MECHANISMS OF COPING WITH RECURRENT DROUGHTS: A CASE OF LIVESTOCK FARMERS IN MURANG'A SOUTH SUB-COUNTY, MURANG'A COUNTY, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF MASTERS IN ENVIRONMENTAL STUDIES (CLIMATE CHANGE AND SUSTAINABILITY) IN THE SCHOOL OF ENVIRONMENTAL STUDIES OF KENYATTA UNIVERSITY

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DECLARATION

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

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DEDICATION

To my wonderful parents, Duncan and Elizabeth, my dear husband Gibson for being the driving force that propelled my determination towards completion of this work.

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List of abbreviations and acronyms

ARTES	Africa Rainfall and Temperature Evaluation System
ASAL	Arid and Semi Arid Areas
FAO	Food Agricultural Organization
FEWS	Farming Early Warning Systems
G.O.K	Government of Kenya
GHG	Greenhouse Gases
Ha	Hectares
IGAD	Intergovernmental Authority for Development
ILRI	International Livestock Research Institute
ILRR	International Livestock for Rural Reconstruction
IPPC	Intergovernmental Panel for Climate Change
ISDR	International Strategy for Disaster Reduction
LM3	Lower Midland 3
LM4	Lower Midland 4
NASA	National Aeronautic and Space Administration
NCCK	National Council of Churches of Kenya
NDMC	National Drought Mitigation Centre
SPSS	Statistical Package for Social Sciences
UM3	Upper Midland 3
UM4	Upper midland 4
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
WWF	World Water Forum

ABSTRACT

One third of the African people live in drought prone areas. Drought is the most limiting factor in agricultural production in Sub Saharan Africa. The disaster is exacerbated by lack of adequate coping mechanisms which is often disaster response rather than prevention. A case study on drought coping mechanisms was conducted among livestock farmers in Murang'a South Sub-County of Murang'a County in central Kenya. The purpose of the study was to determine the strategies used by livestock farmers to cope with recurrent droughts. The objectives were: to find out how livestock farmers in the study area perceive drought, to identify the effects of drought, to find out how livestock farmers counteract the problem of drought to reduce vulnerability and to determine the constraints faced by the livestock farmers in their attempt to cope with drought. Descriptive survey research design was used. Stratified random sampling was applied to select a sample of two hundred households. The primary sampling unit was an individual household. Data was collected by administering a semi-structured questionnaire to two hundred livestock farmers. Data on perception of drought, preparation in readiness for drought, the effects of droughts on livestock farmers and their households as well as their strategies in responses to disturbances and changes during drought were investigated. The factors exacerbating vulnerability were also investigated. The generated data were subjected to statistical analysis using SPSS. Descriptive statistics such as percentages and frequencies were used to summarize the data which was presented using tabulations, histograms and pie charts. The relationships between the variables were analyzed by the Chi- square nonparametric test. Findings of the study revealed that majority (98.5%) of the livestock farmers' perceived drought as a serious environmental hazard regardless of their gender and education level. Majority (71%) of the livestock farmers experienced death of their livestock during drought. Other major effects of drought included; food and water scarcity and increase in absenteeism of children from school. There was a negative relationship between farmers' education level and death of animals during drought (chi- square test df =4, $p<0.05$ (14.909). To cope with drought, the farmers sought alternative employment, received government assistance and engaged in casual labour. Some of the measures used to cope with drought differed significantly across education level. The major constraints faced by the livestock farmers in their attempt to cope with drought were low value of livestock, poverty, pests and diseases, and high prices of foodstuffs. From the study, it was concluded that, livestock farmers in Murang'a South Sub-County were not coping with drought in a sustainable way as their sufferings were substantial. Based on the study findings, with the frequency and intensity of drought there is need for effective capacity building on drought, its signals and sustainable coping strategies to reduce vulnerability. Dissemination of information on adverse climate should be done to the livestock farmers in good time to enable them make early preparations. Further research is suggested on assessment of the best ways of linking farmers to markets during drought to reduce losses.

CHAPTER ONE

INTRODUCTION

1.1Background to the study

The world has been witnessing long term changes in climate patterns and variability with rapid acceleration in recent decades. Considerable shifts in long term temperature and rainfall averages, sea levels, frequency and intensity of droughts have been observed (IPCC, 2000). The average global temperature has warmed by 0.8^0C in the past century and 0.6 ^{0}C in the past three decades (Hansen *et al.*, 2006). The last few decades of the twentieth century were the warmest in the last 400 years (National Research Council, 2006).

Different scholars describe the effects of climate change differently, e.g.; warm sea surface leading to increased droughts in equatorial and Eastern Africa (Funk *et al.*, 2005), less precipitation (IPPC,2001), alteration in African diversity (Lovett *et al.*, 2005) and decline in long cycle crops (Funk *et al.*, 2005). Communities living in dry lands have been experiencing crop failures and diminishing household sizes. Livestock loss in dry lands has been due to severe and persistent droughts which have led to tremendous human suffering (Jama *et al.*, 2005).

Globally, people are struggling to cope with the burden of increasing unpredictable weather affecting their livelihoods. According to the Food Agriculture Organization (2005), livestock systems in the world occupy about 45% of the earth's surface employing about1.3 billion people. In Kenya, most livestock farmers either practice mixed farming or pastoral production in the rangelands (Musimba *et al.*, 2004).

Water is the most important limiting factor in livestock production in arid and semi arid lands (ASALS) of Sub Saharan Africa (Thornton *et al.*, 2009). Climate change has led to declining water resources leading to overcrowding around the remaining water resources and pasture (ILRR, 2002). The World Water Forum (WWF, 2000) estimates that a third of Africa's population live in areas that are prone to drought. During drought, many livestock farmers lose their livestock through death. Tarhule

and Lamb (2003) suggest that Africa lost several hundred million US dollars in damages caused by mid-1980 droughts.

According to Kandji (2006), Kenya is a drought-prone country primarily because of its peculiar climatic conditions. He further states that although Kenya is dissected by the equator, it contains only a few pockets of high and regular rainfall areas. ASAL covers 80% of the country where rainfall is between 200mm to 500mm and periodical droughts are part of the climatic system (Kandji, 2006).

The devastating recurrent droughts across Kenya cause widespread hunger, shortage of drinking water, and in the case of cattle, death. Pictures of hundreds of cattle carcasses being dipped into a mass grave near Nairobi highlight the scale of the natural disaster (Dugan, 2011). Since natural and man-made disasters are part of humanity, it is important that their impacts on livelihood be understood and measures taken to minimize the severity of the impacts as it is not enough to just focus on the hazard threat without addressing the factors that make people suffer immensely when disaster strikes (Wisner *et al.*, 2006).

According to the International Livestock Research Institute (ILRI, 2009), as the climate changes, livestock must adapt to survive. The recurrent droughts also call for farmers to come up with mechanisms to cope with the drought to reduce vulnerability. The degree to which a population can be affected by drought depends largely on various response or coping options available to them or their degree of vulnerability which in turn can be decreased by adequate pre-drought planning (Patrick, 2003). Coping mechanisms are the actual responses to crisis on livelihood systems in the face of unwelcome situations and are considered as short term responses (Berkes and Jolly, 2009). The coping strategies depend on access to resources and technology (Adger, 2009).

1.2 Statement of the problem

Drought has long been a theme in Kenya, and East Africa more broadly though the extreme dry spells appear to be hitting with more frequency (FAO, 2005). It is cyclic

based on the *El Nino* and *la Nina* phenomenon. Despite having this knowledge, some communities continue to be persistently vulnerable to drought and the cycle of vulnerability seems to be worsening over time. The overall problem is that mechanisms of coping with drought are not well conceptualized not only at the national level but also at the local levels as stated by Unganai (1994). He argued that farmers and governments especially in developing nations appear less able to cope with disasters. There is a disturbing revelation of governments and other stakeholders adopting firefighting policies all the time instead of preparing the counter measures in advance (Unganai, 1994).

This is especially so for areas which have been hit hard by the effects of drought such as Murang'a South Sub-County. According to FEWS-NET (2010), in Central Kenya, Makuyu area is one of the areas most vulnerable to drought. Vulnerability is essential to understand so as to be able to design drought preparedness and mitigation strategies, relief policies and programs (Patrick, 2003). According to NCCK, 2011, the area did not receive adequate rainfall for five consecutive years from 2006 to 2010. In this regard, conducting a detailed study on the strategies the livestock farmers in the study area use to cope with drought and reduce vulnerability is of paramount importance.

1.3 Research justification

Drought has a direct negative impact on natural pasture growth, often resulting in lack of fodder and consequent economic loss for livestock owners that may reach disaster levels (ILRI, 2006). In recent years there has been an increase in drought which has led to great losses for the farmers. Predictions indicate that the highest risk of future damages due to drought associated with climate change will affect crop and livestock farming.

Although Kenya is exposed to drought, the effects are not likely to be evenly distributed. Some communities will feel the effects more than others due to varying coping mechanisms used. It is important to examine the drought coping mechanisms being used in the area and the constraints that exacerbate vulnerability.

1.4 Research questions.

The research questions used in the study were;

(i) How do farmers perceive drought?

(ii) What are the effects of drought to livestock farmers and their households?

(iii) How do farmers in the study area cope with the problems associated with drought?

(iv) What constraints do farmers experience when attempting to cope with drought?

1.5 Objectives of the study

1.5.1 General objective:

To find out the strategies used by livestock farmers to cope with problems associated with drought.

1.5.2 Specific objectives

The specific objectives of the study were;

(i) To find out how the farmers in the study area perceive drought

(ii) To identify effects of recurrent drought to livestock farmers in the study area.

(iii) To determine how livestock farmers counteract the problem of drought to reduce vulnerability.

(iv) To determine constraints livestock farmers face in their attempt to cope with drought.

1.6 Hypotheses

The study tested the following hypotheses;

$H0_1$: Farmers' perception of drought differs significantly across gender and education level.

$H0_2$: The effects of drought experienced differ significantly across education level of farmers and family size.

$H0_3$: The measures put in place by farmers to counteract the impact of drought differ significantly across gender and education level.

1.7 Conceptual framework.

Ford and smith developed a conceptual framework based on two phases; current vulnerability and future vulnerability. Based on the conceptual framework, any

change in climate (gradual change in extreme weather) causes an impact on livelihood. However the world has a record of adapting and reducing vulnerability to impacts of weather and climate related events (Pachauri and Resinger, 2007) and thus coping strategies used to reduce the impact and the presence of other internal and external stressors will determine the societal vulnerability to climate change and extreme weather. Identification of current climate variability, its impacts on livelihoods, current coping strategies and stressors help assess the future likely changes, impacts, coping strategies and social vulnerability. For the sake of this study, identifying the situation of drought, its impacts on livelihoods, the current coping mechanisms, vulnerabilities and identification of stressors help assess the future likely changes, impacts, coping strategies and social vulnerability. This is summarized in Fig. 1.1

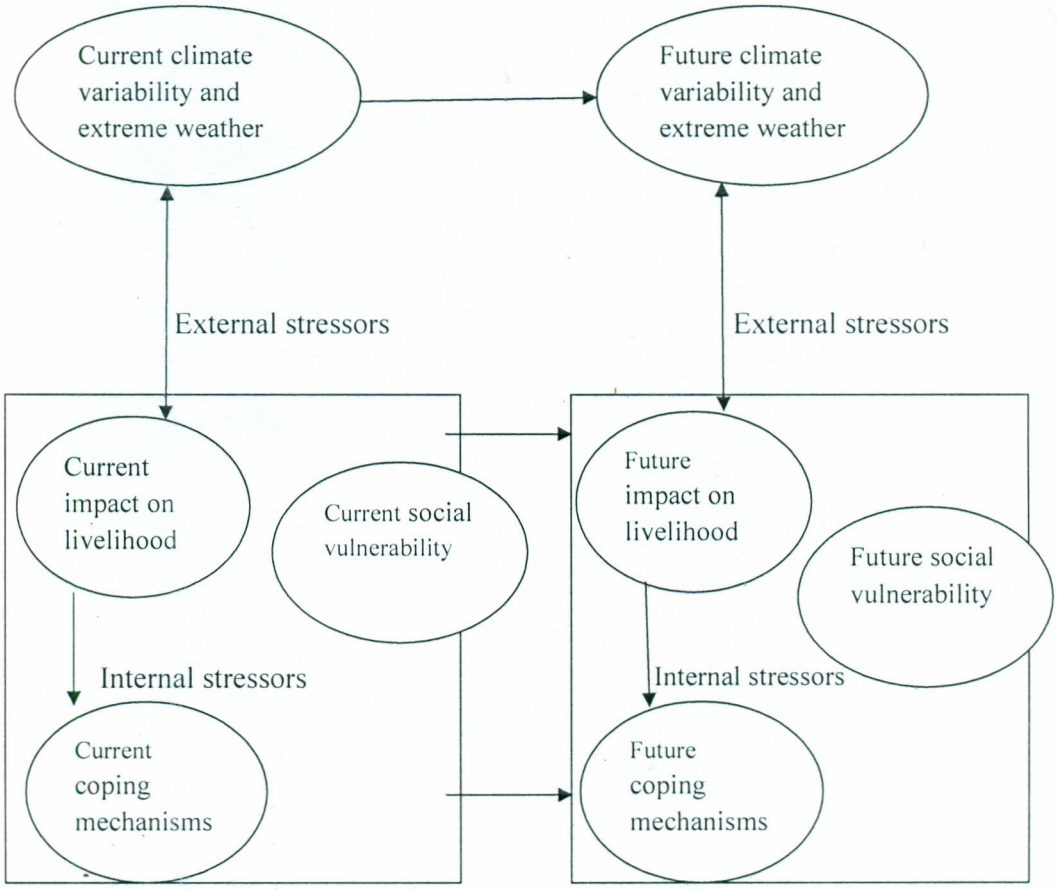

Fig 1.1 Conceptual framework

(Adapted from Ford and Smith, 2000)

1.8 Limitations of the study

The study was confined to two hundred livestock farmers in Murang'a South Sub-County due to constraints of finance, time and distance. This may therefore affect generalization for the entire population. The research could also be limited by willingness of the respondents to answer in case the information could be considered sensitive or intrusive (e.g. information on whether the family has been dispersing some of its members during drought or whether their children miss school due to drought related problems) leading to bias.

1.9 Definition of terms

Climate variability; Variation in normal average weather pattern.

Coping mechanisms; The actual responses to crisis on livelihood systems in the event of unwelcome situations.

Drought; A long period of dry weather when there is no enough rain for successful growing of crops or the replenishment of water supplies.

Elnino; Warmer than normal sea-surface temperatures (SSTS) in the tropical Pacific ocean that impact global weather pattern.

Indicators; Signals or signs of a looming drought.

Lanina; Cooler than normal sea-surface temperature (SSTS) that impact global weather pattern

Livelihood systems; Arrangements of providing income to live on or a way of living or support for a community or household.

.**Livestock farmer;** A farmer who rear domestic animals for food and other products either for sale or personal use

Pastoral farming; practice in which people keep animals as a way of life and move with them from place to place in search of water and pasture.

Perception of drought; View of drought by the farmers having experienced it.

Rangelands; dry lands.

Stressors; Factors that make a community suffer more during drought.

Vulnerability; likelihood of households to suffer from climatic adverse impacts and their inability to respond to stress resulting from the impact.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews past studies done by researchers in the field pertaining to the variables under study. This includes perception of drought, impact of the drought, history of drought in Kenya, drought coping mechanisms and the constraints faced by farmers in their attempt to cope with drought.

2.2 Perception of drought

Wilhite (2000) described drought as a natural hazard that differs from other hazards because it has a slow onset, progresses over months or even years, affects a large spatial region, causes little cultural damage and its onset and end are often difficult to determine due to its severity. According to Wilhite (2000), drought affects practically all climatic regions and more than half the whole earth is prone to drought each year however, the drought varies significantly between regions.

According to Hisdal and Tallaksen (2000), drought is the most costly disaster compared to all natural disasters. It kills more people and animals than the combined effects of hurricanes, floods, tornadoes, blizzards and wild fires. Taleb (2007) suggested that limiting drought to a single definition and single possible cause is highly problematic. NDMC (2006) argues that conceptual definitions help in understanding the concept of drought, while operational definitions concentrate on the beginning, end and the severity of the drought and focus on frequency, longevity and the impacts of the drought.

Drought is associated with the reduction of the seasonal amount of precipitation received (Hirji *et al.*, 2002) and can be broken into four main categories as suggested by Wilhite (2000), who narrowed the categories from a wide range of drought types. The first three approaches measure drought as a physical phenomenon, while the fourth covers supply and demand issues, tracking the effects of water shortfall as it ripples through socioeconomic systems (NDMC, 2006). The four categories are meteorological, agricultural, hydrological and socio-economic.

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2.2.1Meteorological drought

Meteorological drought occurs when there is a reduction in rainfall supply in direct comparison to the average expected over that particular period (Wilhite, 2000). This definition concentrates on the degree of dryness and the length of that dry period. Meteorological definitions can be site or region-specific, and measure dryness and rainfall received comparing this against a normal and/or acceptable baseline. This is often pegged on an internationally accepted thirty year precipitation period (Wilhite, 1985).

2.2.2 Agricultural drought

Agricultural drought refers to shortage of sufficient water available for a crop at any given stage of its development resulting in impaired growth, wilting and ultimately reduced crop yields (NDMC, 2006). This definition looks at the link between meteorological and/or hydrological droughts and agricultural impacts, and focuses more on the vulnerability of the crops at their different growth stages vis-à-vis plant-water needs. Wilhite *et al.*, (1985) argues that definitions of agricultural drought link various characteristics of meteorological drought to agricultural impacts. The severity of the drought is therefore measured by the incompatibility of the available soil moisture and the plant-water demands.

2.2.3 Hydrological drought

Hydrological drought is an extended period of months or years when a region notes a deficiency in its water supply (Wilhite, 2004). It is shortage of water harmful to man's agricultural activities which occurs in an interaction between agricultural activity (demand) and natural events (supply), which results in a water volume or quality inadequate for plant and/or animal needs (NDMC, 2006).

2.2.4 Socio-economic drought

Socio-economic drought focuses on the impact of drought to people's socio-economic activities and results from the impact of the other three categories of drought on the supply and demand of goods and services (NDMC2006). This type of drought occurs when the demand of an economic good such as food grains outstrips

the supply of that good as a result of weather-related water supply short fall. Fig 2.1 shows the different types of droughts.

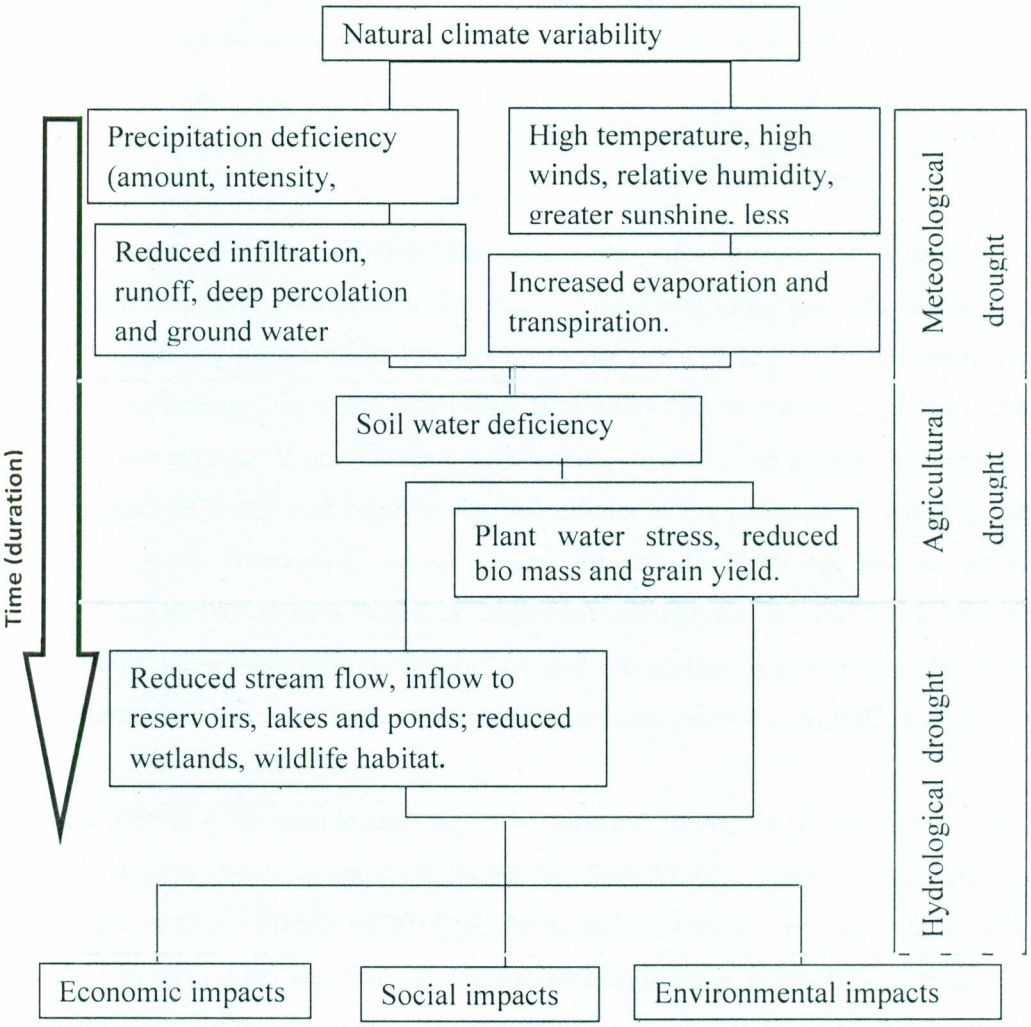

Fig 2.1 Different types of droughts. Source; NDMC, 2006

2. 3 Impacts of drought

Impact refers to hazard, risk, and biophysical vulnerability or generally vulnerability (Brooks, 2003). Biophysical vulnerability is the extent of damage inflicted by climate change on livelihood and social systems (Deressa and Hassan, 2008). The impacts of drought extend beyond the areas physically affected by drought after the event has ended (Coleen *et al.*, 2006)

Kinsey *et al* (1998) described drought as a major risk facing rural households in Zimbabwe whose source of livelihood is dependent on agriculture. According to Bruschweiler and Gabathriler (2006), arid and semi arid regions face increasing difficulties which includes recurring drought, over-grazing, population growth which causes disruptions and severe degradation leading to impoverishment, hunger and distress.

According to NDMC (2006), the sequence of impacts associated with meteorological, agricultural and hydrological droughts emphasizes their differences. When drought begins, the agricultural sector is the first one to be affected because of its heavy dependence on stored soil water. Soil water can be rapidly depleted during extended dry periods. If precipitation deficiencies continue, the people dependent on other sources of water will begin to feel the effects of the shortage. Those who rely on surface water (reservoirs and lakes) and sub-surface water (ground water) for example, are the last to be affected. A short term drought that persists for three to six months may have little impacts on surface and sub-surface water depending on the characteristics of the hydrologic system and water requirements (NDMC, 2006).

Drought affects more people than any other disaster in Africa (Rekacewicz, 2002). Ethiopia, Kenya, Somalia and Uganda are the East African countries most affected by drought as of the middle of 2011 (Riebeek, 2011). The two year drought of 2010 and 2011 in this region was the worst to hit the area in sixty years. When the grazing lands fails to sustain the cattle, their owners have no assets and nothing to eat (Riebeek, 2011). Data on stream flow, run off and other hydrological variables between districts shows decrease in volume (Strezepek and Mccluskev, 2006). African countries are likely to be among the most vulnerable to impacts of climate change due to lack of institutional capacity (Riebeek, 2011). Appendix 2 shows how famine has been occurring in Africa while appendix 3 shows the effects of recent droughts on livestock in selected African countries.

Periods of drought can have significant environmental, agricultural, health, economic and social consequences. The effects vary according to vulnerability. Areas with

populations that depend on subsistence farming as a major source of food are more vulnerable to drought-triggered famine (Hogan, 2010).

Drought can have a substantial impact on the ecosystem and agriculture of the affected region (Wilhite, 2004). According to Wilhite (2004), it is difficult to assess the impact of drought in various sectors because the impact can be regional or local. They further suggested that drought may linger for a long time or last for a short time and if a short time drought occurs at a critical stage of crop growth the impact on agriculture may be severe.

According to NDMC (2006), drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. The impacts of drought gradually spread from agricultural sector to other sectors and also extend beyond the areas physically affected after the event has ended (Coleen *et al.*, 2006). Coleen *et al* (2006) further stated that the impacts are diverse and can be classified broadly as environmental, social and economic as discussed below;

2.3.1 Environmental impacts of drought.

Environmental impact of drought is characterized by; damage to natural habitats, reduced forests, crop and rangeland productivity, reduced water levels and reduced cloud cover leading to higher day temperature hence increased evapo-transpiration. Other characteristics are increased dusts and sandstorms, soil desiccation, decreased soil productivity, decreased water resources, reduced water quality, degradation of landscape quality and increased incidences of animal diseases and mortality while the remaining species concentrate in the areas where there is water (Coleen *et al.*, 2006) These impacts are associated with several effects which includes; loss of biodiversity, reduced income, shortage of food, lower accessibility to water and scorching of plants leading to withering and drying up. Other effects include; increased fire hazards, increased soil erosion and air pollution, desertification and soil degradation, lack of drinking water, increased cases of water borne diseases, loss

of income and food, increased soil blow activities, permanent loss of biological productivity and increased vulnerability to predation as shown in Table 2.1.

Table 2.1 Environmental impacts of drought

IMPACT	EFFECTS
Damage to natural habitat	Loss of biodiversity
Reduced forests, crop and rangeland productivity	Reduced income and food shortage
Reduced water levels	Lower accessibility to water
Reduced cloud cover	Plant scorching
Increased day time temperature	Increased fire hazards
Increased evapo-transpiration	Crop withering and drying
More dust and sandstorms	Increased soil erosion and air pollution
Decreased soil productivity	Desertification and soil degradation
Decreased water resources	Lack of drinking water
Reduced water quality	More water borne diseases, increased salt concentration
Increased incidences of animal diseases and mortality	Loss of income and food ; reduced breeding stock
Soil desiccation	Increased soil blow activities
Degradation of landscape quality	Permanent loss of biological productivity of the landscape
Species concentration near water	Increased vulnerability to predation

Source; Coleens *et al.*, 2006

2.3.2 Social impacts of droughts.

The social impact of drought is characterized by; poor distribution of resources, increased quest for water, unstable marginal lands, reduced quality of grazing lands and crop yield, employment layoffs, food insecurity, increased pollutant concentration, increased forest and rangeland fires and also urbanization. These

impacts are associated with several effects which includes; migration, resettlement and conflicts between water users, poverty and unemployment, overstocking leading to reduced quality of animals, reduced or no income and malnutrition, Other effects are; civil strikes and conflicts due to insecurity, public health risks, increased threat to human and animal life leading to social pressure and reduced safety as shown in Table 2.2.

Table 2.2 Social impacts of droughts.

Impacts	Effects
Poor distribution of resources	Migration, resettlement, conflict between water users
Increased quest for water	Increased conflict among water users
Marginal lands become unstable	Poverty and unemployment
Reduced quality of grazing lands and crop yield	Overstocking, reduced quality of animals
Employment layoffs	Reduced or no income
Food insecurity	Malnutrition, civil strikes and conflicts
Increased pollutant concentration	Public health risks
Increased forest and rangeland fires	Increased threat to human and animal life
Urbanization	Social pressure and reduced safely

Source; Coleens *et al.*, 2006

2.3.3 Economic impacts of droughts.

Economic impact of drought is characterized by; reduced business with retailers, food and energy shortages, loss of crops for food and income, reduction in quality of livestock due to reduced pasture and water, water scarcity, loss of jobs, income and property, less income from tourism and recreation as most wildlife die and forced financial loans (Coleen *et al.*,2006). These impacts affect humanity in several ways which includes; increased prices for farm commodities, drastic increase in prices of domestic and imported goods, sale of livestock at reduced prices, increased transport costs, deepening poverty, unemployment, increased capital shortfalls and increased debts from financial institutions as shown in Table 2.3.

Table 2.3 Economic impacts of drought

Impacts	Effects
Reduced business with retailers	Increased prices for farm commodities
Food and energy shortages	Drastic increase in price of goods, expensive import/subsidies
Loss of crops for food and income	Increased expense for buying foods from shops
Reduction of livestock quality	Sale of livestock at reduced market price
Water scarcity	Increased transport cost
Loss of jobs, income and property	Deepening poverty; unemployment
Less income from tourism and recreation	Increased capital shortfalls
Forced financial loans	Increased debt; increased credits for financial institution

Source; Coleen *et al.*,2006

According to Paul, 1998, the impacts of drought can further be classified as direct or indirect or assigned orders of propagation (Fig 2.2). In a community whereby agriculture is the main economic activity, the direct impact or first order impact of drought is detected in the form of a reduction in food production caused by reduced rangelands and forest productivity, reduced water level, increase in fire hazard, increase in livestock and wildlife death rates, and damage to wildlife and fish habitat (Paul,1998). This leads to high food prices and decrease in per capita food consumption.

Indirect or second order impact of drought includes reduction in crop productivity which leads to low or no income for farmers, increased food prices, unemployment and migration, decreased food production leading to abnormal increase in food prices while non availability of jobs reduce the food entitlement of the people, especially small scale farmers and landless labourers which leads to famine (Paul, 1998). Figure 2.2 elaborates the direct (first order) and indirect (second order) impacts of drought

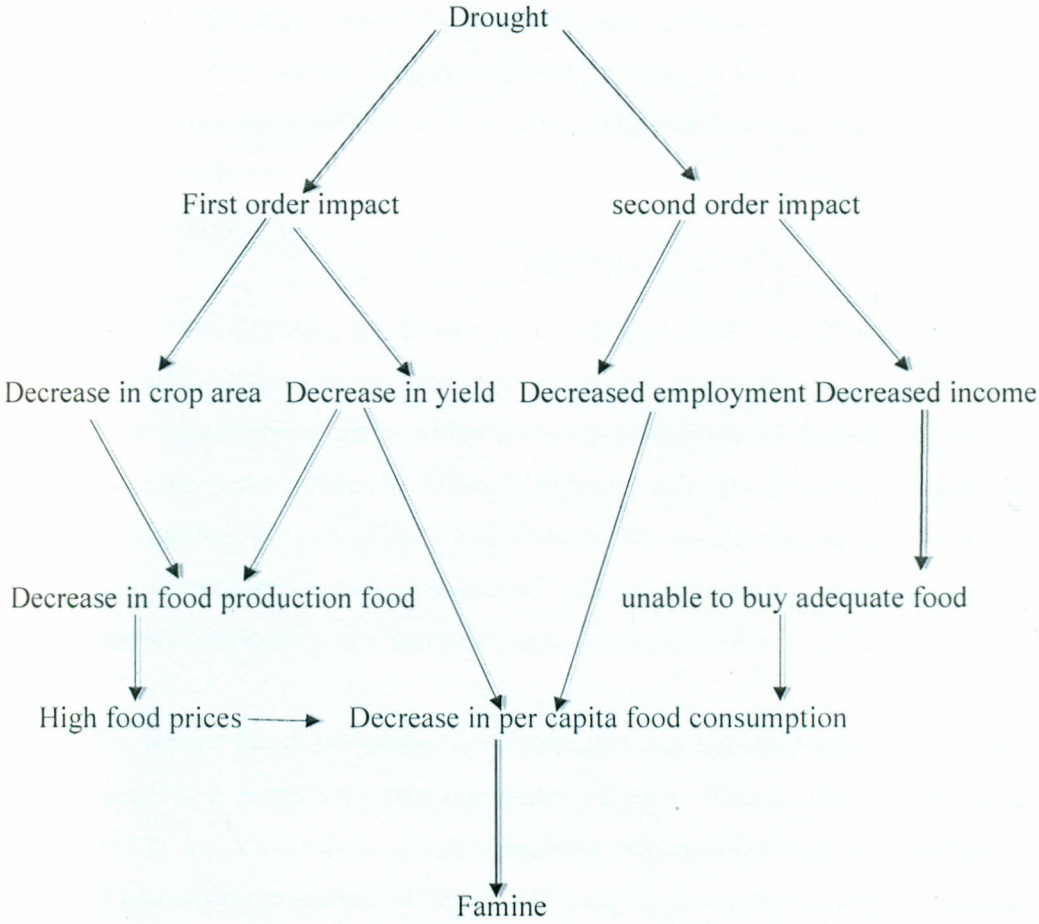

Figure 2.2 Direct and indirect impact of drought. Source; Paul, 1998.

2.4 Drought in Kenya

Almost 70% of Kenya landmass is affected by drought (UNDP, 2012). Kenya experiences drought on a cyclic basis, the major ones coming every ten years and the minor ones every three to four years. A major drought is a long period of dry weather when there is no enough rainfall which causes enormous losses while a minor drought causes marginal losses. The 2004 drought was a replica of what happened in 1974, 1984 and 1994 (UNDP, 2012). Appendix 4 shows chronology of drought incidences in Kenya since 1883.

According to UNDP (2012), Kenya's drought is characterized by severe reduction of water and moisture leading to dryness that cannot sustain plant life, people walking

for long distances to look for water and in some cases people wait for relief supplies. Drought impact in Kenya has been increasing in severity in the last four decades and this has been associated with environmental degradation that has been taking place due to urbanization, extension of agricultural land into forests and logging of trees to burn and sell charcoal for economic gains (UNDP, 2012).

According to UNEP (2000), the factors contributing to severity of drought in Kenya are; inadequate water storage capacity, increased destruction of forests, poor management of catchment areas which includes destruction of forests, bushes and plants that retain water in the soil. Other factors are; cultivation of stream banks and steep slopes causing erosion of the topsoil which silts up the dams and pans usually used as dry weather water reservoirs, lack of policy for managing water and drought and inequitable distribution of water resources.

In 2008/09, Kenya faced one of the worst droughts that left over ten million people without food and access to drinking water (Dugan, 2011). This disaster was exacerbated by lack of adequate disaster response mechanism which is often disaster response rather than prevention. Wilhite (2002) argues that vulnerability is worsened by a multitude of factors that include government policies, land use and water management, among others.

2. 5 Coping with drought

The degree of drought and the resultant land and resources degradation are said to be greater in those countries whose social and economic support systems cannot endure the effects. This includes the fragile environments in dry eco-systems where people have few and limited coping mechanisms (ILRI, 2006).

Coping mechanisms are actual responses to crisis on livelihood systems in the event of unwelcome situations (Berkes and Jolly, 2009). Smallholder subsistence and pastoral systems especially those located in marginal environments, areas of high rainfall variability or high risks of natural hazards are often characterized by livelihood strategies that have been evolved to reduce overall vulnerability to climate

shocks and to manage their impact. The mechanisms lie within the framework of the individuals, groups or society's risk of tolerance level (Kivaria, 2007). Eriksen *et al* (2005), in the study on the dynamics of vulnerability by locating coping strategies practiced by drought victims in Kenya and Tanzania described coping strategies as principal and complementary.

According to International Strategy for Disaster Reduction (ISDR, 2005), coping with drought hazards can be enhanced by developing strategies which adequately address several questions. These questions deal with how frequently or extensively a certain type of drought occurs in a given region, the vulnerabilities and expected losses which are associated with the particular type of drought and the costs of implementing the plausible strategies or options for mitigating the disaster that can be caused by that type of drought. Diversification of farming activities renders communities in fragile ecosystems less vulnerable to the vagaries of nature (Ellis, 1998).

The direct effects of drought (Fig 2.2) can be reduced by using drought mitigation techniques in respect to the effects of drought (Paul, 1998). According to Karanon (1993), the indirect impact of drought (Fig. 2.2) make drought victims adopt various strategies to cope with the hazard. The victims are often compelled to borrow money or sell their land, household goods and/or livestock at low prices in order to buy food. These practices were said to be hard options by Karanon (1993) and are considered as components of agricultural adjustments to mitigate drought.

According to Paul (1998), who carried out a study on drought coping mechanisms in Bangladesh, the mechanisms used includes; crop replacement strategy, cultivated irrigation, the sale of household belongings, sale of livestock, sale of land, mortgaging of land, sale of poultry and housing structures while some received support from government and Non-governmental organizations. Kinsey *et al* (1998) carried out a research on response of rural households during drought in Zimbabwe and found that the coping mechanisms adopted by the farmers included; gardening and selling vegetables, working as casual labourers and selling livestock.

Campbell (1999) in his study of response to drought among farmers in Kajiado, Kenya, established that the mechanisms to cope with drought in Kajiado included; Prayer and payment to a rainmaker, movement of livestock to areas with water and pasture, liquidation of assets, sale of land, use of environmental resources such as firewood, engagement in tourism and wildlife activities, horticultural activities as well as migration in search of jobs. Sweet (1998) carried out a study on drought coping mechanisms in Namibia and found that the farmers reduced in non-food expenditures, rationed available foods for both human and livestock consumption, there was seasonal movement of animals, sale of livestock and assets as well as increased borrowing.

According to Thorlakson and Neufeldt (2012), who studied drought coping mechanisms in Lower Nyando, the farmers reduced food consumption by restricting the size, reduced number of meals taken each day, sold livestock and engaged in casual labour in order to cope with drought. According to Musimba *et al* (2004), goats are increasingly being preferred because they are more drought tolerant and suited for the browse species that survive extended dry conditions and drought.

Normally, what starts as coping strategies can become adaptations for households or the whole community (Moench, 2004). How communities cope with the current climate-related shocks and stresses can give insight into their ability to deal with future variability brought about by climate change (Kates, 2000). According to ILRR (2002), the extreme weather conditions affect the agro-pastoralists more than the pastoralists due to the opportunistic strategy of nomadic pastoralism which enables pastoralists and their stock to track forage and water in space and time. Herd mobility allows pastoralists to escape natural shocks therefore making them less vulnerable to climate variability (Nyariki *et al*., 2005).

Livestock producers have traditionally adapted to various environmental and climatic changes by building on their in-depth knowledge of the environment in which they live according to Thornton *et al,* (2009), who identified ways to increase adaptation in the livestock sector. They include; Production adjustments, breeding strategies

institutional and policy changes, livestock management systems and building the capacity of livestock keepers which includes increased awareness of global changes, and improved capacity of herders/livestock producers to understand and deal with climatic changes.

Climate change is giving rise to new scenarios requiring not only new coping mechanisms but alternative livelihoods and refined social systems. While some work is being done by the Ministry of Environment, Kenya Meteorological Department and other centers such as Intergovernmental Authority for Development (IGAD), more analytical work is needed on climate vulnerability and approaches that could minimize resilience at regional, national and local levels (Dugan, 2011). Community based strategies and disaster risk reduction can be encouraged since their effects are immediate. This is especially so for areas highly vulnerable to drought like Makuyu in Murang'a South Sub-County. According to NCCK communications (2011), the most affected areas by drought in Central region of Kenya are Makuyu and Kakuzi areas.

2.6 Constraints in coping with drought.

The United Nations Environmental Program (UNEP) argues that instead of focusing on the agent of shock, assessments should focus on communities' vulnerabilities to the impacts of a drought rather than the drought itself (UNEP, 2003). Vulnerability is the likelihood of households and communities to suffer from climatic adverse impacts and their inability to respond to stresses resulting from the impacts (Thornton *et al.*, 2009). Selvarajan *et al,* (2002) defines vulnerability as the extent to which a natural or social system is susceptible to sustaining damage as a result of climate change. Adger (2000) describes social vulnerability as the exposure of groups or societies to stress resulting from the impacts of environmental change. He further argues that it generally consists of disruption to livelihoods and loss of food security.

According to Selvarajan *et al,* (2002), vulnerability has two sides; an external side and an internal side. Internal stressors refer to defenseless and insecurity, lack of capacity to anticipate, cope, resist and recover from climatic impacts. External

stressors refer to exposure to risks and shocks. They are non climate stressors or constraints which exacerbate vulnerability. Management of such stressors by the government and development partners would in itself constitute a powerful strategy to reduce vulnerability (Adger, 2009).

According to Patrick (2003), the more directly dependent a population is on the natural resource base of an area, the greater the vulnerability when there is interference in the productivity of the natural resource base. Wilhite (2002), states that the most affected people are those that find it hardest to reconstruct their livelihoods following the disaster and that vulnerability is closely correlated with human infrastructure and socio-economic conditions. He further argues that vulnerability is worsened by a multitude of factors that include government policies, land-use and water management among others. Subsistence farmers in developing countries find it difficult to cope with such climatic- related hazards as they do not have the capital to invest in new adaptive practices with which to protect their homes and families (Thompson 2007).

According to Thorlakson and Neufeldt (2012), in the study of drought coping mechanisms in Lower Nyando, farmers sold the livestock, however livestock prices dropped by 50% during this period. Farmers in this area were also forced to use more detrimental coping strategies to cope with the reduced productivity in 2009 to 2010. The farmers defined detrimental coping strategies as those that have harmful long-term impacts on household productivity. These strategies included; selling oxen reserved for ploughing leading to lower farm productivity during the following season, consuming seeds reserved for planting which had negative repercussions as many farmers were forced to plant fewer seeds the following season due to the depletion of their personal seed stores and constraints in capital (Thorlakson and Neufeldt 2012).

In Middle Nyando, limited capital following the drought restricted farmers' ability to purchase fertilizer and other chemical inputs regularly used. Some Middle Nyando

farmers reported being forced to lease part of their farms for 2 years to wealthy farmers in the area in order to feed their families (Thorlakson and Neufeldt 2012).

This coping mechanism is especially detrimental as it prevents farmers from accessing their main source of livelihood, their land, for 2 years. According to some farmers, engaging in casual labour during periods of drought was also a detrimental coping strategy as it delays the planting in their own farms (Thorlakson and Neufeldt 2012).

2. 7 Knowledge gaps

Based on the literature reviewed especially from FEWS-NET (2010) and NCCK (2011), Makuyu area in Murang'a South Sub-County is one of the most drought affected areas in Central region of Kenya. However, the studies have left out some important areas which includes; the way the livestock farmers in the area perceive drought, the level of the impacts of drought on livestock farmers, the mechanisms used by the livestock farmers to cope with drought and the constraints that exacerbate vulnerability in the study area. This study has filled this knowledge gap by investigating how the farmers perceive drought, the effects of the drought on the farmers and their households, the drought coping mechanisms used by the livestock farmers and the constraints they are facing in their attempt to cope with drought.

CHAPTER THREE
RESEARCH METHODOLOGY

3. 1 Study area

The study covered Makuyu and Maragua Divisions in Murang'a South Sub-County which is located in Murang'a County in the central highlands of Kenya. Murang'a South Sub-County in the extreme east of Murang'a County where it borders Machakos County to the East, and Kirinyaga and Embu counties to the North-East as indicated in Figure 3.1.

3.1.1 Position, size and administrative units

Murang'a South Sub-County lies between latitudes 0°45'S and 1°00'S and between longitude 37 01'E and 37° 18'E. It covers an area of 467 km^2 of which 315 km^2 (67%) is arable land. The average farm size is 0.93ha .Administratively it's divided into two divisions (namely Maragua and Makuyu). Makuyu division is made up of Kambiti, Kamahuha and Makuyu wards while Maragua division is made up of Nginda, Ichagaki and Maragua Ridge wards as indicated in appendix 6.

3.1.2 Topography and drainage

The study area has an average elevation of 1394m above sea level. The Sub-County has only two permanent rivers draining along the extreme end of the Sub-County where it borders Kiharu Sub-County. These rivers are Maragua and Sabasaba. Other small rivers include Ngumbo and Mutoho.

3.1.3 Climate and agro-ecological zone

The area is generally semi arid. The annual rainfall averages between 760mm around Maragua Ridge and Kambiti (LM4) to 1020mm around Makuyu (UM3-4) with a 66% rainfall reliability (Jaetzold, 2006).The rainfall peaks in April. The Sub -County receives bimodal rainfall and therefore has two cropping seasons. Annual Mean temperature ranges between 22-29°C (UNDP, 2012). The region is in semi arid agro ecological zone and has tropical savanna type of climate. There are four main agro-ecological zones namely: UM3, UM4, LM3 and LM4 (appendix 5).

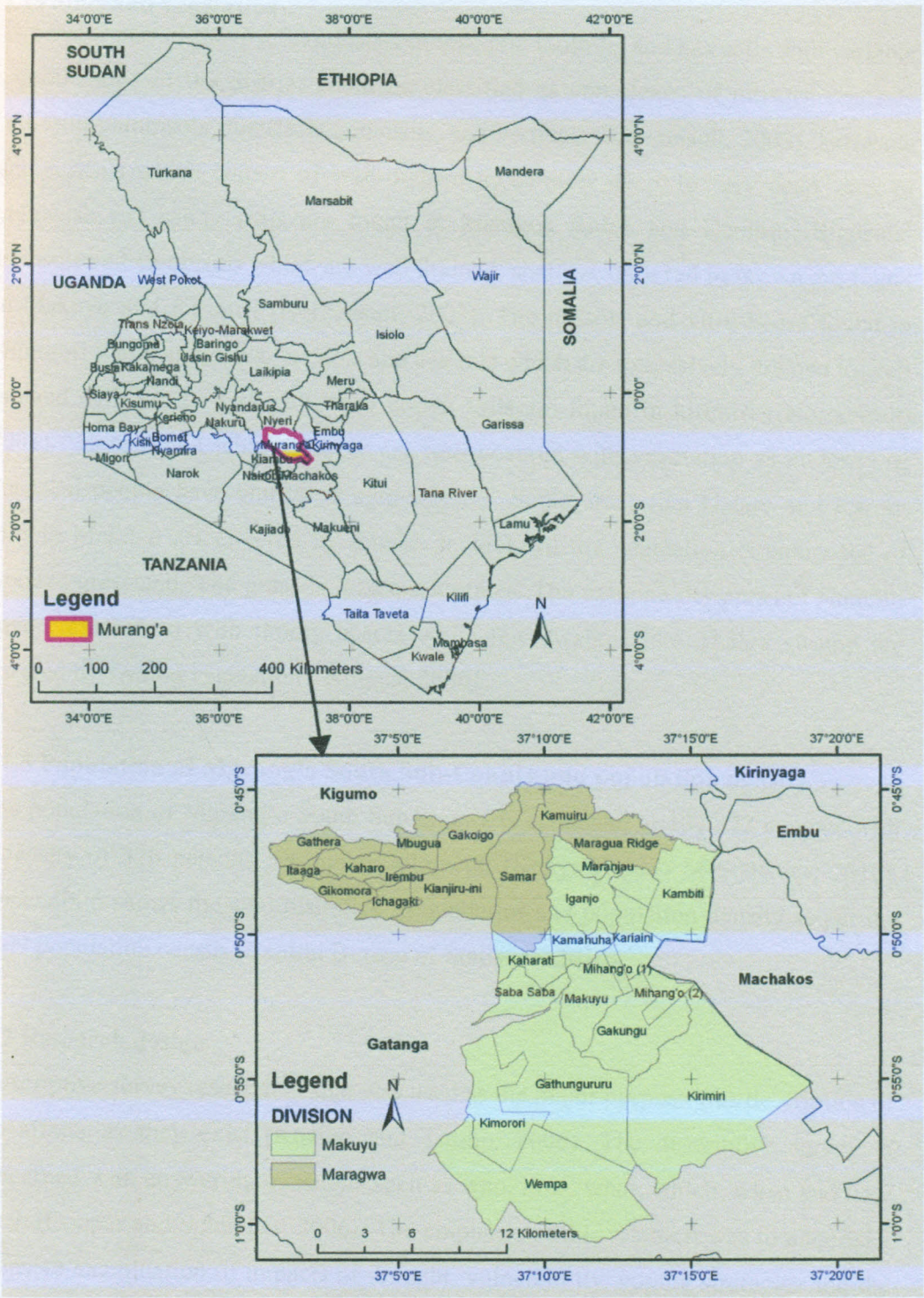

Fig 3.1 Study area.
Source; Department of Resource Survey and Remote Sensing (Year 2014)

3.14 Soils and vegetation.

The major part of the district consists of volcanic foothills and has soils with variable topsoil. Soils in the district could be classified as complexes of nitisols, regosols ,lithosols cambisols ferralsols arenosols, and vertisols (Norconsult, 2003). Ferrasols and acrisols which consist of well-drained moderately deep, to very deep, dark to yellowish red sandy soils are found in Maragua Ridge and Kambiti. Rigosols' lithosols and cambisols which are well drained, shallow, dark red to brown are found in Makuyu and Kirimiri (Norconsult, 2003). The nitisols and vitisols are found in Kimorori while arenosols, luvisols and acrisols which are excessively drained to well drained dark red to dark yellowish brown soils are found in kirimiri ((Norconsult, 2003). Nginda and Ichagaki areas are well covered with vegetation as majority of the local people have embraced agro-forestry. Some areas like Gatare and Karura hills in Makuyu are covered by forests. In Makuyu the vegetation is composed of wooded grassland. The grass is mixed with trees .The extreme dry areas of Kambiti have grass mixed with thorny acacia while few swamps like Thaara swamp are covered by swamp vegetation (Kinyua, 2000).

3.1.5 Population of Murang'a South Sub-County and population density

The population of Murang'a South Sub-county is estimated at 152,272 persons with a density of 326 persons per square kilometer (Kenya Bureau of Statistics, 2010). Appendix 6 shows the administrative boundaries and population density as per the 2009 population census (Central Bureau of Statistics, 2010).

3. 2 Research design

Descriptive survey research design was used as the major purpose was description of the affairs as they exist (Kombo and Tromp, 2006). The descriptive survey is concerned with answering questions such as who, how, what, which, when and how much (Cooper and Schindler, 2006). The emphasis of this research was to undertake intensive examination of impacts of drought, vulnerability, coping strategies and the constraints exacerbating vulnerability and therefore a case study strategy was used. A case study seeks to achieve an in-depth understanding of a phenomenon, event or occurrence within its real life context (Mugenda and Mugenda, 2012).

3. 3 Sample size and sampling procedure

3. 3.1 Sample size

Livestock farmers were targeted irrespective of their gender. The primary sampling unit was the individual household. A household is a group of people in a housing unit living together as a family and sharing the same kitchen. The sample consisted of two hundred households. The sample size was determined using sample size calculator software for a finite population as the households in each division were less than fifty thousand. The CRS software uses the following formula in the calculation of the sample size.

$$S = \frac{Z^2 * (p) * (1-p)}{C^2}$$

Where

S = sample size

Z = Z value (e.g. 1.96 for 95% confidence level)

P =percentage picking a choice, expressed as decimal (0.5)

C =confidence interval, expressed as decimal (0.098)

$$\frac{(1.96)^2 * 0.5 * (1 - 0.5)}{(0.098)^2} = 100$$

correction of finite population

$$\text{New SS} = \frac{SS}{1 + \frac{SS - 1}{N}}$$

Where N is the population

$$\frac{100}{1 + \frac{(100-1)}{25562}} = 99.61$$

$$\frac{100}{1 + \frac{(100-1)}{14632}} = 99.32$$

The household sizes for Makuyu and Maragua divisions (Appendix 6) were 25,562 and 14,632 respectively (Central Bureau of Statistics, 2010). Sample sizes of 100

households were selected from each of the two divisions at a confidence level of 95% and confidence interval of 9.8% based on the sample size calculator software formula. Sudman (1976) suggested that, for descriptive statistics like frequencies any sample size will suffice and that a minimum of 100 elements is needed for each major group or sub-group.

3. 3. 2 Sampling procedure

The researcher used stratified random sampling procedure taking into account the two Sub- counties with the different household sizes to select a sample that represents the entire population but with due regard to the individual's ability to provide the type of information sought. Proportional allocation based on the number of households as per 2009 population census (Appendix 6) was used. The household head who had to be involved in livestock farming was the respondent. This is the person who makes major economic, social and household decisions. He had to be 18 years and above. Table 3.1 shows the distribution of the sample in each ward

Table 3.1 Sample distribution

DIVISION	WARD	PERCENTAGE	SAMPLE SIZE
MAKUYU	Makuyu	60.42	61
	Kambiti	14.32	14
	Kamahuha	25.26	25
	Divisional totals	**100**	**100**
MARAGUA	Maragua Ridge	11.33	11
	Nginda	44.89	45
	Ichagaki	43.78	44
	Divisional totals	**100**	**100**

With the help of the sub-county livestock production officer, six agricultural officers in charge of the six wards in the two divisions were identified (Appendix 6). These extension officers are directly involved with livestock farmers and participate in various ways in assisting the farmers. The rationale of the study was to get a

comprehensive overview of the study and therefore households were randomly selected.

3.4 Data collection instruments

Both primary and secondary sources of data were used. The primary source of data was a semi-structured questionnaire while secondary sources included journal articles, Government reports, district development plan, theses and dissertations. A semi-structured questionnaire (Appendix 1) was used to collect the information. The questionnaire help harness diverse ideas and assist in cross checking the results and consequently help to increase validity, reliability of the findings and ease data analysis (Bryman and Bell, 2008). The questionnaire comprised several sections. The sections comprised of perception of drought, effects of the drought, and the strategies adopted by the victims to cope with the hazard. Exploratory questions such as 'what' and 'how' and inductive research was used to harness detailed and valuable insights. The questionnaire focused on a range of issues including socio economic status, impact of drought on the livelihood and the society, coping mechanisms and the factors exacerbating vulnerability. Questions were both open ended and close ended. The open-ended questions provided in-depth knowledge on concept of drought, the coping mechanisms and constraints faced in trying to cope with drought.

3.5 Data collection

3.5 1. Pre-testing the research instrument

.A pilot study was conducted to test the suitability of the questionnaire for the research. A sample of six livestock farmers, three from each division were randomly selected and interviewed. Two livestock officers participated in the pre-testing exercise. The pre-testing enabled the researcher to ascertain the reliability and validity level of the instrument. This enabled the researcher to detect any possible errors and revise the instrument accordingly to ensure consistency.

3.5.2 Administering questionnaire

Semi-structured questionnaires (Appendix 1) were used to collect data from the livestock farmers. Two hundred (200) livestock farmers were interviewed using a

structured questionnaire. Each respondent was given brief explanation about the study before the questionnaire was administered. In case the respondent could not understand English the questionnaire was administered by the trained research assistants who were fluent in both kamba and kikuyu language as the area is inhabited by the two communities. Photography complemented transect walks as some events were recorded to show how the farmers were coping with drought as the study was conducted during a dry period.

3. 6 Data analysis and presentation.

Questionnaires were examined to ensure that they were consistently filled. Both qualitative data and quantitative data were first cleaned and coded. Quantitative data was entered in Microsoft excel worksheet and copied to statistical package for social sciences (SPSS) for analysis. Descriptive statistics such as frequency and percentages were used to summarize the data. The comparison of the relationship between various socio-economic factors such as gender, household size and farmers' education level and their perception on drought, effects and coping mechanisms used by the livestock farmers were analyzed using the Chi-square non parametric test. Qualitative data was discussed based on the original objectives of the study. The data was presented using tabulations, histograms and pie charts.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Demographic data of the study respondents

This section presents the background information of the 200 livestock farmers in Murang'a South Sub-County who took part in the study. The information contained in this section includes farmers' gender, marital status, education level, farmers' family sizes, their occupations, number of years lived in the sub-county and type of livestock reared. It also focuses on farmers' sources of water for domestic use.

4.1.1 Farmers' Gender

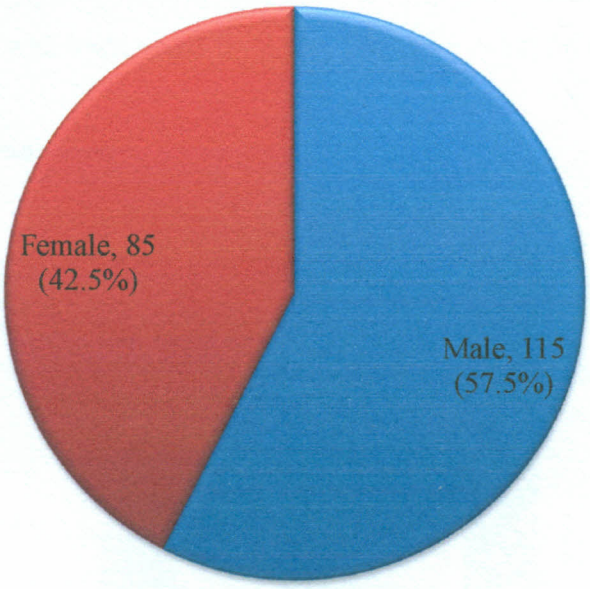

Figure 4.1: Gender of the respondents

Among the 200 respondents, 57.5% were males and 42.5% were females. Gender may determine the perception of drought, the effects of drought, type of drought coping mechanisms applied by the farmers and also the constraints the farmers are exposed to.

4.1.2 Farmers' marital status

Marital status may determine the type of coping mechanism used and the constraints faced in trying to cope with drought.

Table 4.1 Marital status of the study respondents

Marital status	Farmers	Percent
Married	156	78.0
Single	20	10.0
Divorced	7	3.5
Widow	14	7.0
Widower	3	1.5
Total	**200**	**100.0**

The results in indicate that majority (78.0%) of the farmers were married. This shows that most of the respondents had families to cater for; implying that majority of them were expected to engage in farming activities to help them generate money to provide their families with basic needs since they are living in a rural environment.

4.1.3 Farmers education level

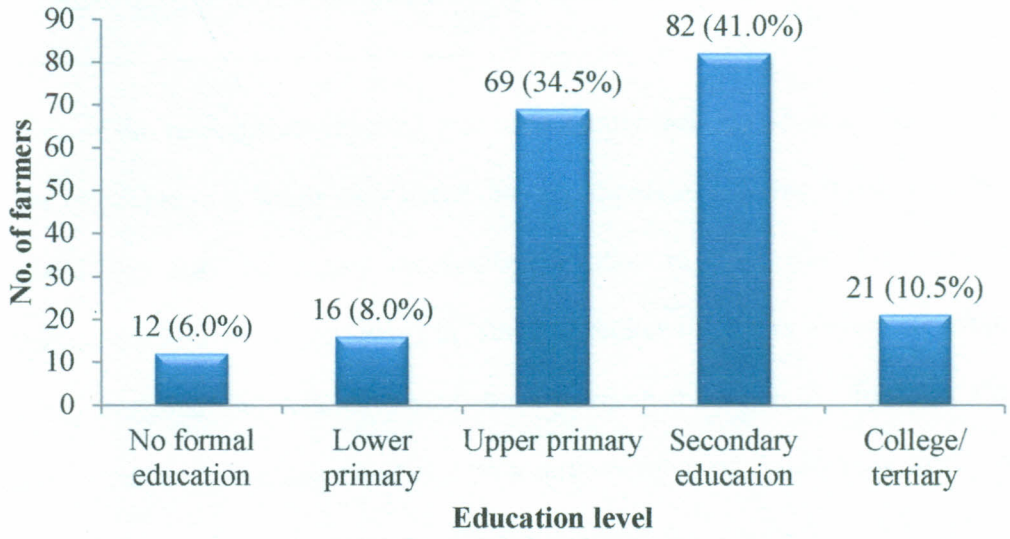

Figure 4.2: Respondents' education level

This analysis shows that most of the respondents had attained upper primary and secondary education. It is evident that most of the respondents had basic know how. The respondents that had attained secondary education and College/ tertiary were at least half of the entire sample. This clearly shows that although majority of the farmers had not attained higher academic qualifications (degree qualifications) most

of them were literate, meaning they could read and understand information about drought. The few who were not literate could therefore get the information from the many literate ones. Education may enhance farm productivity directly by improving the quality of labour, through changing farmers' attitudes, beliefs and habits. Education is therefore thought to be most important to farm production in an economic environment or rapidly changing technology (Shultz, 1975).

4.1.4 Household size

Table 4.2 presents farmers' family size

Table 4.2: Farmers' family size

Family size	Frequency	Percent
3 and Below	82	41.0
4-6	79	39.5
7-9	30	15.0
10 and above	9	4.5
Total	**200**	**100.0**

Majority of the respondents reported that their family size was 3 and below. The number of people in a family may determine the impact of extreme weather on the household and also the coping mechanisms applied to cope with the extreme weather. According to Dugan 2011, in Turkana region of Kenya several children were malnourished and schools closed down because there was no food for the children which indicates that families with a large number of children are likely to suffer more during drought compared with families with few numbers of children.

4.1.5 Farmers' main occupation

Farmers' main occupation was another parameter that the study looked at as shown in Table 4.3.

Table 4.3: Respondents' main occupation in Murang'a South Sub-County.

Occupation	Farmers	Percent
Farmer	165	82.5
Business person	22	11.0
Teacher	11	5.5
Civil servant	2	1.0
Total	**200**	**100.0**

Majority of the respondents were mainly farmers. This implies that majority of the study respondents were relying on subsistence farming as their main occupation. According to Patrick (2003), the more directly dependent a population is on the natural resource base of an area, the greater the vulnerability. The community living in Murang'a South Sub-County is therefore likely to be more vulnerable to drought. According to NDMC (2006), when drought begins, the agricultural sector is the first one to be affected because of its heavy dependence on soil water.

4.1.6 Duration of stay by farmers in Murang'a South Sub-County.

Table 4.4 illustrates the number of year's study respondents had lived in Murang'a South Sub-County

Table 4.4: Number of years lived in Murang'a South Sub-county

No. of years in that area	Farmers	Percent
Below 10 yrs	31	15.5
11-20 yrs	80	40.0
21-30 yrs	52	26.0
31-40 yrs	37	18.5
Total	**200**	**100.0**

Most of the farmers had lived in Murang'a South for 10 years and more and might have experienced unusual climate variability. Kenya experiences drought on a cyclic basis, the major ones coming every ten years and the minor ones every three to four years (UNDP, 2012) Most of the respondents are therefore likely to have suffered drought at one time as they are settled in a drought prone area (FEWSNET, 2010).

4.1.7 Type of livestock reared by farmers in Murang'a South Sub-County.

Livestock play important roles in household income and the livelihood of the farmers. In this regard, the study sought to establish different types of livestock reared by the study respondents. The results of this analysis is summarized and tabulated in Table 4.5.

Table 4.5: Type of livestock reared by respondents in Murang'a South Sub-County (multiple responses)

Type of livestock	Yes		No	
	F	%	F	%
Cattle	169	84.5	31	15.5
Goats	120	60.0	80	40.0
Sheep	24	12.0	176	88.0
Pigs	34	17.0	166	83.0
Poultry	157	78.5	43	21.5

Majority of the farmers were rearing cattle, poultry and goats. Pigs and sheep were reared by a very small number of farmers. According to Musimba *et al* (2004), with the increasing cases of drought, goats are increasingly being preferred because they are more tolerant to dry conditions.

4.1.8 Sources of water used by farmers in Murang'a South Sub-County

Water is a vital resource for the survival of all living things. Table 4.6 illustrates the main sources of water used by the study respondents.

Table 4.6: Main water source used by farmers in Murang'a South Sub-County

Type of water source	Frequency	Percent
Stream/river	116	58.0
Borehole	43	21.5
Ponds	6	3.0
Dams/ reservoirs	2	1.0
Stored water	33	16.5
Total	**200**	**100.0**

The major source of water among most of the farmers was the stream/rivers. According to NDMC (2006), when drought occurs, the people dependent on streams/ rivers and boreholes feel the effects of the shortage first. The last people to be

affected are those ones who use surface water (reservoirs and lakes) and sub surface (ground) water. The community living in Murang'a South sub-county is therefore likely to feel the effect of the drought immediately the drought sets in.

4.2 Farmers' perception about the drought in Murang'a South sub-county.

The first objective of the study was to find out how farmers in the study area perceive drought. To address this objective, the study focused on farmers' knowledge of the drought, various sources of drought information and farmers' views and feeling about the drought. The results of this analysis are discussed below.

4.2.1 Livestock farmers' experience of failure of expected rainfall over extended period of time in Murang'a South Sub-county.

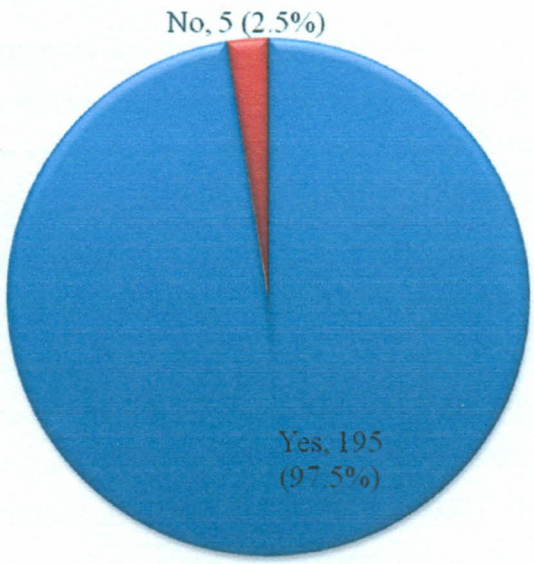

Figure 4.3: Livestock farmers' responses in relation to experiencing failure of expected rainfall over extended period of time in Murang'a South Sub-county.

Majority of the farmers stated that they experienced failure of adequate rainfall over an extended period of time. Only a few mostly the respondents who were new in the study area said that they have never experienced drought for the time that they had lived in Murang'a South. Climate change with expected long term changes in rainfall patterns and shifting temperature zones are expected to have negative effects on agriculture (Charles and Rashid, 2007). As a result extreme climate variability such

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as drought is frequently accompanied by loss of biodiversity, decimation of livestock herds, widespread food scarcity, mass migration and great loss of human life (Tarhule and Lamb, 2003). For the farmers in Murang'a South Sub-County therefore their experiences with failure of expected rainfall over a long period of time might have made them adopt measures to reduce vulnerability.

4.2.2 Livestock farmers' awareness of the forthcoming drought in Murang'a South Sub-County.

Table 4.7: Livestock farmers' awareness of the drought occurrence

Farmers' awareness	Frequency	Percent
Not aware of the forthcoming drought	155	77.5
Aware of the forthcoming drought	45	22.5
Total	**200**	**100.0**

Majority of the farmers were not aware of the forthcoming drought. Most farmers were therefore caught unaware by the drought. Considering the high percentage of respondents who were not aware of the impending drought conditions; it signifies that coping in such circumstances would be difficult as preparation is triggered by awareness. According to Dugan (2011), drought is exacerbated by lack of adequate response mechanism which is often disaster response rather than prevention. Wilhite (2004) found that there is a tendency for people to panic when they learn of an impending disaster brought about by drought and some start buying grains and other commodities to hoard them before they are finished in the market in preparation for drought. This preparation according to Wilhite (2004) reduced the farmers' sufferings and was therefore said to be a useful mechanism in coping with an impending disaster.

4.2.3 Sources of drought information among livestock farmers in Murang'a South Sub-county.

Information about drought is vital for farmers and can be received from various sources. Table 4.8 illustrates the various sources of drought information among livestock farmers.

Table 4.8: Sources of drought informationamong livestock farmers in Murang'a South sub-county (multiple responses).

Sources of information	Yes		No	
	F	%	F	%
Radio alone	28	62.2	17	37.8
Television alone	10	22.2	35	77.8
Radio and Television	8	17.8	37	82.2
Friends and neighbours	5	11.1	40	88.9
Television and newspaper	3	6.7	42	93.3
Radio and newspaper	2	4.4	43	95.6
Newspaper alone	1	2.2	44	97.8
Extension officers	1	2.2	44	97.8

Based on these results, out of the 45 farmers who had prior knowledge of the looming drought, majority of the farmers in Murang'a South sub-county depended on radio and T.V as the main source of information. The extension officers seem not to have disseminated drought information. This may be due to lack of knowledge of understanding different environmental indicators of predicting the coming weather and climate conditions. The results concur with Sweet (1998) who carried out a study in Namibia and found that radio and television were the most important in disseminating information on drought while only a few farmers got information from the agricultural extension officers yet they were the agency responsible for creating awareness to farmers about any form of a disaster associated with agriculture.

4.2.4 Livestock farmers' feelings about the drought.

A better understanding of the multidimensional nature of drought may avert or reduce its often destructive nature and improve the sustainability of environment in Murang'a South sub-county. It is important to learn what farmers' conceive drought to be, as it affects their actions in response to drought and will ultimately, influence the economic and environmental sustainability of their livelihood activities (Dagel, 1997).

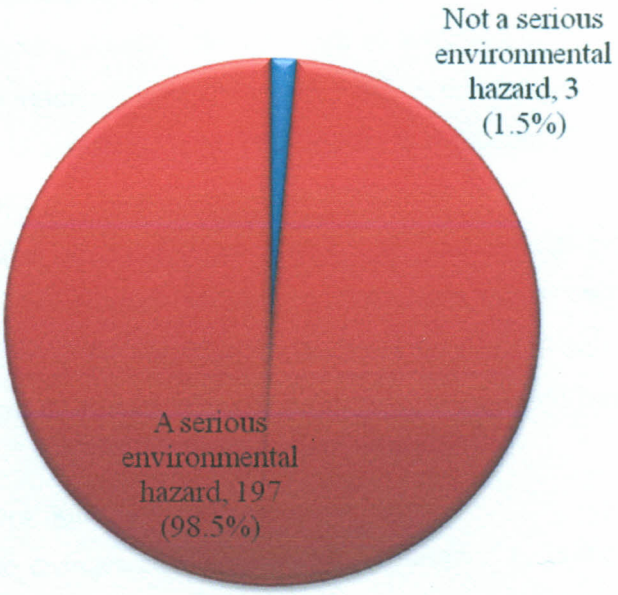

Figure 4.4: Livestock farmers' views in relation to drought in Murang'a South Sub- County.

Majority (98.5%) of the farmers viewed drought as a serious environmental hazard while only 1.5% did not view it as a serious threat. Compared to other natural disasters such as floods or pests, drought conditions are more long-term and more difficult to cope for farmers and their families (Bosch *et al.*, 2002).

4.2.5 Reasons why livestock farmers in Murang'a South Sub-county perceive drought as a serious environmental hazard.

The results are presented in Table 4.9.

Table 4.9: Reasons why Murang'a South district livestock farmers perceive drought as a serious environmental hazard (multiple responses)

Reasons	Farmers	Percentage
Water scarcity	178	90.4
Poverty	161	81.7
High prices of foodstuff	154	78.2
Low value of livestock	111	56.3
Increase in movement of people in search for jobs	102	51.8
Inadequate pastures	93	47.2
Low income level which lead to school dropout	78	39.6

As indicated, majority of the farmers perceived drought as a serious environmental hazard due to the following reasons; drought lead to water scarcity, poverty, high price of foodstuff, low value of livestock and increase in movement of people from one location to another in search for jobs This implies that drought plays a great role in economic survival of the natural resources and therefore most of the farmers who had experienced it had a strong opinion that drought is a serious environmental disaster. According to Hisdal and Tallaksen (2000), drought is the most costly disaster compared to all natural disasters. It kills more people and animals than the combined effects of hurricanes, floods, tornadoes, blizzards and wildfires.

4.2.6 Livestock farmers' knowledge of predicting drought

Understanding climatic changes and variability help farmers' to prevent and avoid damages that occur as a result of extended dry season. Table 4.10 illustrates number of farmers with knowledge of predicting drought and those who did not have knowledge of forecasting the drought occurrence.

Table 4.10: Farmers knowledge in relation to drought prediction in Murang'a South Sub-County.

Can you be able to predict drought	Farmers	Percent
Yes	35	17.5
No	165	82.5
Total	**200**	**100.0**

Among the 200 livestock farmers, only 17.5% were in a position of forecasting the drought occurrence. This clearly indicates that majority of the livestock farmers in Murang'a South Sub-County could not identify signs and signals of drought occurrence. This was despite the fact that 97.5% had at one time or the other experienced drought and viewed drought as a serious environmental hazard (Fig 4.4) which could make them suffer immensely whenever drought occurred. The degree to which a population can be affected by drought depends largely on various responses or coping options available to them, or their degree of vulnerability, which in turn

can be decreased by adequate pre-drought planning (Patrick, 2003). Patrick (2003), further stated that Prior to any form of disaster, it is necessary to have fore knowledge of the situation such as the likely duration and intensity of a looming disaster in order to plan ahead and reduce the level of vulnerability to such disasters.

4.2.7 Murang'a South Sub-County farmer's indigenous drought warning signals

Early warning, a major element of disaster risk reduction, can help prevent loss of life and reduce the potential economic impacts of a disaster if people are prepared and know what to do in response to the warning. Table 4.11 illustrates the indigenous drought warning signals as per the farmers' beliefs.

Table 4.11: Murang'a South Sub-County livestock farmers' indigenous drought warning signals (multiple responses)

Farmers' indigenous drought warning signals	Farmers	Percent
Increased fruit yields	34	97.1
Reduced ants	20	57.1
Migration of butterflies	15	42.8
Locust infestation	3	8.57
Infestation by army worms	2	5.71

Among the 35 farmers who could predict drought majority of them viewed increase in fruit yields and reduced ants as indicators of a looming drought. This concurs with Kinsey *et al* (1998) who carried out a study on drought coping mechanisms used by rural households of Zimbambwe and found that the community viewed abundance of wild fruits as an indicator of a looming drought.

4.2.8 Murang'a South Sub-County livestock farmers' perception of drought across their gender and education level

Farmers' gender and education level may influence farmers' perception of drought.

$H0_1$: Farmers' view of drought differs significantly across gender and education level.

Table 4.12: Murang'a South Sub-County livestock farmers' perception about drought across gender

Gender	Farmers' s view about drought				Total		Chi-square statistics
	A serious environmental hazard		Not a serious environmental hazard				
	F	%	F	%	F	%	
Male	114	57.0	1	0.5	115	57.5	χ^2=0.728
Female	83	41.5	2	1.0	85	42.5	df=1
Total	**197**	**98.5**	**3**	**1.5**	**200**	**100.0**	Sig.=0.394

Not significant at p<0.05 level

Chi-square test results revealed that there was no significant gender difference among farmers' perception in relation to drought χ^2 (1, N=200) =0.728, p=0.394. This means that both male and female farmers did not differ in their perceptions toward the drought. In agreement with the finding, previous studies conducted by Mengistu (2011) and Teshome, *et al*, (2008) established that both male and female farmers ranked drought as the foremost climate related hazard and characterized it as the most disastrous in the area.

Table 4.13 presents farmers' perception about the drought across their educational level.

Table 4.13: Murang'a South Sub-County Livestock farmers' perception about drought across education level.

Highest level education	Farmers' perception				Total		Chi-square statistics
	A serious environmental hazard		Not a serious environmental hazard				
	F	%	F	%	F	%	
No formal education	12	6.0	0	0.0	12	6.0	
Lower primary	16	8.0	0	0.0	16	8.0	χ^2=1.984
Upper primary	68	34.0	1	0.5	69	34.5	
Secondary education	81	40.5	1	0.5	82	41.0	df=4
College/ tertiary	20	10.0	1	0.5	21	10.5	
Total	**197**	**98.5**	**3**	**1.5**	**200**	**100.0**	Sig.=0.739

Not significant at p<0.05 level

The chi-square test results showed that there was no significant relationship between farmers' education level and their perceptions' towards drought, χ^2 =1.984, df=4, p=0.739. Results show that majority of the farmers with secondary education, college education and all those with no formal education and lower primary education viewed drought as a serious environmental hazard. This means that farmers' educational level did not have any influence on their perception towards the drought.

4.3 Effects of recurrent drought to the livestock farmers in Murang,a South Sub-County.

The second objective of the study sought to identify the effects of recurrent drought to the livestock farmers in the study area. To answer this research objective, the study sought to find out animals that are mostly affected by the drought, causes of animal deaths and the major effect of the drought towards farmers themselves. The following sections presents results of this analysis.

4.3.1 Animals mostly affected by the drought

Table 4.14: Animals mostly affected by drought in Murang,a South Sub-County

Animal mostly affected by the drought	Farmers	Percent
Cattle	181	90.5
Goats	10	5.0
Pigs	2	1.0
Sheep	3	1.5
Poultry	4	2.0
Total	**200**	**100.0**

Majority (90.5%) of the respondents were of the view that cattle were the most affected animals by drought. This could be perhaps that cattle were less resistant to drought in comparison with sheep, goats and pigs. Another reason could be that cattle consume a lot of water and fodder in comparison with other domestic animals such as goats, sheep, pigs and poultry. The findings conform with the results by Musimba et al, (2004) who found that goats were increasingly being preferred especially in semi-arid regions because they are more drought tolerant and suited for

the browse species that survive extended dry conditions and drought compared to cattle.

4.3.2 Murang,a South Sub-County farmers' experience of animals dying as a result of drought

The study further sought to establish whether respondents had ever experienced death of domestic animals as result of drought. Results of this analysis is tabulated in Table 4.15

Table 4.15: Livestock farmers' experience of animals' death due to drought in Murang'a South Sub-County

Farmers' experience	Farmers	Percent
Experienced death of animals	142	71.0
Never experienced animals' death	58	29.0
Total	**200**	**100.0**

Majority (71.0%) of the respondents reported having experienced death of animals as a result of drought. Sweet (1998) found that drought led to reduced water supply and high livestock mortality. According to Huho *et al,* (2010), drought is the greatest cause of animal mortality and in 1999-2000 it cost the economy of Kenya 2.5 billion us dollars. Dugan (2011) stated that the devastating recurrent drought across Kenya causes widespread hunger, shortage of drinking water, and in the case of cattle death. In Namibia Sweet (1998), found that many livestock farmers suffered death of animals as they were unable or to sell their animals in significant numbers before they died or became unmarketable. Bosch *et al*, (2002) found that farmers and their families are affected by drought in many ways which are; financially, emotionally and physically. According to Coleens et al (2006), drought is detected in the form of reduced food productivity, reduced water levels and increase in livestock deaths.

4.3.3 Major causes o animals deaths during the extended dry season in Murang'a South Sub-County.

Figure 4.5 shows the major causes of animals' death during the extended dry season in Murang'a South Sub-County.

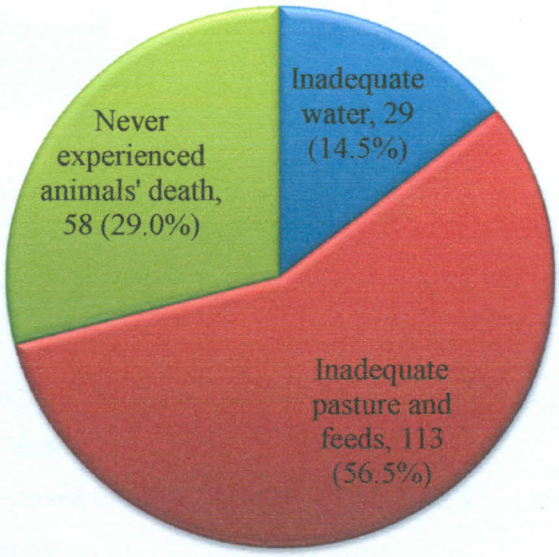

Figure 4.5: Causes of animal deaths in Murang'a South Sub-County.

Most of the livestock farmers reported that their animals died during drought due to inadequate pasture and feeds while others stated that their animals died due to inadequate water. In line with the findings FAO (1984), observed that insufficient levels of fodder around the village lead to weight loss and increased deaths among stock, especially where immigrant herds put further pressure on limited local pastures. The farmers in the area mostly depended on stream/ river as the major source of water (Table 4.18) and as per NDMC 2006, when drought occurs such farmers are the ones who feel the effects most hence the high cases of animal loss especially for cattle which require more water compared to the other type of animals reared. In Namibia the major cause of animal deaths during the extended dry periods is inadequate water which leads to a significant loss in animal herds especially for pastoral communities (Sweet, 1998). According to Coleens *et al* (2006), most of the livestock deaths are caused by lack of adequate water and pasture.

4.3.4 Effects of drought on livestock farmers and their households in Murang'a South Sub-County.

All the farmers who had ever experienced drought were asked to indicate the effects of drought on their lives and those of their households. Table 4.16 illustrates their responses.

Table 4.16: Effects of drought on Murang'a South Sub-County livestock farmers (Multiple responses)

Effects of drought	Yes		No	
	F	%	F	%
Do you have enough food for your family during drought?	34	17.0	166	83.0
Do you have enough water for domestic use during drought	38	19	162	81. 0
Do your children miss school during drought due to drought related problems??	75	37.5	125	62,5
Do any of your children drop out of school as a result of drought related problems?	41	20.5	159	79.5
Have you ever experienced loss of human life in your family as a result of drought related problems?	35	17.5	165	82.5

A notable proportion (83%) of livestock farmers indicated that they lacked enough food during drought while another proportion of them stated that they lacked enough water for domestic use during drought. Several respondents reported that some of their children miss school as a result of drought related problems while other children even drop out meaning that education of the children was easily sacrificed as the households diverted available resources to purchase food and other household essentials. In addition to this 17.5% reported that they have ever experienced loss of human life due to drought. This implies that extended dry season had negative impacts towards farmers. In line with the findings, Dugan (2011) stated that the devastating recurrent drought across Kenya causes widespread hunger and shortage of drinking water while Paul (1998) stated reduction of food entitlement to the people especially to the small farmers and landless labourers as a major effect of drought. The findings also concur with Coleen *et al.*, (1998) who stated that the impacts of drought spread gradually from the agricultural sector to other sectors of the economy. From the findings the effects have spread to several other sectors including education and health. Severe droughts can trigger socio-economic declines

from which many people are unable to recover when normal climatic conditions return, and economic and ecological crises are often closely linked (Shackleton, 1993). More so, prolonged drought has put an increased risk on farm sustainability for farmers and families. The loss of a farm can be a traumatic experience and means a major change in lifestyle, place of residency, and the end of family business (Boeckner *et al.*, 2003).

4.3.5 Effects of drought across farmers' education level and family size.

$H0_2$: The effects of drought experienced differ significantly across education level of livestock farmers and family size.

Chi-square test statistics was conducted and the results of this analysis are shown in Table 4.17, 4.18 and 4.19 respectively.

Table 4.17: Livestock farmers' education level and experience of animals' death as a result of drought

Highest education level	Farmers' experience of animals dying as a result of drought				Total		Chi-square statistics
	Yes		No				
	F	%	F	%	f	%	
No formal education	11	5.5	1	0.5	12	6.0	χ^2=14.909
Lower primary	8	4.0	8	4.0	16	8.0	
Upper primary	58	29.0	11	5.5	69	34.5	
Secondary education	51	25.5	31	15.5	82	41.0	df=4
College/ tertiary	14	7.0	7	3.5	21	10.5	
Total	**142**	**71.0**	**58**	**29.0**	**200**	**100.0**	Sig.=0.005*

***Significant at p<0.05 level**

As reflected , Chi-square test results revealed that there was a significant relationship between farmers' education level and farmers' experience of animal death as a result of drought, χ^2 =14.909, df=4, p=0.005. Results show that among the 12 farmers with no formal education, 11 of them experienced animal death as a result of drought with only one farmer indicating that he/she had never experienced animal death as a result of drought. The analysis further showed that out of 82 farmers with secondary education, 51 experienced animal deaths as a result of drought while 31 had never experienced animals' death.

Table 4.18 shows adequacy of food during the drought across different family size.

Table 4.18: Adequacy of food during the drought across different family size

Household size	Do you have enough food for your family during drought				Total		Chi-square statistics
	Yes		No				
	F	%	F	%	F	%	
3 and below	25	12.5	57	28.5	82	41.0	χ^2=19.032
4-6	8	4.0	71	35.5	79	39.5	
7-9	1	0.5	29	14.5	30	15.0	df =3
10 and above	0	0.0	9	4.5	9	4.5	
Total	**34**	**17.0**	**166**	**83.0**	**200**	**100.0**	Sig.=0.000*

***Significant at *p*<0.05 level**

Chi-square statistical test revealed that there was a significant relationship between farmers' household size and adequacy of food for family during the drought, χ^2 =19.032, df=3, *p*=0.000. The findings indicate that of the 82 farmers who had a family size of 3 members and below, 12.5% had enough food for the family during the drought season while 28.5% did not have adequate food for the family. Among 30 farmers with a family size of 7-9 members, 14.5% did not have adequate food for the family with only one reporting that he/she had adequate food for the family. This implies that farmers with larger family size were more likely to experience food shortage during drought compared to farmers with smaller family size.

Table 4.19 shows differences in family size and farmers' experience of human loss during drought.

Table 4.19: Family size and farmers' experience of human loss as a result of drought

Household size	Have you experienced loss of human life in your family				Total		Chi-square statistics
	Yes		No				
	F	%	F	%	F	%	
3 and Below	4	2.0	78	39.0	82	41.0	χ^2=24.600
4-6	15	7.5	64	32.0	79	39.5	
7-9	13	6.5	17	8.5	30	15.0	df =3
10 and above	3	1.5	6	3.0	9	4.5	
Total	**35**	**17.5**	**165**	**82.5**	**200**	**100.0**	Sig.=0.000*

***Significant at *p*<0.05 level**

The Chi-square statistical test showed that there was a significant relationship between farmers' household size and farmers' experience of human loss as a result of drought, χ^2 =24.600, df=3, p=0.000. The findings show that families with 4 members and above experienced higher cases of human loss as a result of drought compared with the families with 3 members and below. This implies that large sized families were more likely to experience loss of human life during drought compared with small sized families

4.4 Ways in which livestock farmers in Murang'a South Sub-County were counteracting problems related to drought to reduce vulnerability.

The third objective was to find out how the livestock farmers in the study area were counteracting the problems related to drought to reduce vulnerability. To ascertain this, the study focused on preparations made by the farmers before the drought, strategies adopted by the livestock farmers to reduce vulnerability and the type of assistance received either from the government or Non-Governmental Organizations. The following section presents results of this analysis.

Table 4.20: Muranga South Sub-County farmers' responses in relation to whether they had prepared before drought occurrence (multiple responses).

Had you prepared for the last drought before it occurred	Farmers	Percent
Yes	171	85.5
No	29	14.5
Total	**200**	**100.0**

Majority (85.5%) stated that they had not prepared for the extended dry season whereas 14.5%) farmers reported that they had prepared for the drought. This could have been due to the fact that most of them were not aware of the forthcoming drought. Drought preparedness and management are effective strategies to reduce risks and the impacts associated with droughts (Mwang'ombe *et al.*,2011) Preparedness for drought necessitates greater institutional capacity at all levels of government and more efficient coordination between different levels of government. Preparedness also implies increasing the coping capacity of individuals and

communities to deal with drought events (Sivakumar and Wilhite 2002). Natural and man-made disasters are part of humanity experiences and therefore it is important that their impacts on livelihood be understood and measures taken to minimize the severity of the impact (Wisner *et al*, 2006).

4.4.1 Preparations made by the livestock farmers in Murang'a south Sub-County before drought occurrence

Table 4.20 shows some of the preparations made by the farmers before drought occurrence

Table 4.21: Preparations made by livestock in farmers Murang'a south Sub-County before drought occurrence (multiple responses)

Preparations made before drought occurrence	Frequency	Percentage
Water harvesting	19	65.5
Planting of drought tolerant crops	11	37.9
Prepared silage	10	34.5
Planting of more fodder	7	24.1

Among the 29 livestock farmers who had prepared for the last drought before it occurred majority (65.5%) engaged in water harvesting during the rainy season as one of the major strategies of coping with water scarcity during the dry season. These findings corroborate with the results by Mwang'ombe *et al*, (2011) who established that farmers in Kibwezi district had developed both short and long term mechanisms to cope with the adverse dry conditions brought about by the unusual climatic patterns. The study showed that the main effect of unusual climatic events was water scarcity and most farmers responded to this through rain water harvesting. Similarly, Madely (2009), found that various methods of rain water harvesting have been used by dry land communities in an effort to cope with water scarcity in these areas. These methods include roof catchment and sinking of boreholes. Monnik(2000) stated that existence of an early indicator of a disaster provide adequate information in order to put up a timely measure to counter or manage the effects of the impending disaster such as drought.

4.4.2 Strategies adopted by different livestock farmers to counteract drought related problems in Murang'a South Sub-County.

Presented in Table 4.21 are coping strategies adopted by different farmers to counteract drought related problems.

Table 4.22: Ways adopted by Murang'a South Sub-County livestock farmers' to counteract drought problems (multiple responses)

Ways of counteracting drought problems	Yes		No	
	F	%	F	%
Do you seek alternative employment during drought?	134	67	66	33.0
Do your family members receive assistance from the government?	131	65.5	69	78.5
Do you render services/ assistance in exchange for food?	48	24.0	152	76.0
Do you disperse some of your family members to meet family needs?	43	21.5	157	78.5

Majority of the livestock farmers sought alternative employment while and others received assistance from the government during the extended droughts. The findings concur with Kinsey, (1998) and Thorlakson and Neufeldt (2012) who carried out a study in Zimbambwe and Nyando respectively and found that seeking additional employment as casual labourers was one of the most important adjustment mechanisms during drought. Paul (1998) in his research on drought coping mechanisms found that some farmers received support from the government as a coping strategy.

Tesfaye (2003) who carried out a research on drought coping mechanisms in Cote D Ivoire found that seasonal migration by able-bodied males to seek alternative employment is a way of pooling risks across space and increasing income during droughts. A study of the 1984 famine in Northern Ethiopia found that although humanitarian aid was influential in saving people's lives, indigenous coping and survival techniques were equally important and instrumental in saving a greater number of people from death (Rahmato 1991). The mechanisms lie within the framework of the individuals, groups or society's risk of tolerance level (Kivaria, 2007).

4.4.3 Assistance received from the government by the Murang'a Sub-County livestock farmers.

Figure 4.6 reflects the type of the assistance the livestock farmers in the study area received from the government.

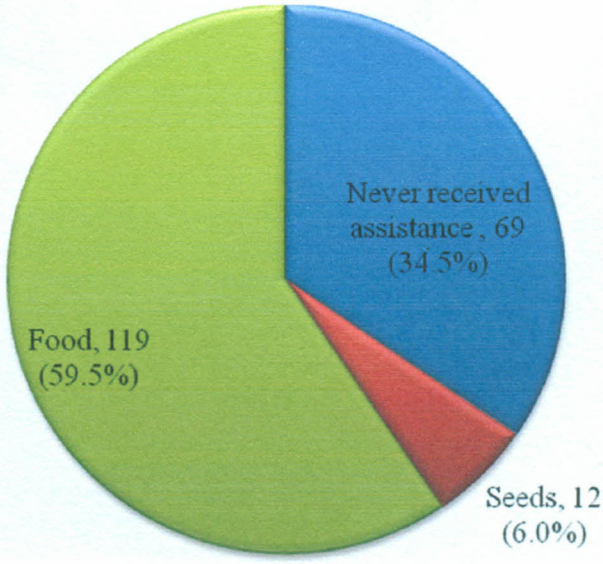

Figure 4.6: Type of assistance Murang'a South Sub-County livestock farmers received from the government

The major form of support provided by the government during drought seasons was relief food. In agreement with the findings, Kinsey, (1998) found that during the drought season, the main form of relief provided by the national government was household income support operated by the Department of Social Welfare (DSW). This form of assistance was in two categories; free food distributions for the elderly and the disabled as well as distributions on the basis of participation in food for work program for destitute families with able-bodied members. The food program also targeted children under the age of five. In addition, income support was also provided to needy households in the form of assistance with school and examination fees. Seeds and fertilizer packs were also distributed before the subsequent season in Zimbambwe. In Namibia, during drought the government was involved in the distribution of free food only to "vulnerable" groups, namely children under 5 years old, pregnant/lactating women, the elderly and the physically or mentally handicapped (Devereaux *et al.*, 1993). In Ethiopia, major responses of government

during drought were water harvesting and food for work (Helmut, 2004). Plate 4.1 shows farmers receiving assistance from government officers.

Plate 4.1: Farmers receiving relief food and seeds offered by the government at Kambiti, Murang'a South in September 2013.

4.4.4 Other methods used by livestock farmers to cope with drought in Murang,a South Sub-County.

Table 4.23: Other methods used by Murang,a South Sub-County livestock farmers to cope with drought (multiple responses)

Methods	Farmers	Percentage
Transporting fodder and water from other areas.	101	50.5
Reduction of meals	93	46.5
Casual labour	84	42.0
Selling livestock	78	38.0
Sand harvesting	76	38.0
Charcoal burning	57	28.5

Majority of the livestock farmers were transporting fodder and water from other areas while others reduced the number of meals and also worked as casual labourers.

Livestock was also sold most probably to reduce losses and also supplement income. In line with the findings, Mengistu, (2011) found that farmers employ various coping strategies against climate risks. These strategies included: food for work scheme, credit, petty businesses (such as firewood and charcoal selling), reduction of daily meal in amount and frequency and also moving to other areas in such of fodder and water. Similarly, Thorlakson and Neufeldt (2012) established that during periods of drought and hunger, the most common coping strategy in Lower Nyando was to reduce food consumption through restricting of the amount, diversity and number of meals taken each day. Another popular coping strategy in Lower Nyando was engaging households who were involved in off-farm activities in casual farm labour.

In addition, Campbell, (1999) who conducted a study on drought in Kajiado, Kenya, found that during the drought season several mechanisms to cope with drought were used. These mechanisms included; prayer and payment to a rainmaker, movement of livestock to areas with water and pasture, liquidation of assets, sale of land, use of environmental resources such as fire wood, engagement in tourism and wildlife activities, horticultural activities as well as migration in search of jobs, pastures and water. Other coping mechanisms adopted by farmers during these periods included gardening and selling of vegetables, working as casual labourers, selling livestock and livestock products such as milk (Kinsey, 1998). In addition to this, some farmers reported that they sold their livestock in order to save them from death. In line with the findings, Sweet (1998) asserts that when livestock is threatened by drought, the main option is to sell some animals or buy in feeds. The coping strategies depend on access to resources and technology (Adger, 2009). Normally, what start as coping strategies can become adaptations for households or the whole community (Moench, 2004).

Measures put in place by livestock farmers in Murang'a South Sub-County to counteract the impact of drought across gender and education level

$H0_3$: The measures put in place by livestock farmers to counteract the impact of drought differ significantly across gender and education level.

This hypothesis was tested using Chi-square statistical test and the results of the analysis were in Tables 4.23 and 4.24 respectively.

Table 4.24: Measures used by Murang'a South Sub-County livestock farmers' to counteract the impact of drought across gender

Ways of counteracting drought problems		Gender				Total		Chi-square statistics
		Male		Female				
		F	%	f	%	F	%	
Rendering services/ assistance in exchange for food	Yes	25	12.5	23	11.5	48	24.0	χ^2=0.758
	No	90	45.0	62	31.0	152	76.0	df=1
	Total	**115**	**57.5**	**85**	**42.5**	**200**	**100.0**	Sig.=0.384
Dispersing some family members to meet family needs	Yes	22	11.0	21	10.5	43	21.5	χ^2=0.900
	No	93	46.5	64	32.0	157	78.5	df=1
	Total	**115**	**57.5**	**85**	**42.5**	**200**	**100.0**	Sig.=0.343
Seeking alternative employment during drought	Yes	72	36.0	62	31.0	134	67.0	χ^2=2.360
	No	43	21.5	23	11.5	66	33.0	df=1
	Total	**115**	**57.5**	**85**	**42.5**	**200**	**100.0**	Sig.=0.124

Not significant at p<0.05 level

Chi-square tests statistics revealed that there was no significant differences among the male and female farmers in relation to strategies employed to counteract the impact of drought, at p<0.05 level. Results show that 24.0% of farmers who reported that they were rendering services in exchange for food during the drought, 12.5% of them were males while 11.5% were females. Among the 21.5% farmers who were dispersing some family members to meet family needs, 11.0% were males while 10.5% were females. The results further show that out of the 134 farmers who were seeking alternative employment during drought, 36.0% were males while 31.0% were females. This clearly shows that both male and female farmers were not differing in terms of measures they were employing to counteract the impact of drought. The results concur with Kinsey (1998) who carried out a study on response of rural households to drought in Zimbambwe and found that coping mechanisms adopted are virtually the same but only differ in application. Both male and female in Zimbambwe were coping with drought in the same way (Kinsey et al, 1998).

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Table 4.25: Measures used by Murang'a South Sub-County Livestock farmers' to counteract the impact of drought across education level

Highest level of education	Rendering services/ assistance in exchange for food				Total		Chi-square statistics
	Yes		No				
	F	%	F	%	F	%	
No formal education	2	1.0	10	6.6	12	6.0	χ^2=5.815
Lower primary	7	3.5	9	5.9	16	8.0	
Upper primary	19	9.5	50	32.9	69	34.5	df =4
Secondary education	17	8.5	65	32.5	82	41.0	
College/ tertiary	3	1.5	18	11.8	21	10.5	Sig.=0.213
Total	**48**	**24.0**	**152**	**76.0**	**200**	**100.0**	

Highest level of education	Dispersing some family members to meet family needs				Total		Chi-square statistics
	Yes		No				
	F	%	f	%	F	%	
No formal education	5	2.5	7	3.5	12	6.0	χ^2=12.139
Lower primary	7	3.5	9	4.5	16	8.0	
Upper primary	16	8.0	53	26.5	69	34.5	df =4
Secondary education	14	7.0	68	34.0	82	41.0	
College/ tertiary	1	0.5	20	10.0	21	10.5	
Total	**43**	**21.5**	**157**	**78.5**	**200**	**100.0**	Sig.=0.016*

Highest level of education	Seeking alternative employment during drought				Total		Chi-square statistics
	Yes		No				
	F	%	f	%	F	%	
No formal education	2	1.0	10	5.0	12	6.0	χ^2=15.310
Lower primary	10	5.0	6	3.0	16	8.0	
Upper primary	49	24.5	20	10.0	69	34.5	df =4
Secondary education	59	29.5	23	11.5	82	41.0	
College/ tertiary	14	7.0	7	3.5	21	10.5	
Total	**134**	**67.0**	**66**	**33.3**	**200**	**100.0**	Sig.=0.004*

***Significant at p<0.05 level**

Among the farmers who were rendering services in exchange for food, 1.0% had not attained any formal education, 9.5% had upper primary education whereas 1.5% had college education. In relation to dispersing of some family members to meet family needs, out of 6.0% of the farmers who had no formal education, 2.5% of them were

dispersing some of the family members while 3.5% were not. Among the farmers with lower primary education, 3.5% of them were dispersing family members while 4.5% were not. The results further indicate that among 10.5% farmers with college education, only 0.5% farmer reported that he/she dispersed some of the family members. The remaining 10.0% indicated that they were not dispersing their family members as a result of drought. With regard to seeking of alternative employment, results show that majority of the farmers with secondary 29.5% and college 7.0% education were more likely to seek alternative employment compared to farmers with no formal education 1.0%. This implies that rendering services in exchange for food and also dispersing some family members to meet family needs during drought did not differ significantly across level of education. The findings also showed that farmers with higher education level were likely to engage in mechanisms of counteracting drought compared to farmers with low level of education. These results concur with De Jonge (2010) who found that farmers who have university education are more likely to respond to climate change than farmers who have primary education. Similarly, Deressa *et al*, (2009) found that there was a positive relationship between education and adaptation to climate change. Farmers who are more educated have more knowledge on measures to adapt to change in climatic conditions and thus better prepared to cope with climate change compared with the less educated farmers. Education therefore plays an important role in adaptation to climate change.

4.5 Constraints faced by Murang,a South Sub-County livestock farmers' in their attempt to cope with drought

To investigate the constraints the livestock farmers are facing in their attempt to cope with drought, the study first established farmers' opinions in relation to efficiency of the mechanisms they employ to cope with drought.

4.5.1 Murang'a South Sub-County livestock farmers' views in relation to efficiency of measures they use to cope with drought.

Figure 4.8 depicts livestock farmers' response in relation to efficiency of measures they apply to cope with drought.

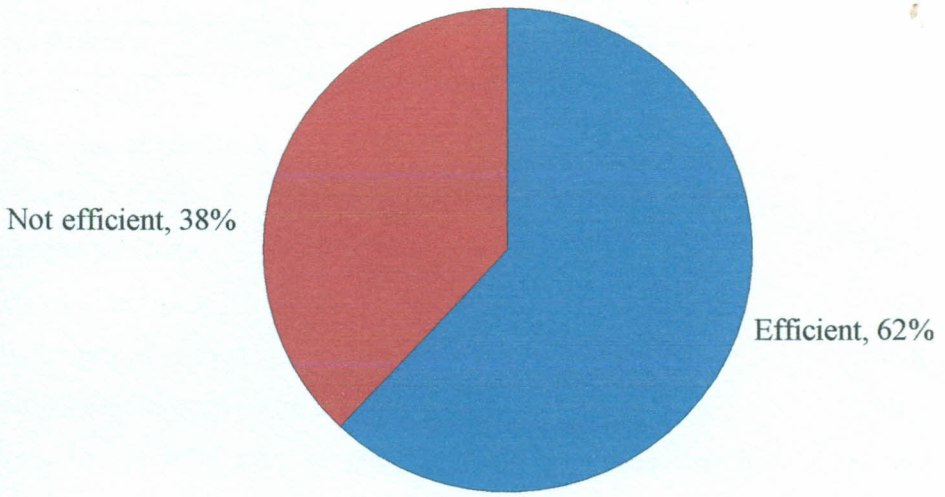

Figure 4.7: Livestock farmers' responses in relation to efficiency of measures they use to cope with drought

From the results, 62.0% of the farmers reported that the measures they employed to cope with drought were efficient in reducing its effects while 38.0% reported that those methods were not efficient. According to Wisner *et al,* 2006, it's not enough to just focus on the hazard threat without addressing the factors that make people suffer immensely when disaster strikes. Some of these factors may be invisible and seem distant from the disaster. According to Adger(2009), the key parameters to note when analyzing the vulnerability of a community when disaster strikes include the stress to which a system is exposed to and its sensitivity. He further argues that these factors determine the adaptive capacity of the community. According to Thorlakson and Neufeldt (2012), farmers in Lower Nyando used the drought resistant crops to try and cope with the extended periods of inadequate rainfall but reported that it was not effective as there was great loss associated with those strains if the rains failed completely. These farmers therefore opted not to use the strain due to fear of even more sufferings (Thorlakson and Neufeldt).

4.5.2 Challenges Faced by Murang'a South Sub-County Farmers' in their attempt to cope with drought

Table 4.26 illustrates major challenges faced by farmers in their attempt to cope with drought.

Table 4.26: Challenges faced by Murang'a South livestock farmers in their attempt to cope with drought (multiple responses)

Constraints	Frequency	Percentage
Low rainfall	116	93.5
Low value of livestock	110	88.7
Poverty	106	85.5
Inadequate funds	104	83.9
Pests and diseases	98	79.0
Higher prices of food	86	69.4
Inadequate skills on water harvesting	73	58.9

Among the farmers who reported that the measures that they employed were efficient, over 65% noted the major challenges they face while coping with drought as low rainfall, low value for their livestock, poverty, inadequate funds, pests and diseases and high prices for food. These are therefore the major factors that make them unable to adapt when drought strikes. This agrees with Wilhite (2002) who argued that vulnerability is worsened by a multitude of factors that include government policies, land use and water management, among others. Farmers experienced poverty during the extended dry seasons. This is because the immediate effect of drought on the farming sector is the fall of food production. During this time farmers are faced with an inadequate harvest to feed their families and to meet other basic needs within the household. To cope with these challenges, most of the farmers sell their domestic animals and as a result decrease family resources and also level of income as the animal products like milk and manure earn them income in normal circumstances. The animals are sold at very low prices hence low earnings from the sale of livestock. Pests and diseases was another major factor which hindered farmers in their attempt to cope with drought. Livestock diseases compromise animals' welfare and reduce their productivity. Consistent with these findings, Olwero (1998) found that whenever drought occur, its often accompanied by huge losses through general crop failure, crop damage, livestock deaths, pests and disease outbreaks, displacement of people among other negative factors, all of which impact negatively on the socio-economic status of the affected households.

CHAPTER FIVE
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions, recommendations based on the study findings and suggests areas for further research.

5.2 Summary of the study findings

The main goal of the study was to find out the strategies used by the livestock farmers to cope with problems associated with drought by investigating their actions before and during the drought. Data for the study was collected from 200 livestock farmers in Murang'a South Sub-County. Given below is the summary of the main study findings.

5.2.1 Farmers' perception about the drought

The study findings revealed that majority of the farmers both male and female viewed drought as a serious environmental hazard. This was justified by the following reasons. Drought lead to water scarcity, poverty, high price of food, low value of livestock, inadequate pastures, low incomes and increase in movement of people from one location to another in search for jobs. This clearly showed that drought plays a great role in survival of the natural resources and therefore most of the farmers who had experienced it had a strong opinion that drought is a serious environmental disaster.

5.2.2 Effects of recurrent drought to the livestock farmer

The study established that majority of the farmers experienced death of animals during the drought. The major causes of this death were inadequate pasture, feeds and water. In addition to this, the results of the analysis revealed the major impacts of drought on farmers and their households as lack of adequate food and water. Other effects mentioned include increase in children absenteeism from school and some even dropping out of school while for some loss of human life. Both male and female were affected in the same ways. Farmers with lower education levels and those with larger families seemed to suffer more during drought compared to farmers with higher levels of education.

5.2.3 Ways in which farmers were counteracting problems related to drought to reduce vulnerability

In relation to this objective, the results showed that majority of the farmers had not prepared for the extended dry season. However, among those who had prepared for the drought, the following were some of the preparations they had made; storing water through rain harvesting, planting drought resistant crops, preparing silage for the animals and planting more fodder in their land. During drought, some farmers sold their animals in order to save them from death, others sought alternative employment, some dispersed their family members to meet family needs, others received assistance from the government in form of relief food and seeds while other farmers engaged in sand harvesting and charcoal burning. These measures of counteracting drought seemed not to differ significantly across gender; however some of the adopted measures differed significantly across education levels.

Findings of this study are generally consistent with results of past studies on mechanisms of coping with drought except that sand harvesting and charcoal burning seem to be applied to cope with drought in Murang'a South Sub-County while liquidation of assets such as farm machinery and personal effects is not used as a strategy in the study area contrary to many other studies.

5.2.4 Constraints faced by livestock farmers in their attempt to cope with drought

The study found that the major challenges faced by farmers while trying to cope with drought were low rainfall, low value for their animals, poverty, inadequate funds, pests and diseases. Other challenges mentioned were higher prices for food stuffs and inadequate skills of water harvesting.

5.3 Conclusions

Considering these study findings, the study concludes that livestock farmers experienced huge losses during extended period of dry season. The study established that most of the farmers faced livestock death, higher prices of food, low value of livestock and increase in movement of people from one location to another. Consequently, this increases the poverty level of the farmers across the study area

hence lowering the economic growth of the Sub-County, county and the country as a whole. The study therefore, concludes that drought plays a great role in economic survival of the natural resources and hence there is need for establishing effective coping strategies especially with the unpredictable weather patterns.

From the analysis of the current coping strategies being employed it is clear that the livestock farmers in Murang'a South Sub-County are not coping with drought in a sustainable way as their sufferings were substantial. The suffering was made worse by lack of adequate funds and other resources with which to buffer them against adversity. With increase in the frequency and intensity of drought therefore, existing coping mechanisms may no longer be able to support households during difficult times in future which might lead to tremendous suffering among the members of community.

5.4 Recommendations of the study

Arising from the study findings, the following recommendations are made:-

i. With the increasing rate of erratic rainfall patterns, drought and desertification, drought and disease resistant animals and short duration high yielding crops should be developed through research efforts and be made available to farmers by the Ministry of Agriculture, Livestock and Fisheries.

ii. Since drought seems to be a long time theme in Kenya and the dry spells seem to be hitting with more frequency, there is need for effective capacity building to strengthen the most vulnerable groups in agricultural production with requisite knowledge and information necessary for climate change mitigation and adaptation. This can be done through the Ministry of Environment, Water and Natural Resources.

iii. Since most of the farmers lacked knowledge of identifying signs and indicators of the drought which made them suffer immensely, there is need for the Meteorological Department to improve dissemination of climate information through radio and TV where most of the farmers can access the information.

iv. With the knowledge that drought affects people of all ages, the Ministry of Education should incorporate drought management into the school curricula. This

will ensure basic knowledge in dealing with drought hence adapt to future diversity with minimum external assistance.

v. In order to alleviate worse effects of drought, the Ministry of Devolution and Planning which deals with emergency and relief programs should be prepared for the hazard before it occurs. It should develop projects to deal with drought in advance and implement them promptly to minimize the great losses associated with droughts.

vi. Due to the challenges faced by livestock farmers in marketing their livestock during drought the Ministry of Industrialization and Enterprise Development should encourage establishment of additional interest groups to boost development of livestock produce enterprises.

5.5 Areas for Further Research

The following are the areas for further research

i. Due to time factor and financial constraints, the current study was conducted only in Murang'a South Sub-County. The study findings therefore cannot be generalized in the whole Country and as such a similar study should be conducted in other drought prone sub-counties to determine whether similar results would be obtained.

ii. There is need to understand the challenges faced by farmers in trying to cope with drought. In depth analysis that will aid in addressing the problem of vulnerability is required and therefore a research to illuminate this would be relevant.

iii. Another key area for further study where focus is required is an assessment of the best way of linking livestock farmers to markets during droughts. This will aid in benefiting farmers in selling their livestock in good time and at a higher value before the animals' health deteriorate.

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APPENDICES

Appendix 1

RESEARCH QUESTIONNAIRE

Dear respondent,

My name is Martha Wanjiku. I am a postgraduate student at Kenyatta University studying climate change and sustainability. I am undertaking research on the impacts of drought and the coping mechanisms adopted by the Kenyan people.

The questionnaire is aimed at collecting information that will be useful for my thesis requirements. Your honest response will be of great assistance to me during this study. Any information given will be treated as confidential and will only be used purely for academic purposes.

I will appreciate any additional information that you may consider relevant for this research.

RESEARCH QUESTIONNAIRE

Questionnaire number…….. Sub-county…… Ward……..

Human demography

1. Age of the respondent …… years.
2. Gender
    1. Male.
    2. Female.
2. Marital status (Tick where applicable)
    1. Married.
    2. Never married.
    3. Divorced.
    4. Widow/er.
3. What is the highest education level achieved? (Tick where applicable)
    1. No formal education.
    2. Lower primary.
    3. Upper primary.
    4. Secondary school.
    5. College/ tertiary.

4 .Total number of persons in the household.....

5. Main occupation .....

6. How long have you lived in this area? .....years.

7. How long have you been farming in Murang,a South Sub-county? .....years.

8. What type of livestock do you rear? (Tick where applicable)

1. Cattle.
2. Goats.
3. Sheep.
4. Pigs.
5. Poultry.
6. Others (specify).....

9. What are your main sources of water? (Tick where applicable)

1. Stream/ river.
2. Borehole.
3. Ponds.
4. Dams/ reservoirs.
5. Stored water.
6. Others (specify).....

B. **Perception of drought**

1. Have you ever experienced failure of expected rainfall over a long extended period of time mostly a season or more during the time you have been farming in Murang,a South?

1. Yes.
2. No.

If yes

3. a) When did you last experience it? .....

b) How long did it last? .....

4. Were you aware of the incoming drought before it occurred?

1. Yes.
2. No.

If yes

5. Where did you get the information from?

1. Television.
2. Radio.
3. Newspaper.
4. Friends and neighbours.
5. Extension officers.
6. Others (specify).....

6. Did you get the information in good time?

1. Yes.
2. No.

7. How often does drought occur in your locality?

Once in every .....years.

8. Which year did you experience the worst drought? .....

9. Do you consider drought to be a serious environmental hazard?

1. Yes.
2. No.

10. Why do you think so? Specify reasons

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11 a) Can you be able to predict drought?

1. Yes.
2. No.

If yes

b). What are the indicators of a looming drought?

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.....

.....

C. Effects of droughts

1. Among the animals which you rear, which animal is mostly affected by drought? (Tick where applicable)
    1. Cattle.
    2. Goats.
    3. Sheep.
    4. Pigs.
    5. Poultry.
    6. Others (specify) .....

2. Do you usually have enough fodder during drought?
    1. Yes.
    2. No.

4. What is the distance to the fodder supply areas in the following periods?
    a. During drought ..... kilometers
    b. Before drought ..... kilometers

5. Do some of your animals die during the drought?
    1. Yes.
    2. No.

If yes

6. What is usually the cause of the death?
    1. Inadequate water.
    2. Inadequate pasture and feeds.
    3. Others (Specify) .....

D. Effects of drought to farmers and their households

1. Do you have enough food for your family during drought?
    1. Yes.
    2. No.

2. Do your children miss school during drought due to inadequate food at home?
    1. Yes.
    2. No.

3. Do you have enough water for domestic use during drought?

    1. Yes.
    2. No.

4. What is the distance to the water source during the following periods?

    a. During drought .....kilometers.
    b. In absence of drought .....kilometers.

5. Do any of your children drop out of school as a result of drought related problems?

    1. Yes.
    2. No.

6. Have you ever experienced deaths of persons in your family as a result of drought related problems?

    1. Yes.
    2. No.

E. Responding to drought and its related problems

1. Were you prepared for the last drought before it occurred?

    1. Yes
    2. No

    If yes

2. What preparations had you made?

    .....
    .....
    ... .
    .....
    .....
    .....

3. What do you usually do to save your animals from death during drought?

    .....
    .....
    .....

4. Do you render services/assistance in exchange for food when there is drought?

1. Yes
2. No

If yes

5. What is your perception about the assistance rendered, does it help you or do you feel exploited at that time? .....

.....

.....

6. Do you seek alternative employment during drought period/season?

1. Yes
2. No

b. If yes, is the employment within your Sub-County or elsewhere?

1. Within
2. Elsewhere

7. Do your family members receive assistance from the government during drought?

1. Yes
2. No

8. If yes what type of support? (Tick where applicable)

1. Food
2. Seeds
3. Clothes
4. Housing materials
5. Others (specify).....

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9. Does the assistance come at the right time?

1. Yes.
2. No

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10. Is the assistance you receive enough to meet your needs during that time?
    1. Yes.
    2. No.
11. Do you receive assistance from NGOS/ humanitarian organizations during drought?
    1. Yes.
    2. No.

    If yes

12. What type of assistance? (Tick where applicable)
    1. Food.
    2. Seeds.
    3. Clothes.
    4. Housing materials.
    5. Others (specify).....

    .....

    .....

    .....

    .....

13. Does the help come at the right time?
    1. Yes.
    2. No.
14. According to your own assessment, which body offers the best assistance to you during drought?
    1. Government
    2 .NGOS/humanitarian organizations
    3. Others (specify).....

    .....

    .....

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15. Can you conclude that the measures adopted to cope with the drought help to reduce its adverse effects?

    1. Yes
    2. No

16. If yes, what are the major constraints that hinder your coping strategies?

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APPENDIX 2

List of famine periods in Africa since 1970

Date	Event	Location
1972-1973	Famine in Ethiopia	Ethiopia
1980-1981	Famine in Uganda	Uganda
1984-1985	Famine in Ethiopia	Ethiopia
1991-1992	Somalian famine caused by drought	Somali
1998	Sudan famine caused by drought and war	Sudan
1998-2000	Famine in Ethiopia	Ethiopia
2003	Famine in Sudan	Sudan
2005	Malawi food crisis	Malawi
2005-2006	Niger food crisis	Niger
2006	Horn of Africa food crisis	Somalia, Ethiopia Djibouti, Kenya
2008	East Africa food crisis	East Africa
2008	Horn of Africa	Somalia, Djibouti, Ethiopia and Kenya
2009	Kenya food crisis	Kenya
2010	Sahel food crisis	Sahel
2011	Horn of Africa	Kenya, Somalia, Ethiopia and neighboring countries

Source; Cormac, 2012

APPENDIX 3

Effects of recent droughts on livestock in a few African countries

1981- 1984	Botswana	20% reduction in national herd
1982- 1984	Niger	60% loss of national cattle herd
1983- 1985	Ethiopia (Borana plateau)	37% loss of cattle
1991-1992	Northern Kenya	70% loss of cattle
1993	Namibia	22% loss of cattle, 41% loss of goats
1995- 1997	Greater horn of Africa	29% loss of cattle, 25% loss of goats
1998- 1999	Ethiopia (Borana plateau)	62% loss of cattle, 30% loss of goats
1999- 2001	Kenya	30% loss of cattle, 30% loss of goats,18% loss of camels
2002	Eritrea	10- 20% loss of livestock in some areas
2002	Ethiopia (Afar and Somalia)	4% loss of cattle, 10 to15% loss of goats
2004-2006	Kenya	70% loss of livestock in some pastoral communities
2005	Kenya (Mandera and Marsabit)	30- 40% loss of cattle and goats, 10-15% loss of camels
2009	Tanzania and Kenya	Maasai lost 70- 90% of their livestock
2010	Niger	75% of livestock threatened
2010 May	Somalia	70- 80% livestock loss

Tearfund, 2010

APPENDIX 4
Chronology of drought incidences in Kenya since 1883

Date	Region	Remarks
1883	Coast	Worst famine in 30yrs
1889 to 1890	Coast	One year drought and famine
1894 to 1895	Coast	Information not available
1896 to 1900	Countrywide	Failure of three consecutive rainy seasons, human deaths
1907 to 1911	L. Victoria, Machakos, Kitui and Coast	Minor food shortages
1913 to 1919	Eastern and coastal area	Impacts exacerbated by warfare
1921	Rift valley, Central and Coast	Food shortage, crop and livestock loss
1925	Northern Rift valley and Central provinces	Heavy loss of livestock, Lorian swamp dried up: deaths occurred
1938 to 1939	Countrywide	Food shortage, about 200 deaths
1942 to 1944	Central and coast	Severe especially at the Coast
1947 to 1950	Eastern, Coast, Western and Rift valley	Mombasa was driest, water shortage in Nairobi
1950 to 1955	Eastern and Rift valley	Droughts followed by floods. Cattle mortality at 70 to 80% in Maasailand
1960 to 1961	Widespread	Nairobi hit by water shortage, wildlife deaths in Nairobi national park
1972	Most of Kenya	Human and livestock deaths in northern districts, Maasai cattle loss of about 80%

1973 to 1974	Eastern, Central and North Eastern provinces	Crop production paralyzed
1974 to 1976	Central, Eastern, Western and Coast provinces	Famine in Eastern province, water shortage, migration of people and livestock
1980	Countrywide	Large food deficit
1984	Central, Eastern, Rift valley and North Eastern provinces	Moderately severe in Eastern province, relief food imported
1987	Eastern and Central	4.7 million people dependent on relief food.
1992 to 1994	Northern, Central, Eastern	Severe food shortage
1999 to 2000	Countrywide except West and Coastal belt	Severe food shortage

Source, UNEP, 2000

APPENDIX 5

AGRO-ECOLOGICAL ZONES IN MURANG'A SOUTH

Agro-ecological zone	Altitude (m)	Ward	Approx. Area (Km2)	Hectares/Livestock unit (ha/LU)	Major enterprises
Transitional Zone (UM4)	1370 to 1490	Kamahuha, Makuyu, Kambiti	55	0.8 – 1.5	Natural pastures
				0.25 – 0.3	Cultivated forages
Cotton Zone (LM3)	1160 to 1140	Kamahuha Kambiti	30	0.8 – 1.5	Natural pastures
				0.25 – 0.3	Cultivated forages
Marginal Cotton Zone (LM4)	1060 to 1160	Maragua Ridge Kambiti	15	1.5 – 3.0	Natural pastures
				0.3 – 0.5	Cultivated forages

Source; Jaetzold *et.al,* 2006.

APPENDIX 6

ADMINISTRATIVE AREA, POPULATION AND POPULATION DENSITY IN MURANG'A SOUTH

DIVISION	Ward	SUB-LOCATION	2009 CENSUS			
			TOTAL	HOUSEHOLDS	Sq. KM	DENSITY
MAKUYU	MAKUYU	KIMORORI	11114	2895	25	451
		GAKUNGU	7969	2131	24	327
		MAKUYU	6821	1832	14	488
		GATHUNGURURU	5465	1422	46	119
		WEMPA	15786	4245	55	286
		KIRIMIRI	12120	2924	76	159
		TOTAL	**59275**	**15449**	**240**	**247**
	KAMBITI	KAMBITI	5056	1289	20	249
		MIHANG'O	4000	1006	9	431
		KARIA-INI	3583	878	11	318
		MARANJAU	1934	489	7	281
		TOTAL	**14572**	**3662**	**48**	**305**
	KAMAHUHA	SABASABA	9938	2784	13	743
		KAHARATI	4800	1242	9	512
		KAMAHUHA	4528	1193	9	516
		IGANJO	4923	1232	16	303
		TOTAL	24189	6451	48	506
	DIVISIONAL	**TOTAL**	**98036**	**25562**	**336**	**292**
MARAGUA	M/RIDGE	KAMUIRU	2979	730	11	278
		MARAGUA RIDGE	3644	928	19	189
		TOTAL	6623	1658	30	467
	NGINDA	ITAAGA	2950	813	4	703
		KAHARO	3763	1004	7	568
		MBUGUA	3781	989	8	481
		GAKOIGO	7567	2119	13	585
		IREMBU	1515	404	2	692
		GATHERA	4784	1239	9	538
		TOTAL	**24360**	**6568**	**43**	**567**
	ICHAGAKI	ICHAGAKI	5636	1403	11	523
		KIANJIRU-INI	10242	2980	13	791
		SAMAR	2899	837	27	106
		GIKOMORA	4476	1186	7	623
		TOTAL	23253	6406	58	401
	DIVISIONAL	TOTAL	54236	14632	131	414
DISTRICT TOTAL			**152,272**	**40,194**	**467**	**326**

SOURCE: CENTRAL BUREAU OF STATISTICS, 2010

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