among the farming household heads, given the fact that the ability of the farmers to employ appropriate technologies in harvesting the rain water seems limited. Additionally, the level of education held by the farming household heads (mostly primary level of education) tends to inhibit their acquisition of adequate knowledge for controlling unexpected floods or soil degradation.

On the other hand, farming household heads in this study were found not to use deep ploughing machines like tractors for farm preparation, plant early, and use crop rotation (71.6%; 64.4%; &

57.2%, respectively). This tends to suggest that more concern is placed on state of soil fertility than seeds or method of planting and farm preparation, although the capability to meet the cost of such farming practices seems to be beyond the farmers. Furthermore, the small sizes of farms among the households as revealed in this study compounds the ability to practice crop rotation. This finding, however, seems to contradict what Enete, et al (2011) found out that farmers in Nigeria have resorted to planting drought resistant crops like cassava to combat climate change effect.

Studies focusing adaptation practices in the developed world have revealed contrasting results. Jackson, et al., (2011) found when they examined adaptation strategies for agricultural sustainability in Yolo County in California, USA. They (Jackson, et al., 2011) found out that farmers in the particular area implement water conservation practices, and adopt voluntary Green House Gas (GHG) mitigation practices. Similarly, the findings also seem to contradict what Ramsey and Tarleton (2008) found that farmers use crop rotation frequently as a farm level adaptation to multiple risks in climate change among farmers in Canada. Another study done in Kenya by Oremo (2013) also produced results which contradict those shown in Table 4.7. In an attempt to identify small scale farmers' perception and adaptation measures to climate change in Kitui County, Oremo (2013) found that the farmers rely on extension service, educational attainment, membership to social and economic group. The present study therefore reveals that in Lower Nyakach Division, farmers have adapted soil conservation practices that involve control of soil erosion as well as application of farm yard manure and mulching. This situation is probably explained by capability theory in that the ability of local farmers to adapt practices which can enhance their food security is limited to the mentioned practices.

4.3.3 Challenges Faced in Adaptation Strategies for Climate Change

The last objective of the study sought to determine the challenges facing local farmers in adapting strategies meant to address climate change aimed at enhancing food crop production. Thus, the researcher developed a questionnaire with statements related to challenges facing farmers in adapting strategies for climate, whereby the sampled household heads were requested to express their agreements to the statements as: **1**- Strongly Disagree; **2**- Disagree; **3**- Neither Agree nor Disagree; **4**- Agree**5**- Strongly Agree. Table 4.8 presents the distribution of

respondents by level of awareness of local farmers to climate change. Table 4.10 presents distribution by challenges faced in adaptation strategies.

Table 4.8: Distribution by Challenges faced in Adapting to Climate Change

No	Items	1	2	3	4	5
1	Lack of information on adaptation practices	1.2	49.2	4.8	43.6	1.2
2	Unavailability of information on forthcoming climate	0.8	80.0	2.0	15.6	1.6
3	Lack of Government subsidies	0.8	9.2	3.2	70.4	16.4
4	Inadequate extension services	1.2	6.8	0.4	77.6	14
5.	Lack of financial resources	1.6	0.4	00	75.2	22.8
6	Small sizes of land	00	40.8	4.0	48.4	6.8
7.	Poor farming practices	00	35.6	3.2	50.0	11.2
8.	Late preparation of farms	00	42.4	2.8	42.4	12.8

Table 4.8 illustrates that amongst the challenges faced in adapting measures that mitigate climate change effects, the sampled households agreed that: inadequate extension services (77.6%); lack of financial resources (75.2%); lack of government subsidies (70.4%); poor farming practices (50.0%); small sizes of land (48.4%); and late preparation of farms (42.4%) are some of the factors which constrain adaptation to climate change among household heads in the sampled sub locations. This implies that while the farming household heads perceive the government, through the agricultural extension services, as duty bound to assist them in adapting to climate change; this has remained a big challenge. This has been coupled with lack of adequate financial resources, which points at the low level of income among the households in the study area.

Interviews conducted with KII also generated information with a theme of inadequacy of services to the small scale farming household heads. For instance, one KII stated that:

> *Farmers lack financial resources and enough capital to engage in mechanised farming in the wake of climate change* (A3).

One of the four KII commented that:

> *Poor infrastructure and inadequate climate change implementation has remained barriers to adaptation to climate change in the entire country* (C3).

This suggests that low financial resources inhibits the farmers in their effort to use machineries like tractor for soil preparation, as well as water conservation implements to adapt to drought. This conforms to Eriksen et al's (2008) assertion that the most vulnerable people to climate change effects are often the poor and the marginalised. Similarly, Antwi-Agyei, et al (2013) also found that households are constrained by financial barriers, institutional barriers and a lack of information on climate change characteristics in Ghana.

Similar sentiments were also deduced from FGDs in all the four sub locations. In the four FGDs, most common statement from discussants emerged that:

> *We have been constrained by lack of professional information that could support us to apply the modern farming methods, use of resistant seeds and the machinery involved to combat climate change effects* (F4).

In another FGD session, it emerged that:

> *Due to inability to cope with changes in climate, farmers have been unable to combat strange crop diseases like Miguna Miguna, thus escalating the state of poor maize harvests* (F2).

This implies that extension services to the farmers seem to be wanting. This is besides lack of adequate income to purchase inputs and employ appropriate machineries in land preparation. This therefore renders the local small scale farmers in this Division incapable of leading their desired live of food security in the household.

On the other hand, the farming household heads did not agree that unavailability of information concerning forthcoming climate and lack of information on adaptation practices (80% & 49.2% respectively), are challenges that they face in adapting strategies meant to mitigate climate change effects. This therefore isolates lack of resources as a major challenge in adaptation to climate change, hence begging for individual capability in this in ensuring adaptation. As stated by Ribot (2010), it is the responsibility of individual communities to define their own vulnerabilities and designing just adaptation strategies that are planned to shield them from

climate change that threatens their ability to function. In this regard, farmers in Lower Nyakach Division face challenges in adapting to climate change due to lack of resources.

Findings in this section seem to agree with those obtained by Antwi-Agyei, et al. (2013) in a study carried out in Ghana, that households are constrained by a range of barriers, the most important of which included financial barriers, institutional barriers and a lack of information on climate change characteristics. Inability to access essential climate information and to acquire necessary inputs was also established by Nzeadibe, et al. (2011) in a study among farmers in Niger Delta. It is therefore clear that the theory of capability advanced by Sen (1992, 1999, and 2004) seems to apply to local farmers in Lower Nyakach Division. The poor harvests, and hence food insecurity, results from lack of functioning of individual farmers which may enable them acquire well-being (food security for that matter).

Thus, as evident from studies done in other developing countries, farmers in Lower Nyakach Division face challenges in acquiring adequate resources for adaptation to climate change. Equally, inadequacy of extension services with regard to necessary adaptation practices to be adopted in the face of shifts in climate continues to worsen resource related challenges among farmers in the Division.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1Introduction

This chapter presents a summary of the findings of the study, conclusion and recommendations. The researcher also offers recommendations for the purpose of improving awareness of, and adaptation to climate change, as well as suggesting further studies based on the study findings.

5.2 Summary of Findings

The general objective of this study was to establish farmers' awareness of, and adaptation strategies towards climate change in lower Nyakach Division, Kisumu County-Kenya. It assessed the level of awareness of local farmers to climate change, indigenous adaptation strategies used by farmers to mitigate climate change effects, and the challenges faced by farmers in adapting mitigation approaches for addressing climate change effects.

The analysed data revealed that the sampled household heads agreed that they were aware that shifts in climatic condition experienced in the area include common short and inconsistent patterns of rainfall; decreased rainfall in recent past; prolonged drought; floods during rainy seasons; and unprecedented intense amounts of rainfall. The respondents also agreed that radio broadcasts is a common source of weather information. But the respondents disagreed that they rely on internet for weather information, as well as that they receive weather information from extension officers. However, delays in farm preparation cannot entirely be attributed to heavy rainfall. It therefore seem that the capability of these local farmers to employ equip themselves with timely climate information is wanting.

In regard to indigenous adaptation strategies, the respondents agreed that multi cropping is the only alternative they employ; weeding is done more than once, probably to loosen the soil structure for enhance of crop growth; they normally plant early maturing crops; they often plant drought resistant hybrid seeds; and they apply manure intensively in their farms. The respondents, however, disagreed that they use tractors to plough their farms; most of them plant early; and that most of them use crop rotation as indigenous adaptation strategies.

Amongst the challenges faced in adapting measures for mitigation of climate change effects, the respondents agreed that inadequate extension services, lack of financial resources, lack of government subsidies, poor farming practices, small sizes of land, and late preparation of farms. But the respondents disagreed that unavailability of information concerning forthcoming climate and lack of information on adaptation practices are challenges that they face in adapting strategies meant to mitigate climate change effects.

5.3 Conclusions

This study was anchored upon capability theory advanced by Sen (1992, 1999, and 2004). The theory has two basic tenets: functioning and capabilities. It articulates that functioning is an achievement, while capability is the ability to achieve. Based on the summary of findings which the analysed data generated, the study makes the following conclusions:

Although the local farmers in Lower Nyakach Division are aware of inconsistent shifts in climatic conditions, their ability to achieve reasonable crop production and consequently food security is limited. The only important source of weather information remains radio broadcasts, and not agricultural extension officers, hence limiting their options on adaptation to climate change.

The local farmers in Lower Nyakach Division have limited options with regard to adaptation practices for mitigating impacts of climate change due to their incapability. Due to small sizes of farms, the farmers employ intensive cropping by planting drought resistant seeds and planting early maturing crops, although fertilizers and heavy machineries like tractors are seldom used for farm preparation. Hence strange diseases like Miguna Miguna and pest invasion have tended to reduce maize crop production to a great extent

Finally, the challenges faced in adapting measures for mitigation of climate change impacts in the area is a direct reflection of lack of ability to achieve such measures. The farmers are unable to access adequate extension services, they lack financial resources and government subsidies, employ poor farming practices, and do not prepare their farms in time.

5.4 Recommendations

The study makes the following recommendations for improvement in food security and further research that should be done to improve awareness of, and adaptation strategies to mitigate climate change. This, in turn, would enhance the level of awareness of local farmers to climate change, indigenous adaptation strategies, and methods to address challenges faced in adapting strategies to climate change.

5.4.1 Recommendations for Improving Awareness of, and Adaptation to Climate Change

Given that the local farmers in the do not obtain weather information from extension officers yet these are experts in agriculture who are well placed to provide advice on climate change, more extension services need to focus on these farmers. The Ministry of Agriculture should ensure that the mandate of extension services should include, among other duties, dissemination of climate change information to local farmers. Farmers should also be educated through village barazas on appropriate adaptation methods for mitigation of climate change in their respective communities.

The study also revealed that the local farmers do not use ploughing methods which enable penetration and absorption of water into the ground during intense rainfall, and consequently absorption and retention of water in the soil. Thus, much emphasis should be laid on tractor ploughing as opposed to other methods. Similarly, it emerged from the findings that local farmers in the area do not plant early and seldom use crop rotation. The local farmers should be advised to plant early, possibly at the onset of the rainy season, so as to utilize the season fully. Furthermore, crop rotation is an essential farming practice which ensures that nutrients are preserved for different crops. Farmers should therefore be encouraged to practice extensive crop rotation in their farms each planting season.

The challenges revealed by the study include lack of resources and extension services to adapt to climate change. Thus, the researcher recommends that extension services to the local farmers should be enhanced, and more financial resources should also be availed to the local farmers in terms of loan facilities and other grants by the government and NGOs. Moreover, subsidies in terms of farm inputs (seeds, fertilizers, and costs of tractor ploughing) should also be extended to the local farmers. Farmers should also be sensitized to prepare their farms early enough to enable planting at the onset of the rains during rainy season.

5.4.2 Recommendations for Further Research

Emanating from the findings of the study, the researcher recommends that further studies be done on the following areas.

i) The contribution of Radio Stations announcements on awareness of, and adaptation to climate change.

This remains a particular area to be researched on given that, although the study revealed that the local farmers in the area often receive weather information through radio, food crop production among the households still remain low. This begs an explanation as to whether radio announcements related to weather forecasts are helping local farmers to adapt appropriate farming practices which can help them enhance food crop production.

ii) Effectiveness of land ploughing methods on household crop production.

The study has revealed that the local farmers do not involve ploughing implements like tractors for land preparation. In the wake of low production of food crops, there is need for an investigation into the effectiveness of ploughing methods used by local farmers.

iii) Availability of information on adaptation practices and household crop production.

It has been revealed by the study that the sampled local farmers do not view unavailability of information adaptation practices as a challenge being faced in adapting strategies to mitigate climate change effects. It is therefore prudent to determine whether or not availability of information related to adaptation practices enhances household food crop production.

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