INFLUENCE OF DROUGHT VARIABILITY ON LIVESTOCK FEEDING PRACTICES BY MAASAI PASTORALISTS IN MAILWA SUB-LOCATION OF KAJIADO COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

This thesis is my original work and has not been presented for an award of a degree in this or any other University.

Signature…… Date……..

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RECOMMENDATION

This thesis has been submitted with our approval as university supervisors:

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DEDICATION

This work is dedicated to my family for its constant encouragement and patience that saw me through the academic endeavor, thus realizing my long cherished dream.

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ABSTRACT

All the regions of the world are vulnerable to climate change where droughts have become more unpredictable due to climate change. Effects droughts are felt most severely by the livestock based economies and livelihoods in the Kenyan Arid and Semi-Arid Lands (ASALs) where rainfall amounts are low, erratic and unreliable. Pastoralism is a key production system in ASAL areas using extensive grazing for livestock production. While pastoralists in ASAL areas have adjusted their livestock feeding practices to cope with changes in droughts, their characteristic responses are less understood. There was need therefore, to establish the influence of drought variability on livestock feeding practices by Maasai pastoralists in Mailwa sub-location of Kajiado County. This area was purposively selected as it is inhabited mainly by the Maasai practicing pure pastoralism. The study used a descriptive research design. Population of the study consisted of 437 male and female household heads. Proportionate random sampling technique was used to select136 household heads comprising of both male and female. Data was collected using a semi-structured interview schedule and analyzed using descriptive and inferential statistics with SPSS software (version 17). Chi-square was applied to test the hypotheses at 0.05 confidence level. Rainfall data from Maasai Rural Training Centre (MRTC) Isinya was analyzed using Microsoft Excel to give a general pattern of rainfall in the area for the last five decades. Results indicated that 87.5% of pastoralists traditionally used seasonal movement of livestock as a response to cope with drought in addition to herd splitting and livestock mix. On current livestock feeding practices, 97.8% practiced seasonal movement of livestock in addition to purchasing of commercial feeds and hay. On frequency of droughts, 98.5% had noticed an increase in frequency where droughts have become an annual occurrence. On duration of droughts, 97.8% had noticed an increase in the duration where droughts lasted for a period of 7-12 after onset. On changes in rainfall patterns, 99.3% had noted changes in rainfall patterns where onset of rainfall was no longer predictable. It can be concluded that seasonal movement of livestock in search of pasture and water used as a traditional coping strategy is still in place, frequency and duration of droughts in the area have increased while onset of rainfall is no longer predictable. The study recommend up scaling of traditional drought coping strategies related to livestock feeding, adoption of improved drought tolerant livestock breeds, development of more water harvesting facilities and policy interventions that that promote adoption of technologies that enhance harvesting and storage of grass hay.

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ABBREVIATIONS AND ACRONYMS

APF	African Partnership Forum
ASALs	Arid and Semi-Arid Lands
AU	African Union
DAO	District Agricultural Officer
DM	Dry Matter
FAO	Food and Agriculture Organization
FEWSN	Famine Early Warning Systems Network
GDP	Gross Domestic Product
GOK	Government of Kenya
HIV/AIDS	Human Immune Virus/ Acquired Immune Deficiency Syndrome
KNBS	Kenya National Bureau of Statistics
ILRI	International Livestock Research Institute
IPCC	Intergovernmental Panel on Climate Change
I UCN	International Union for Conservation of Nature
IUCNNR	International Union for Conservation of Nature and Natural Resources
MEA	Millennium Ecosystem Assessment
MRTC	Maasai Rural Training Centre
NCST	National Council of Science and Technology
NRC	National Research Council
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

All the regions of the world are vulnerable to climate change. According to International Union for Conservation of Nature and Natural Resources [IUCNNR](2010), the Mediterranean region has been experiencing a clear shift towards a warmer and dryer climate which is a threat to wildlife and people in the region. Climate change effects has also been felt in the coastal and marine ecosystems that are essential for supporting biodiversity and people's livelihoods in Pacific Islands, Australia, and New Zealand which are connected by the Pacific Ocean. Extreme weather events in South America has resulted in increased rainfall in Venezuela, flooding in the Argentinean Pampas, drought in the Amazon and hail storms in Bolivia. Countries of Central and West Africa are particularly vulnerable to climate change especially arid and semi-arid zones which represent a large part of the region.

Impacts of a changing climate are already being felt in Kenya. These impacts include reduced food production due to erratic and unpredictable rainfall patterns, water scarcity, increasing temperatures that lead to spawning of disease vectors and diseases such as malaria to areas in which they are not traditionally prevalent, rising tides which threaten coastal cities, as well as frequent droughts and floods (Ochieng & Makaloo, 2010). Although drought affects the country as a whole, its effects are felt most severely by the livestock based economies and livelihoods in the Kenyan Arid and Semi-Arid Lands [ASALs](Zwaagstra, Sharif, Wambile, Leeuw, Johnson, Njuki, Said, Ericksen & Herrero 2010). ASALs constitute about 83 percent of the total land mass in Kenya and are home to about ten million people where rainfall amounts are low, the timing erratic and unreliable. These areas are adversely affected by drought and the worsening effects of climate change, which have led to environmental degradation and drying up of water pans. According to Huho, Ngaira and Ogindo (2011), drought in Kenya is the most common hazard encountered by households on a widespread level in ASAL areas with the government having declared five drought related national disasters between 1993 and 2011. Droughts in these areas have increased in both frequency and intensity from once in ten years in the 1970s, to once in 5 years in 1980s, once in every 2-3 years in the 1990s and have become the norm since 2000.

Pastoralism is one of the key production systems in ASAL areas which use extensive grazing in rangelands for livestock production where the sub-sector in Kenya contributes for 10- 12 percent of Gross Domestic Product ([GDP]) and forming one third of the agricultural GDP (Mariara, 2008). Kajiado is classified as an ASAL area with high levels of food insecurity occasioned by persistent droughts. Average annual potential evaporation ranges from 1600 to 2200 mm which means that for the greater parts of the year there is a moisture deficit. Mailwa sub-location of Kajiado Central District, Kajiado County is inhabited mainly by the Maasai pastoralist community. According to Kenya National Bureau of Statistics (2010), Kajiado Central district livestock population consists of 95,534 cattle, 218,961 sheep, 270,148 goats, 472 camels and 31,564 donkeys. Kajiado District Annual Progress Report (2006/2007) indicates that vegetation cover is open grassland, wooded grassland, bushed grassland, wood and bush land which makes the area suitable for pastoralism. Pastoralism is the main livelihood for the Maasai community in the county but its sustainability is uncertain due to the influence of drought variability attributed to climate change. Maasai pastoralists keep livestock under extensive grazing system in which they move livestock from one area to another in search of pasture and water.

According to Ogeto (2007), pastoralists' social structure and livestock husbandry is organized in such a way that ensures sustainability of their livelihood in their resource-poor environment. Their production system is characterized by mobility and flexibility to counter extreme environmental fluctuations. They keep many and diverse livestock that serve as social capital, insurance against disaster as well as ensuring optimum range utilization. Strategies that ensured sustainable rangeland utilization included milk production that support more people than meat, maintenance of dry season grazing reserves, mobility, livestock diversity, maximizing stock numbers, herds splitting, retention of animals past their prime age, maintenance of herds with a high proportion of females and social security through stock loans and redistribution. These strategies enabled pastoralist's survival and maintenance of high biological diversity in rangelands. Success of pastoralism is mainly attributed to pastoralist's pasture management techniques and the indigenous livestock breeds they keep. Climate variability and traditional adaptation strategies have long been part of pastoral production systems in the region. However, convergence of unprecedented levels of land use change coupled with increasing climate uncertainty is eroding the resilience of ecological and social systems alike (Ochieng & Makaloo, 2010). Feeding of livestock is still a major challenge to sustainable productivity of pastoral

communities in the dry land areas in view of the current climate variability. The impacts of climate change such as higher temperature, erratic rainfall and floods are increasing the pastoralists' inability to feed their animals leading to loss of a source of livelihood and food insecurity (Chibinga, Musimba, Nyangito, & Simbaya, 2012). Drought variability impacts on livestock feeding practices but the extent it does is not documented. This study was thus designed to provide the missing information on this phenomenon.

1.2 Statement of the Problem

The impacts of climate change such as higher temperature, erratic rainfall and floods are increasing the pastoralists' inability to feed their animals leading to loss of a source of livelihood and food insecurity. Frequency and duration of droughts have increased which impacts on livestock feed resource but pastoralists coping responses are yet to be characterized. Pastoralists have adjusted their livestock feeding practices to cope but the characteristic responses among the pastoral Maasai community in Mailwa sub-location of Kajiado County are not well understood. A study of how Maasai pastoralists in Mailwa sub-location cope with drought variability in relation to livestock feeding practices was expected to give insights into livestock feeding challenges of pastoralists in Kenya that can be used to develop sustainable livestock feeding practices strategies. Thus the study sought to determine the influence of drought variability on livestock feeding practices among the Maasai pastoralists in Mailwa sub-location, Kajiado County.

1.3 Purpose of the Study

The purpose of the study was to establish the influence of drought variability on livestock feeding practices by the Maasai pastoralists in Mailwa sub-location, Kajiado County.

1.4 Objectives of the Study

The study was guided by the following specific objectives:-

i) To describe traditional and current livestock feeding practices by Maasai pastoralists in Mailwa sub-location, Kajiado County
ii) To establish the influence of frequency of droughts on livestock feeding practices in Mailwa sub-location, Kajiado County
iii) To establish the influence of duration of droughts on livestock feeding practices in Mailwa sub-location, Kajiado County

iv) To establish the influence of change in rainfall patterns on livestock feeding practices in Mailwa sub-location, Kajiado County

1.5 Hypotheses of the Study

Ho_1: Frequency of droughts has no statistically significant influence on livestock feeding practices in Mailwa sub-location, Kajiado County

Ho_2: Duration of droughts has no statistically significant influence on livestock feeding Practices in Mailwa sub-location, Kajiado County

Ho_3: Change in rainfall patterns have no statistically signification influence on livestock feeding practices in Mailwa sub-location, Kajiado County

1.6 Significance of the Study

Pastoral livestock production systems are mostly found in Africa's vast arid and semi-arid areas (African Union [AU], 2010). These systems despite their importance to pastoralists' livelihoods are vulnerable to influence of drought variability. Understanding how drought variability influence livestock feeding practices is significant in that it is expected to influence policy on formulation of interventions that enhances pastoralists' ability to adopt appropriate livestock feeding practices in view of drought variability. This study provides information on the awareness of Maasai pastoralists about changes in frequency and duration of droughts and changes in rainfall patterns as well of consequences on livestock feeding practices a result of drought variability. The study further established that despite changes introduced by drought variability, Maasai pastoralists continued to use traditional method such as livestock movement as the preferred livestock feeding practice in the area.

1.7 Scope and Limitations of the Study

The study focused on the influence of drought variability on livestock feeding practices of pastoralists in Mailwa sub-location in Kajiado Central District of Kajiado County and therefore the results cannot be generalized for other pastoralist areas.

1.8 Assumptions of the Study

The study assumed that the respondents were ready and willing to participate in the study by providing honest and accurate information on the issues raised.

1.9 Definition of Terms

Climate change: National Weather Service (2007) defines climate change as the long term shift in the statistics of weather indicating changes in expected average values for temperature and precipitation for a given place and time of the year over a number of decades. In this study climate change was looked at how it was influencing drought variability in Mailwa sub-location, Kajiado County and how this in turn influenced livestock feeding practices. It was assessed by recording climatic changes observed by the community over a period of 10- 20 years and available climatic data.

Climate change adaptation: The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with drought variability and climate change (IPCC, 2001). In this study climate adaptations were viewed as livestock feeding practices adapted by pastoralists to cope with effects of drought variability.

Drought: A drought is a commonly occurring natural hazard, which is defined as a period when an area receives below average precipitation over extended periods of several months to multiple years (Erickson, 2010). In this study drought was looked at as the number of month's extreme dry conditions persisted in the study area.

Drought variability: In this study, drought variability was looked at in terms of frequency of occurrence, duration and intensity (Kisiangani et al, 2011). It was measured by documenting changes in frequency and duration of droughts and change in rainfall patterns in Mailwa sub-location, Kajiado County.

Household: The household is a group of persons related or not, living under the same roof, under the responsibility of a head whose authority is acknowledged by all the members. The ordinary household is composed of a head of household, his spouse(s), his unmarried children, and possibly his relatives or other persons to whom he is unrelated. The household can be limited

to only one person or a person with his children (Beaman & Dillon, 2010). For this study, the household referred to a group of Maasai pastoralists living within the same compound under the responsibility of a head whose authority is acknowledged by all the members.

Household head: Kenya National Bureau of statistics [KNBS], (2009), defines a household head as 'the most responsible or respected member of the household who makes key decision in the household on a day to day basis and whose authority is honored by all members of the household'. The bureau used a household to refer to a person or a group of persons who reside in the same homestead or compound but not necessarily in the same dwelling unit, have similar cooking arrangement and are answerable to the same household head. This definition was adopted for this study.

Influence: Oxford Advanced Learner's Dictionary 7th edition defines influence as to have an effect on a particular situation and the way it develops. In this study, influence was looked at how drought variability affected livestock feeding practices in Mailwa sub-location, Kajiado County. It was measured by looking at the relationship between drought variability and livestock feeding practices in Kajiado County.

Land tenure: FAO (2002) defines land tenure as the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land ownership. An assessment as to whether various land tenure systems influence livestock production system and therefore livestock feeding practices in the study area was made.

Livestock feeding practices: Livestock feeding management strategies include seasonal movement, use of tree leaves and pods during dry seasons, burning of old pastures, and feeding on crop residues (Davies & Roba, 2010). They were assessed by documenting materials and methods adopted by pastoralists to feed livestock as a result of drought due to climate change.

Livestock movement: This is the mobility that enables pastoralists to take advantage of pasture resources that are only seasonally accessible, and allows access to salt patches (critical for animal health) and other resources and services(in this study, livestock movement referred to the

movement of livestock from the wet season grazing areas to the dry season grazing within and without Kajiado County. It was measured by looking at the distance covered in search of pasture and areas where the pastoralists moved their livestock to during periods of drought

Pastoralism: It is a way of life based primarily on raising livestock, particularly small ruminants, cattle and camels. (AU, 2010). In this study, pastoralism refers to the extensive livestock production systems involving movement from one area to another in search of pasture and water.

Pastoralists: Oxfam (2008) defines pastoralists as people whose way of life largely depends on mobile livestock herding. They live in a range of environments in many countries across every continent in the world. In sub-Saharan Africa mobile pastoralism is predominantly practiced in arid and semi-arid lands (ASALs). In this study, pastoralists are referred to as people who mainly depend on livestock as a source of livelihood.

Pasture: Collins English Dictionary defines pasture as land that is used for grazing as a source of forage for livestock (Collins, 2009). For this study, pastures refer to natural grasses, browse and shrubs on which livestock feed. It was measured in the terms of what pastoralists consider as its seasonal availability and palatability to the various livestock types.

Socio-economic factors: These include but is not limited to; family income, parental education, occupation and status in the community such as contacts within the community (Kiptoo, 2005). In this study, socio-economic characteristics refer to household head's age, gender, marital status, education level, family size, sources of livelihood and occupation. .

Variability: Oxford Advanced Learner's Dictionary 7th edition defines variability as the fact of something being likely to change (Hornby, 2006). In this study, variability was looked as changes in the nature of droughts as a result of climate change over a period of 10-20 years.

Vulnerability: This is the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes. Drought is a

function of drought variability. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. (IPCC, 2001). This study looked at the extent to which pastoralists were affected by influence of drought variability.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This section gives an overview of literature on drought variability and how this in turn affects livestock feeding practices. The literature review will look at information on drought and climate change; pastoralism; livestock feed resource base; and water availability.

2.2 Climate Change

Climate change has various indications that have been seen in the recent years. The evidence of climate change includes rise in sea levels, change in rainfall patterns and increases in global temperatures. A rise in temperatures by 0.2^0C per decade is predicted due to greenhouse gas emission which is likely to hit a 2^0 C threshold by the year 2050 (Intergovernmental Panel on Climate Change [IPCC], 2007). More drastic change is expected and research evidence has revealed that the changes, some of which may be irreversible will affect not only human beings but also other species and the ecosystem as a whole (International Union for Conservation of Nature [IUCN]2010). IPCC (2008) indicates that increased precipitation intensity and variability is projected to increase the risks of flooding and drought in many areas. The frequency of heavy precipitation is likely increase over most areas during the 21st century, with consequences to the risk of rain-generated floods. At the same time, the proportion of land surface in extreme drought at any one time is projected to increase. IPCC (2014) further observed that the impacts of climate change have already affected agriculture, human health, ecosystems on land and in the oceans, water supplies, and some people's livelihoods. The striking feature of observed impacts is that they are occurring from the tropics to the poles, from small islands to large continents, and from the wealthiest countries to the poorest.

According to Getahun (2007), climate change is affecting dry lands and pastoral livelihoods in Africa. As a result, these areas will tend to become drier, and existing water shortages will worsen. In addition, climate change is likely to bring about even more erratic and unpredictable rainfalls and more extreme weather conditions such as longer and more frequent droughts. Parry, Echeverria, Dekens and Maitima (2012) indicate that climate-related risks have always

influenced life in Kenya. Along the coasts, fishermen worry about cyclones and sudden storms. Inland, in the arid and semi-arid regions of eastern and northern Kenya, the livelihoods of farmers and pastoralists depend on the arrival and quality of the rains. In the central and western highlands, bisected by the Great Rift Valley, heavy rains can lead to floods and landslides.

2.2.1 Change in Temperatures

The average global surface temperatures are predicted to increase by 2.8^0C in the 21^{st} century (IPCC, 2007). This can be attributed to the increased concentration of greenhouse gases in the atmosphere. In Kenya, it has been reported that temperatures have been increasing annually at the rate of 0.2°C over the past five decades. Communities have experienced prolonged droughts resulting in acute water shortage (Kasimbu, 2010). The effects of these changes in global surface temperatures are unpredictable and will lead to alterations in the natural systems such as hydrological cycle. Such changes would include increases in frequency of extreme weather events like droughts and floods as well as rise in sea level (Zhai, Lin & Byambadorj, 2009). Warming temperatures will cause the sea levels to rise due to melting polar ice and also will impact on thermal expansion of the ocean. The global sea level rose by 0.17m in the 20^{th} century which is likely to increase to 1 meter by the year 2100 if the current trend persists. This will cause more catastrophes like loss of habitable land for a majority of human populations (International Union for Conservation of Nature [IUCN], 2010).

Moreover, the increasing temperatures have caused continued melting of the polar ice. This means that in the next 30 years there would be no ice in the arctic during the summer months which has adverse effects on the local biodiversity. Thus, there will be pole-ward migration of species causing invasion of new foreign species in areas they were traditionally not known to exist while causing extinction in their area of origin (IUCN, 2010).

A slight change in temperature has adverse effects on people's livelihoods. Pastoralists in Kajiado County are expected to device ways and means to protect themselves from the probable effects of climate change resulting from changing temperature regimes. These changes in temperature may result in drought variability that reduce amount of water and pasture available for livestock use. Thus this study sought to determine the influence of drought variability on livestock feeding practices in Mailwa sub-location, Kajiado County.

2.2.2 Changes in rainfall patterns

Rainfall is the most obvious indicator of drought, as it is defined as a shortage of rainfall. It is a timely indicator of drought as it provides a signal few weeks before the vegetation responds, and many months before livestock dies (Erickson, 2010). However disadvantage of rainfall is that information relies on records from few scattered rainfall stations. Kenya Meteorological Department (2011) reports that the March to May 2011 seasonal rainfall was highly depressed and poorly distributed, both in time and space, over most parts of the country. This was more noticeable in the North-eastern parts of Kenya and the Coastal strip where most meteorological stations recorded less than 50 percent of their seasonal Long-Term Means (LTMs) for March to May. The rainfall was also characterized by late onset in some parts of the country. Change in rainfall patterns have also been noted in India. A report by Guhathakurta and Rajeev an (2006) noted that that the contribution of June, July and September rainfall to annual rainfall had decreased while contribution of August rainfall had increased.

Famine Early Warning Systems Network**, [**FEWSNT], (2010) analyses indicate patterns of observed climate change during the 1960–2009 period in rainfall and temperature indicate that large parts of Kenya have experienced more than a 100 millimeter decline in rainfall. Alterations in rainfall patterns are accompanied by elevated atmospheric carbon dioxide (CO_2) and other elements of climate change. Variability induced by altered rainfall patterns may offset elevated CO_2 effects on soil water content and leaf physiological activity hence affecting growth of grassland species (Fay, Carlisle, Danner, Lett, McCarron, Stewart, Knapp, Blair & Collins, 2002). A study by CARE (2011) in Tana River indicate that the area receives an annual rainfall averaging 300 mm and is prone to prolonged drought which results in the drying up of seasonal water sources. In this area, a significant drought occurs once every three to four years while a major drought can be expected approximately every seven years. Therefore, pastoral communities in the area are affected by chronic water shortages. Nori, Taylor and Sensi (2008) indicate that climate change is likely to induce variability in rainfall patterns and more frequent floods and droughts. A study by Pinho, Galvin, Boone, Zahra and Bucini (2008) in Amboseli ecosystem in Kajiado district indicated that the perception of the community was that rainfall had reduced while droughts were longer and more frequent. According to Dore (2005), increased variation in precipitation has seen wet areas become wetter and arid areas drier.

2.3 Droughts and Climate Change in Africa

World Meteorological Organization [WMO] (2006) indicates that droughts have three distinguishing features: intensity, duration and spatial coverage. Intensity refers to the degree of the precipitation shortfall and/or the severity of impacts associated with the shortfall. Another essential characteristic of drought is its duration. Droughts can develop quickly in some climatic regimes, but usually require a minimum of two to three months to become established. Once a drought begins, it can persist for months or years. The magnitude of drought impacts is closely related to the timing of the onset of the precipitation shortage, its intensity and the duration of the event. Droughts also differ in their spatial characteristics. The areas affected by severe drought evolve gradually, and regions of maximum intensity, such as epicentres, shift from season to season and year to year in the event of multi-year droughts. In larger countries, such as Brazil, China, India, the United States or Australia, drought would rarely, if ever, affect the entire country.

Droughts directly impact on the household food security of over 10 million people living in drought-prone areas (Zwaagstra, Sharif, Wambile, Leeuw, Johnson, Njuki, Said, Ericksen & Herrero, 2010). The costs of climate change could be equivalent to 2.6% of Kenya GDP each year by 2030. The costs of the 1998/2000 drought were estimated at US$2.8 billion. In some regions, up to one third of all livestock perished due to the most recent drought (Ministry of Environment &Mineral Resources, 2011). According to Kasimbu (2010), recurrent drought and climate change have over the years put additional strains on the already limited livelihood resources in the ASAL regions, predominantly occupied by pastoralist and mobile communities especially in Northern Kenya. Drought diminishes the primary production of crops and rangeland vegetation and the secondary production of livestock which depends on primary production (Erickson, 2010).Droughts, unpredictable rains, floods and other natural disasters attributable to climate change affect livestock production (Nandolo, 2011). According to Steeg, Herrero, Kinyangi, Thornton, Rao, Stern, and Cooper (2009), when the probability of drought increases to once every three years, herd sizes decreases as a result of increased mortality and poorer reproductive performance. This decrease in livestock numbers affect food security and compromise the sole dependence of pastoralists on animals and their products, as well as the additional benefits they confer. Droughts in East Africa's dry lands are becoming more frequent.

This creates difficulties for many pastoralists in the region(Institute of Development, 2007).Whether the drought in the Horn of Africa was made more likely by man-made or due to climate change is as yet unclear due to the complexity of the local climate, but it shows the vulnerability of poor people in the region to climate variability (Welly, 2011).

Different studies have shown the trend of droughts in Kenya. Rarieya (2006) indicates that past major droughts were experienced in 1949, 1953, 1954, 1969 and 1984 while more recent droughts have occurred in 1999, 2000 and 2005/06. According to Getahun (2007), a study conducted in Mandera district revealed that incidences of drought had increased fourfold during the past 25 years forcing one third of herders to abandon their pastoral way of life because of adverse climatic conditions. According to Humanitarian Policy Group (2009), surveys by local communities indicate that climate in the Horn of Africa is experiencing an increase in the rates of drought. Reports indicate that drought-related shocks used to occur every ten years but the return period has reduced to five years or less. Kasimbu, (2010) reported that droughts are on the increase both in terms of the frequency and severity. Pastoralists therefore feel that their key sources of livelihoods are threatened. This is likely to influence livestock feeding practices in the affected areas.

2.3.1 Drought variability

Woodhouse and Overpeck (1998) noted that prospects of future droughts are considered both in view of the full range of past natural drought variability and in terms of land use practice and human greenhouse gas–induced climate change. A principal difference between major droughts of the twentieth century and major droughts of the more distant past is the duration, which is on the order of seasons to years compared to decades to centuries. According to Brooks (2004), what has been interpreted as desertification in many instances appears to be the natural response of semi-arid landscapes and ecosystems to climatic variability. World Meteorological Organization [WMO] (2006) classifies droughts as meteorological, agricultural, hydrological and socioeconomic. Meteorological drought is usually defined by a precipitation deficiency threshold over a predetermined period of time. The threshold chosen, such as 75 per cent of normal precipitation, and duration period, for example, six months, will vary by location according to user needs or applications. Agricultural drought is defined more commonly by the availability of soil water to support crop and forage growth than by the departure of normal precipitation over

some specified period of time. Hydrological drought is normally defined by the departure of surface and subsurface water supplies from some average condition at various points in time. Socio-economic drought differs markedly from the other types of drought because it reflects the relationship between the supply and demand for some commodity or economic good, such as water, livestock forage or hydroelectric power that is dependent on precipitation. Supply varies annually as a function of precipitation or water availability.

2.3.2 Indigenous knowledge related to weather forecasting

According to Hartmann and Sugulle (2009), traditional knowledge and information systems have a prominent role in rangeland and livestock management because it is sensitive and comprehensive and can be adapted to changing conditions. However, this knowledge is being eroded by the fast progress of urbanization. Traditional knowledge is useful to pastoral communities in several ways. It is more sensitive to immediate environmental changes and therefore immediately available to the user, it tells how conditions would look like under healthy environmental conditions and it also tells how air humidity is related to the flowering behaviour of trees therefore maintaining awareness of the bigger cycles humans and environment are a part of. Pastoralists can tell the change in droughts, rainfall patterns, distribution and intensity when comparing the present and the past. Influence due to drought variability has induced disturbance in the traditional weather forecasting to an extent that the predictions are not valid anymore. This will in turn affect livestock feeding practices.

2.4 Pastoral Livestock Production System

Pastoralism is an extensive grazing system practiced on rangelands for livestock production. It an important economic and cultural way of life for between 100 and 200 million people throughout the world and cover about 25 percent of the earth's terrestrial surface (Djoghlaf, 2010). Statistics from African Union's (AU) policy framework for pastoralism (2010) indicate that there are 268 million pastoralists. They live and move on 43 percent of Africa's land mass and contribute between 10 to 44 per cent of the Gross Domestic Product in the countries that they live in (Kisiangani, 2011). Livestock kept in include cattle, sheep, goats and camels. In sub-Saharan Africa about 16 percent of the population relies on pastoralism, and in some countries, such as Somalia and Mauritania, pastoralists represent a majority of the population. Pastoral systems are characterized by low population densities, high mobility, complex information

systems and a high dependency on local knowledge. Pastoralists make significant contributions to national economies and to the maintenance of ecosystem in rangelands. As users of rangelands who are reliant upon the provision of numerous ecosystem services (e.g. water, food, fodder), pastoralists have a unique knowledge of how a balance between conservation and sustainable use can be maintained. Pastoralists around the globe are being sedentarised and livestock mobility is declining. Animals once able to move about landscapes to access ephemeral green forage are being confined to small areas with fewer forage choices (Boone, 2005).

Kasimbu (2010) indicated that arid and semi-arid lands (ASALs) in Kenya constitute about 80 percent of the total land mass and are home to about a quarter of Kenya's population. In addition, pastoralists in the ASALs own about 70 percent of the national livestock population with an estimated value of close to USD 1 billion. Rainfall amounts in ASALs are low, erratic and unreliable in spatial and temporal terms leading to frequent droughts. Influence of drought variability on pastoralism is likely to impact on livestock feeding practices.

2.4.1 The Maasai as a pastoral community in Kenya

The Maasai community in Kenya is straddled between Kenya and Tanzania. Their traditional occupation and livelihood is mainly pastoralism. They are semi nomadic pastoralists who keep different species of livestock. Their population in Kenya is estimated to be 1 million and is known to occupy Kajiado, Narok and Laikipia counties. Through interaction with their environments that has a rich flora and fauna, the Maasai community has developed elaborate traditional knowledge, natural resource management practices and cultural rituals (World Intellectual Property Organization, [WIPO], 2006). Land, nature and livestock are the key aspects that depict the Maasai cultural identity. Their main source of livelihood is livestock and livestock products. Thus, any change in the environment that may affect livestock implies a great disruption to their source of livelihood and ultimately their way of life.

The Maasai have been able to develop traditional livelihoods in areas otherwise considered waste lands and unproductive by many. They have survived rough terrains through developing and continuing to develop unique knowledge in dealing with livestock as well as human health and natural resources issues. Now more than ever, the Maasai community is facing serious challenges such as diminishing natural resource base, food security and poverty all of which are

attributable to drought variability (Oxfam, 2008). These changes are likely to affect livestock feeding practices in Mailwa sub-location, Kajiado County.

2.4.2 Vulnerability of pastoral livelihood to drought variability

Sarah and Venton (2009) indicate that due to a reliance on natural resources, pastoralist communities are particularly vulnerable to natural and human-caused disasters. Pastoralists are vulnerable to food insecurity and conflict with approximately 5,000 pastoralists in the Horn of Africa losing their lives from conflict each year. According to Davies (2010), there are two main types of livestock–wildlife conflicts to consider in pastoral systems. The first is competition with other grazers for water and fodder, and the second is conflict with predators who feed on livestock. Conflict with other grazers tends to be most noticeable during periods of stress such as drought. During such periods it is common for pastoralists to move herds into protected areas in search of water and fodder. In doing so, pastoralism comes into direct competition with wildlife. However, access to protected areas during times of drought can be vital to the survival of pastoralists' herds, and can therefore have a significant impact on pastoralists' livelihoods.

Drought variability is predicted to escalate armed conflicts in pastoralists' areas and potentially double this number in the next 10-20 years. National Meteorological Agency [NMA] (2007) outlines some of the impacts of drought variability on grassland and livestock in Ethiopia as change in livestock feed availability, impacts on forage crops quality and quantity and contracting pastoral zones in many parts of the country. According to Hartmann and Sugulle (2009),drought variability is already happening with its impacts being felt by most of the people in the country, particularly pastoral communities, who are more vulnerable to the effects of droughts as they rely on livestock production that is highly weather sensitive.

Climatic shocks including droughts and floods are among the issues that are promoting vulnerability of pastoral communities to food and livelihood crises in dry lands of Eastern Africa. They are also faced with issues of man- made forces such as inappropriate policies which are linked to bans on meat exports (Humanitarian Policy Group, 2009). United Nations Convention to Combat Desertification [UNCCD] (2007) reports that in Kajiado County, declaration of land formally used for grazing into conservation areas has reduced amount of pasture. In addition, change in land use around Isinya and Kitengela from grazing to residential

settlements and horticultural activities has affected pastoralism. Fencing and sub-division of the land is on an upward trend. This in turn will affect livestock feeding practices. This study sought to find out the influence of drought variability on livestock feeding practices among the pastoralists in Mailwa sub-location, Kajiado County.

2.4.3 Options to mitigate impacts of drought on pastoral livestock production systems

Cycles of accumulation, collapse and rebuilding are defining features of the pastoralist way of life, but recent shocks and stresses may be stretching coping capacities in the Horn of Africa's arid and semi-arid lands to breaking point (Institute of development Studies, 2006). Pastoralists have adapted several coping strategies to mitigate the effects of drought variability. Davies and Roba (2010) outlines some of them as moving livestock to alternative grazing zones, selecting pastures within access of functioning markets, shifting from one type of livestock to another like investing in camels that are more resilient, or in sheep that are more marketable.

Davies and Toba (2010) noted that the Maasai alternate the use of their natural grassland according to seasons. This requires a timely decision on when and where to move next. They have in the past predicted droughts as well as weather related diseases by watching the movements of celestial bodies in combination with observing the date of emergence of certain plant species. The Maasai practice every day monitoring of their resource base to determine the trend of range condition and to detect early signs of deterioration. To ensure reliability of evaluation, they have developed various sampling and surveying techniques. They observe forage types, quality, quantity and condition as used by livestock and wildlife. Common indicators used include daily milk yield, animal coat texture and colour, consistence of cow and wildlife dung, and the extent of bush encroachment. These measures can no longer be relied upon due to drought variability.

Oseni and Bebe (2011) propose intervention strategies which if adopted can increase pastoralists' adaptation to drought variability. Some of them include development of policies that provide pastoralists with opportunities to practice mobile livelihoods, enhancing and securing pastoralists' access to strategic resources essential if they are to respond effectively to changes in droughts and researching on appropriate dissemination pathways for climate information and climate impacts to pastoralists and stakeholders involved in policy-making and service provision.

Awour (2011) adds that by modifying livestock diversity through composition and numbers can mitigate impacts of changes in drought. This can be done by investing in goats and camels that less vulnerable to drought variability than cattle and sheep. As pastoralists try to cope with impacts of drought variability, livestock feeding is likely to be affected. This study sought to investigate the effects of drought on livestock feeding practices in Mailwa sub-location, Kajiado County.

2.5 Livestock Feed Resources

Thornton, Steeg, Notenbaert and Herrero (2008) indicate that changes have been noted on pasture quality and quantity. These include the changes in herbage growth due to changes in atmospheric carbon dioxide (CO2) concentrations and temperature, composition of pastures (ratio of grasses to legumes), herbage quality due to concentrations of water-soluble carbohydrates and nitrogen (N) at given dry matter (DM)yields, offsetting of DM yield due to drought and increased N leaching during periods of excessive rains.

Feed quality is the amount of nutrient that an animal can obtain from a feed in the shortest possible time. Crude protein, digestible dry matter and metabolisable energy have been considered more appropriate attributes for evaluation of range forage quality (Arzani, 2006). Drought variability affects pastoralism by reducing carrying capacity of rangelands inducing changes in plant species compositions favourable to less palatable species and reducing availability of water for livestock use (Davies &Roba, 2010). The best correlations between rainfall and herbaceous primary production have been obtained for regions where the rainfall is below 700 mm (Blair, Rains & Kassam, 1980). The general rule is that in the low rainfall region south of the Sahara, 1mm of rain produces 2.5 kg of dry matter per hectare. In regions of low rainfall woody vegetation is also important in the nutrition of game and domestic stock. At 250 mm of rainfall, woody vegetation at a density of 130 plants/ha may yield about 120 kg of DM (Bille, 1979).

Livestock productivity in range lands is primarily determined by species composition. Species composition of mixed rangelands will change since their optimal growth ranges will also change due to Carbon dioxide and temperature changes resulting from climate change. For instance, C3 and C4 species in the grass lands tend to be different in prominence during the summer and the

winter. Slight changes in temperatures cause this balance to change resulting in changes in livestock productivity. For instance, recent studies have suggested that there is likely to be an increase in browse species as a result of increased browse in the range lands (Morgan, Milchunas, LeCain, West & Mosier, 2007). This change in range land species composition will have a significant influence on the type of animal species that can be kept by communities that rely on the range land. This will imply a change in the dietary composition of these communities especially those that rely on livestock for livelihood (Thornton, Herrero, Freeman, Mwai, Rege, Jones, & McDermott, 2007). IPCC, (2008), noted that as global mean temperature exceed warming of 2- 3^{o}C, 20-30 percent, both animal and plant species face extinction. Global warming has been implicated in the loss of biodiversity globally. Thus, climate change is depicted in many studies as one of the causes of species extinction in the 21st century. Nonetheless, the effects will be felt differently in different parts of the world (IPCC, 2007).

The Maasai community has noted changes in plant species composition. They indicated that that some plant species increased, while other key species declined. The increaser species dominated plant composition (Oba &Kaitira, 2006). Hartmann and Sungulle (2009) note that according to the community, the reduction in species composition and diversity was as a result of drought variability and not over grazing *per se*. They indicated that consecutive droughts and seasonal rains did not allow pasture to reach flowering and hence a reduction in biomass. Macharia (2004) adds that some of the unpalatable species identified include *Ipomoea kituiensis*, *I. hildebrandtii*, *Astripomoea hyocyamoides*, *Solanum incanum*, *S. arundo*, *Gnidia latifolia* and *Acacia stuhlmannii.* Pasture is most important feed component for livestock under pastoral production system. Therefore its availability may affect livestock feeding practices in Kajiado County. Thus this study sought to assess how the change in availability of pasture influence livestock feeding practices,

2.5.1 Livestock feeding practices

According to Chibinga, Musimba, Nyangito and Simbaya (2010), the main causes of inadequate pastures in Zambia were increase in livestock numbers, increase in human population and conversion of grazing land to crop agriculture. Charcoal burning, indiscriminate cutting of trees and uncontrolled bush fires were other contributing factors to reduced pastures. Pastoralists were adapting to climate variability by increasing the use of upland pastures during floods and lowland, river pastures in periods of drought. Pastoralists also indicated that in times of droughts

they depended on climate adaptable browse species such as *Parinari curatellifolia* because these species had a tendency to bear excessively in years of severe drought. Other important browse trees during drought were mentioned as *Julbernadia globiflora* and *Piliostigma thinningii*. Other coping strategies included mobility, diversification of livestock species and breads, reservation of rich-patch vegetation areas and maximization of stock numbers. Mobility enabled pastoralists to take advantage of pasture resources that are only seasonally accessible, and allows access to salt patches (critical for animal health) and other resources and services. By keeping more than one species of livestock, pastoralists can generate a wider variety of livestock products and make better use of the available forage in different seasons, even in times of crisis. Pastoralists set aside grazing areas to use as a bank during the dry season or drought times. Livestock accumulation helps ensure survival of herds despite losses incurred during droughts or disease outbreaks. It also represents a method to accumulate food stock and marketable assets at the risk minimization stage that they can eventually sell at the risk absorption stage, when all efforts are directed to sustaining the most valuable animals. According to Munyasi, Gitunu, Manyeki, Muthiani and Nyamwaro(2012), pastoralists in Loitokitok district of Kajiado County managed pastures communally and grazed individually-owned livestock extensively, involving the seasonal movements of people and cattle. These systems were regulated by availability of natural water and good pastures, the presence of diseases along nomadic routes, prevailing security situations, and the timing of important socio-cultural activities.

Mworia and Kinyamario (2008) noted that despite changes in land tenure in Kajiado, traditional herd mobility patterns were used as a coping strategy to the severe la Nina induced drought. Similarly, despite increased diversification of livelihood sources in South east Kajiado after the1972 - 1976 drought characterized by expansion of rain fed agriculture, horticulture and tourism, during the 1994 - 1995 drought traditional strategies of herd movement and use of wild fruits were still applied. According to Western and Nightingale (2002), traditional subsistence pastoralism revolved around optimizing livestock forage intake by selecting the best grazing pastures in any season and minimizing stock losses to drought, disease and predation. Herders vary the species mix, choosing among cattle, sheep, goats, donkeys and camels. They also selectively breed within individual species, move seasonally, adjust daily foraging regimes and herd size and composition to optimize foraging in response to rainfall and local pasture conditions. Herders also select settlement sites according to the availability of water, forage,

fencing and fuel wood, and to minimize climatic extremes, flooding hazards, disease and predation.

2.6 Social and Economic Factors

Hauff (2003) notes that although Maasai have always engaged in a small amount of cultivation due to the loss of land, they have been forced to rely less heavily on their livestock and increase their involvement in other economic opportunities. The Maasai are becoming more sedentary for three reasons; decreasing territory, installation of technological inputs, such as watering points, and government policies. An increase in sedentarization has placed pressure on the land and made access to resources based on residential groupings more difficult. Settling also gives control of territory to individuals or individual domestic groups, so the amount of communal sharing is decreased. As well as this cultural analysis viewpoint, there are also the economic and social factors influencing educational participation. There is a general feeling that there are changes in the attitudes of the Maasai towards education. Children are now sent to school voluntarily and the parents no longer send them because are compelled to do so. The Maasai have specific expectations of those who have an education. Generally this expectation centre on the fact that people with an education should assist the community by sharing the benefits of education by helping those without an education to develop the area (Holland, 2010).

In recent decades the Maasai have been in deep crisis, particularly with regard to the management of their pastures and livestock. In general, their centuries-old occupation is coming under threat of existence. Although the causes for the crisis are several, those related to loss of grazing lands and prolonged drought are most significant. The Maasai identified the loss of grazing land as the main cause for their outmigration (Mung'ong'o & Mwamfupe, 2003). Socio-economic status among the pastoralist is determined by the number of stock one owns. Since goats are the only surviving animals during the drought periods, the number of goats owned determines the availability of milk for family members and whether some can be sold to obtain cash. They also provide food when slaughtered (Wawire, 2011). Pastoralists have developed strong informal social protection networks based on religious, clan or family affiliations. These have always played a vital role in ensuring pastoralist livelihoods have remained viable through the chronic shocks inherent to pastoral lifestyles, but informal social mechanisms are now under

increasing pressure. Formal providers of social protection are governments, private sector, humanitarian organizations and local and international donors (Ali & Hobson, 2009).

2.7 Subdivision of Group Ranches

Burnsilver and Mwangi (2007) noted that pastoral producers in East Africa face a critical dilemma. They are caught between new land tenure rules associated with the dissolution of group ranches and subdivision of communal rangelands, and the unchanged ecological exigencies of their dry land systems. Records showed that by 2006, out of a total of 52 group ranches, 32 had been subdivided and 15 were in progress. The trend towards subdivision implies dramatic changes in pastoral land use from a system predicated on extensive seasonal movement and intensive, short-duration grazing of successive areas of the pastoral landscape, towards one based on intensive, long-term grazing of private parcels where households have fewer options for mobility. The process of privatizing land in individual hands has led to permanent loss of common grazing lands through sales to non-Maasai and commercial ventures (Fratkin, 2001).

2. 8 Water Availability

Over the past 40 years, water scarcity has become significantly increased globally and is affecting about 1-2 billion people worldwide (Millennium Ecosystem Assessment [MEA], 2005). The intensity of droughts, severity of floods and storms are expected to become more apparent in the future. IPCC (2008) predicts that the number of people living with limited access to scarce water supply will increase from the current 1.7 billion to 3.2 billion by 2080. Main sources of water in Kenya include surface water found in oceans, lakes and rivers, ground water in wells and aquifers and rainfall ranging between 200 mm in the arid and semi-arid (ASAL) parts to 2500 mm in the Kenya highlands (Ngaira, 2009). Main sources of water in Kajiado County are springs, shallow wells, boreholes and pans (Arid Lands Resource Management Project, 2011).According to Urama and Ozor (2010), availability of water resources both in quantity and quality in Kenya has been decreasing over time as a result of persistent droughts and land-use patterns and the situation is expected to worsen due to rainfall variability and increased evaporation due to higher temperatures. The impacts are largely felt in the marginal rainfall areas of the country.

Water is an important component in livestock feeding. In livestock production, the relationship between increased temperatures and water demand is well known where water intake increases from about 3 kg per kg DM intake at 10 °C ambient temperature, 5 kg at 30°C, and 10 kg at 35°C for zebu cattle (National Research Council [NRC], 1981). Thus as drought variability takes its course to reduce the amount of available water and the environmental temperatures remain on an upwards trend, more water will be needed by livestock for survival. To this effect, livestock feeding practices may be affected.

According to Wekesa and Karani (2009), the high number of emergency water trucking interventions carried out during the 2008-9 droughts in ASALs is an indicator that there was inadequate water in specific arid districts to meet the needs of vulnerable households and their livestock. There are still parts of the rangelands of Kenya that lack the necessary water resources for their basic needs, whether in terms of quantity or quality or both. Demographic growth is likely to increase pressures for the development of water resources and further exploitation of existing ones. This study tried to determine the influence of availability of water on livestock feeding practices among the pastoralists in Mailwa sub-location, Kajiado County.

2.7 Theoretical Framework

The study was based on the General Systems theory in an attempt to explain the influence of drought variability on livestock feeding practices in Mailwa sub-location of Kajiado County. According to Laszlo and Krippner (2003), this theory was advanced by Ludwig von Bertalanffy by what he called general theory of systems or general system theory. A system is a set of two or more interrelated elements with the following properties. Each element has an effect on the functioning of the whole, each element is affected by at least one other element in the system and all possible subgroups of elements also have the first two properties. In each case, a whole made up of interdependent components in interaction is identified as the system.

Structurally, a system is a divisible whole, but functionally it is an indivisible unity with emergent properties. Livestock feeding practices may be composed of separate entities like mobility, livestock mix, supplementary feeding and reservation of pasture but require to be applied together for proper functioning of the system. The systems approach attempts to view

the world in terms of integrated system and focuses attention on the whole, as well as on the complex interrelationships among its constituent parts.

In this study, drought variability influences frequency and duration of droughts and change in rainfall patterns. This in turn influences livestock feeding practices that are adopted by pastoralists in an attempt to cope with changing conditions in its environment. Pastoralists adopt drought feeding responses that involve livestock movement in search of pasture and water or supplementary feeding using livestock feeding materials that are not normally used when there is no drought.

2.8 Conceptual Framework

The study had one dependent variable namely livestock feeding practices measured in terms of livestock movement, reservation of pasture and supplementary feeding. Figure1 shows the interaction of the independent variable in association with other variables (moderating variables) influencing and affecting the dependent variable. As the influence of drought variability take effect, Maasai pastoralists are expected to adopt appropriate livestock feeding practices in response to the situation.

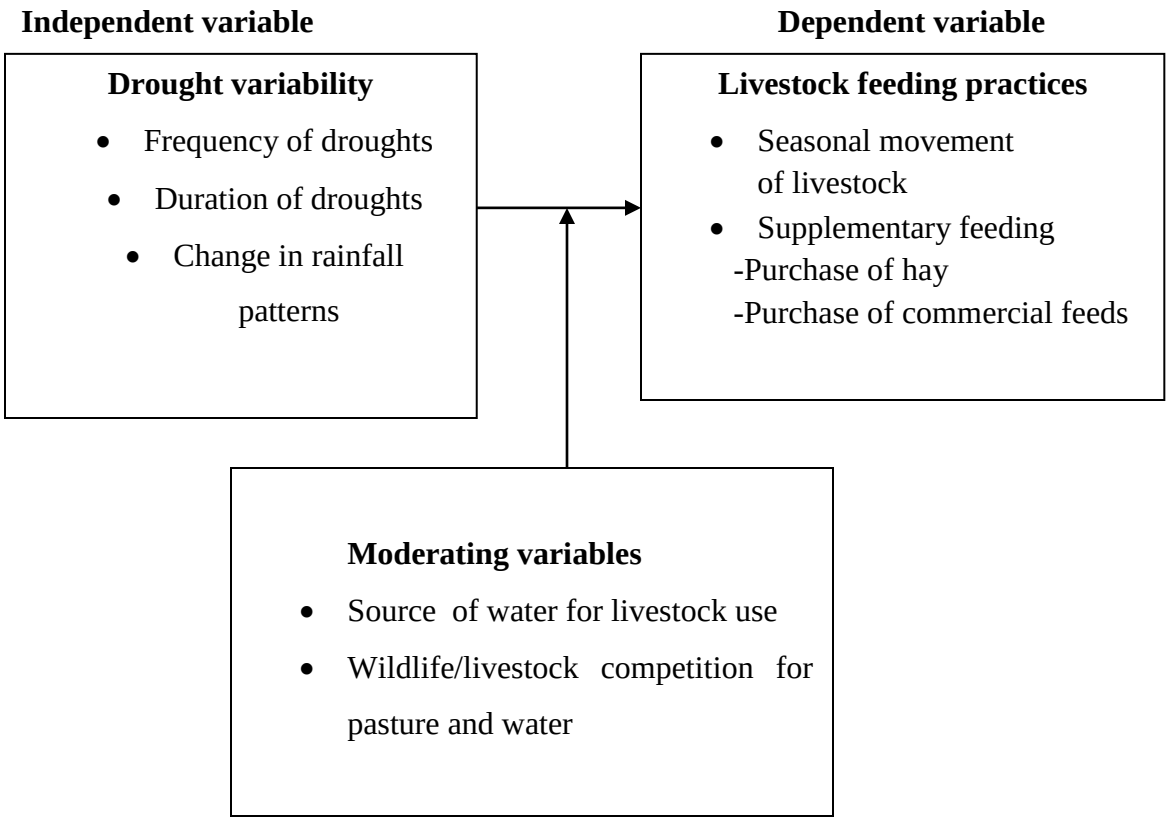

Figure 1: Conceptual Framework on the influence of drought variability on livestock feeding practices in Mailwa sub-location, Kajiado County**.**

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the process that was used to carry out the study. It gives details on the research design employed, study area, research design, sampling procedure, instrumentation, data collection and data analysis procedure.

3.2 Research Design

The study used a descriptive survey design to collect data from the respondents in the study area. The design is recommended for the study because it provides for information about subjects under study. The survey involves questions of the past and current situation (Kothari, 2008). The choice of the design was made based on its ability to determine relationship between two or more variables. In this study, the design was used to determine the relationship between the independent variable (influence of drought variability) and the dependent variable (livestock feeding practices).

3.3. The Study Area

The study was carried out in Mailwa sub-location in Kajiado County. The sub-location was purposely selected because it is one of the ASAL areas in Kenya where Maasai pastoralists still practice pastoralism despite challenges posed by drought variability, sub-division of communal grazing areas and immigration of other communities in search of land for settlement. The pastoralists keep mainly cattle, sheep and goats, camels and donkeys. The average annual rainfall ranges between 500 mm to 1250 mm. The rainfall pattern is bimodal with short rains between October and December; and long rains between March and May. The average annual potential evapo transpiration ranges from 1600 to 2200 mm which means that for the greater parts of the year there is a moisture deficit (DAO, 2011). Mailwa sub-location has a population of 2,130 and 437 households (KNBS, 2009).The vegetation cover is open grassland, wooded grassland and bushed grassland. Wood and bush land makes this area suitable for pastoralism (Kajiado District Annual Progress Report, 2006/2007).

3.4 Target Population

The study targeted all Maasai pastoralist household heads in Mailwa sub-location of Kajiado County. The study targeted 437 household heads (295 male and142 female) in the study area.

3.5 Sampling Procedures and Sample Size

Proportionate simple random sampling technique was used to ensure both male and female household heads were included in the study. This ensured that the subjects randomly selected from each group were the same as the proportion of that group in the target population (Borg and Gall, 1989). Mailwa sub-location was purposively selected for this study because the area is inhabited mainly by Maasai who practice pure pastoralism. Mailwa sub-location has a human population of 2,130 and 437 households who practice pastoralism. This consists of 295 male headed and 142 female headed households (DAO, 2009). A sampling frame containing names of household heads of pastoralists in Mailwa sub-location was obtained from the District Agricultural Officer, Kajiado Central sub-County. A sample size of 136 household heads consisting of 92 males and 44 females as shown on Table 1 were selected for this study using a formula proposed by Kothari (2008).

$$n = \frac{z^2.\ p.q.N}{e^2\ (N-1) + z^2.p.q}$$

Where,

N= Population

n= Sample size

e= Sampling error / alpha error/ confidence interval (0.02)

z= 2.005 = (as per table of area under normal curve for the given confidence level of 95.5 %)

p= Proportion of defectives within the universe

q= 1-p

$$n = \frac{2.005^2\ x0.02x\ (\ 1-0.02)\ x437}{0.02^2(437-\ 1) + 2.005^2x\ 0.02x\ 0.98}$$

$$= \frac{34.432}{0.253}$$

= 136.01

n (sample size) = 136 respondents .

Table 1

Proportionate Sampling for Mailwa sub-location

Household head	Number of household heads (n)	Number of household heads to be interviewed $N = \frac{(n \times 136)}{437}$
Male	295	92
Female	142	44
Total	437	136

3.6 Instrumentation

The study used a semi-structured interview schedule to collect both quantitative and qualitative data from the respondents. The instrument was developed by the researcher and contained both open and close ended questions. Semi- structured interview schedule is preferred because it gives detailed information on specific cases of interest to the researcher, reliability of the information given is high and systematic (Kombo & Tromp, 2006). The interview schedule was also appropriate given that the majority of the respondents had no formal education. The instrument was divided into four sections. Social demographic information was captured in section A; section B captured information on traditional and current livestock feeding practices, section C captured information on frequency of droughts; section D captured information on duration of drought and section D captured information on change in rainfall patterns.

3.6.1 Validity

Content and construct validity of the instruments was achieved through use of experts in the field of community studies and extension, and animal sciences, who reviewed the instrument.

3.6.2 Reliability

Reliability of the instrument was achieved through pretesting in Eluanata sub-location in Kajiado Central sub-County, Kajiado County. Eluanata sub-location has similar characteristics as those found in the study area where pastoralists exhibit similar characteristics to those of the study area. Mugenda and Mugenda (2003) recommend a pretest sample size of 1% to 10% of the sample to be studied. A pretest sample consisting of 14 household heads was randomly selected. Data obtained from pre-testing was analyzed using Statistical Package for Social Sciences (SPSS) to get the reliability coefficient. A reliability coefficient of 0.821 was achieved at 0.05

level of significance; an indication that there was consistency among the items in measuring the concept of interest (Frankell & Wallen, 2000; Mugenda & Mugenda, 2008). The instrument was therefore accepted since the reliability coefficient was more than 0.70 at α =0.05. However, suggestions made by the respondents on words and phrases that were not clear were incorporated in the final instrument.

3.7 Data Collection Procedure

Authority was sought from the Board of Graduate School of Egerton University to carry out the study. This was followed by securing of a research permit from the National Council for Science and Technology. The researcher explained to respondents the purpose of the study before proceeding with data collection. Interviews were conducted in each sampled household with the household head as the respondent and responses entered in the questionnaire. Rainfall data for the last five decades was collected from Maasai Training Centre (MRTC) Isinya to give a general trend of rainfall in Kajiado Central sub-County.

3.8 Data Analysis

Completed interview schedules were serialized, coded and checked to ensure quality control. Data was then processed into a database developed in SPSS data management software (Version 17) for analysis. Rainfall data was analyzed using Microsoft Excel. Descriptive and inferential statistics were used to analyze the data from the respondents. Frequencies and percentages generated from the various data categories were computed and are displayed in different Tables and Figures. Chi-square was used to test the hypotheses at 0.05 level of significance.

Table 2

Summary of Data Analysis

Objective	**Independent Variable**	**Dependent variable**	**Statistical procedures and tests**
i) To describe traditional and current livestock feeding practices by Maasai pastoralists in Mailwa sub-location, Kajiado County	Traditional & current livestock feeding practices	Livestock feeding Practices: -seasonal movement -herd splitting -livestock mixes	Descriptive statistics: -frequencies -percentages
ii) To establish the influence of frequency of droughts on livestock feeding practices in Mailwa sub-location, Kajiado County	Frequency of droughts	Livestock feeding Practices: -seasonal movement of livestock, -supplementary feeding	Descriptive statistics: -frequencies -percentages Inferential statistics: -Chi square
iii)To establish the influence of duration of droughts on livestock feeding practices in Mailwa sub-location, Kajiado County	Duration of droughts	Livestock feeding practices: -seasonal movement of livestock, -supplementary feeding	Descriptive statistics: -frequencies -percentages Inferential statistics: -Chi square
iv)To establish the influence of change in rainfall patterns on livestock feeding practices in Mailwa sub-location, Kajiado County	Change in rainfall patterns	Livestock feeding practices: -seasonal movement of livestock, -supplementary feeding	Descriptive statistics: -frequencies -percentages Inferential statistics: -Chi square

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

The purpose of the study was to determine the influence of drought variability on livestock feeding practices among the Maasai pastoralists. The findings are presented according to the set objectives. The chapter is divided into five subsections. The first subsection describes selected general characteristics of the respondents. The second focuses on traditional and emerging livestock feeding practices in the study area. The third focuses on frequency of droughts while the fourth focuses on changes in the duration of droughts. The last subsection focuses on changes in rainfall patterns. The researcher collected data from the respondents' using researcher administered interview guide. The data collected was analyzed using frequency tables and chi-square test of independence. The influence of these variables on livestock feeding practices is discussed at the end of each subsection.

4.2 General Characteristics of the Respondents

Results presented on Table 3 indicate that out of 136 household heads interviewed for the study, 67.6 % were male while 32.4% were female. The high percentage of male respondents is a reflection of community's culture where men control livestock production which is the major source of livelihood for the community. Widows consisted of 30.9 % of the respondents. This number is high as compared to the number of widowers (1.5%). This scenario conforms to the African culture where a man is expected to remarry after the death of his wife while a woman advanced in age is not expected to do the same after the death of her husband. Widows therefore assume roles and responsibilities of a household head after the demise of their husbands. Based on age, majority of the respondents (48.5 %) were between 41 and 50 years. This may be attributed to the fact that at this age bracket consists of the most energetic members of the community who can make important decisions on livestock management and are able to move along with their livestock in search of pasture and water. Majority of the respondents (86.76%) had no formal education while 8.09 % had primary school education. The rest had secondary school education and above.

Table 3

General Characteristics of the Respondents

	Category	Frequency	Percent
Gender			
	Male	92	67.6
	Female	44	32.4
Marital status	Single	3	2.2
	Married	89	65.4
	Widow	42	30.9
	Widower	2	1.5
Age	31- 40 years	33	24.3
	41- 50 years	66	48.5
	51 - 60 years	24	17.6
	61- 70 years	12	8.8
	71- 80 years	1	.7
Education level	Not gone to school	118	86.8
	Primary level	11	8.1
	secondary level	3	2.2
	Tertiary level	4	2.9
Types of livestock kept	Indigenous cattle (zebu) and shoats	132	97.1
	Improved (crosses) cattle and shoats	4	2.9
Crop farming	Pastoralists who grow crops	2	1.5
	Pastoralists who do not grow crops	134	98.5
n= 136			

Source: Field survey, 2013.

The low levels of formal education in the study area would have an influence on adoption of improved livestock feeding practices in view of drought variability. However, this trend may change drastically in the near future as many respondents indicated that pastoralists are now sending their children to school. The same was reported by Holland (2010) who noted that the attitude of the Maasai towards education has changed over time and children are now sent to school voluntarily. They also have the expectation that people with an education should assist the community by sharing the benefits of education by helping those without an education to develop the area.

The study findings also showed that majority of the respondents (97.1%) kept indigenous cattle sheep and goats, while the rest had improved cattle and shoats. This is illustrated on Table 4.This may be due to the fact that the area is Arid and Semi Land (ASAL) with frequent droughts that are not favourable for improved breeds of livestock. The findings are consistent with those of Hogan (2010) who noted that because pastoralism often takes place in dry lands conventionally defined as water-stressed regions, locally adapted livestock breeds are critical for productivity. Such breeds tend to have higher resistance to disease, drought and parasites since they have evolved in parallel to such pressures. Almost similar findings were reported by Kisiangani (2011).

The findings of the study indicate that very few respondents (about 1.5%) were involved in cultivation. This scenario shows that pastoralists of Mailwa sub-location depend almost entirely on pastoralism as their main source of livelihood. Absence of cultivation means that pastoralists have no access to crop residues that they can use to supplement natural pasture.

4.3 Characterization of Traditional and Current Livestock Feeding Practices

The objective was to describe traditional and current livestock feeding practices by Maasai pastoralists in Mailwa sub-location, Kajiado County. The study findings are presented in the following subsections.

4.3.1 Traditional and emerging livestock feeding practices livestock feeding practices

Respondents were asked to indicate traditional livestock feeding practices used by to cope with drought in the past. Results are as presented on Table 4. Majority of them (87.5%) indicated that

livestock movement in search of pasture was the most important traditional livestock feeding practice used by Maasai pastoralists in Mailwa sub-location. This involves seasonal movement of livestock from one area to another depending on availability of pasture and water. Other practices used to a less extent included herd splitting and keeping of different species of livestock.

Table 4

Traditional Livestock Feeding Practices

Livestock feeding practice	**Frequency**	**Percent**
Seasonal movement	119	87.5
Herd splitting	12	8.8
Livestock mixes	5	3.7
Total	136	100.0

Source: Field survey, 2013

Depending on severity of drought, livestock is moved to other group ranches and national parks in Kajiado County. Majority of the respondents said that the last major drought was during the years 2009-2011 and most of them moved their livestock to Tanzania. According to Ogeto (2007), pastoralists' production system is characterized by mobility and flexibility to counter extreme environmental fluctuations. Further, Chibinga, Musimba, Nyangito and Simbaya (2010) also asserted that mobility enabled pastoralists to take advantage of pasture resources that are only seasonally accessible and allow access to salt patches and other resources and services. By keeping more than one species of livestock, pastoralists can generate a wider variety of livestock products and make better use of the available forage in different seasons, even in times of crisis. According to Munyasi, Gitunu, Manyeki, Muthiani and Nyamwaro (2012), pastoralists in Loitokitok District of Kajiado County managed pastures communally and grazed individually-owned livestock extensively involving the seasonal movements of people and cattle. Mworia and Kinyamario (2008) noted that despite changes in land tenure in Kajiado, traditional herd mobility patterns were used as a coping strategy to the severe la Nina induced drought. Similarly, despite increased diversification of livelihood sources in South east Kajiado after the1972 - 1976

drought characterized by expansion of rain fed agriculture, horticulture and tourism, drought traditional strategies of herd movement was still applied. According to Western and Nightingale (2002) herders vary the species mix, choosing among cattle, sheep, goats and camels. They also selectively breed within individual species, move seasonally, adjust daily foraging regimes and herd size and composition to optimize foraging in response to rainfall and local pasture conditions.

When asked whether there are new livestock feeding practices that have come up in the recent past, all respondents indicated that livestock movement still remained the most important practice. However, other livestock feeding practices were emerging although on a very limited scale. Very few respondents reported that during the last major drought that occurred in the area in 2009-2011, they sold some of the livestock and purchased wheat bran and commercial hay to feed livestock that could not move far. This is a form of supplementary feeding to save the few livestock left behind after the rest has been moved in search of pasture and water.

4.4 Influence of Frequency of Droughts on Livestock Feeding Practices

The second objective was to establish the influence of frequency of droughts on livestock feeding practices in Mailwa sub-location, Kajiado County. The findings of the study are discussed here below.

4.4.1 Changes in frequency of droughts

Respondents were asked whether they had noticed increase in the frequency of droughts in the area for the last 10-20 years. Table 5 illustrates these findings. Majority of the respondents (98.5%) indicated that they had indeed noticed changes in the frequency of droughts in the area.

Table 5

Changes in Frequency of Droughts

Noticed increase in the frequency of droughts	Frequency	Percent
Yes	134	98.5
No	2	1.5
Total	136	100.0

Source: Field survey, 2013

Implication of this is that pastoralists in Mailwa sub-location were aware that frequency of droughts had increased as compared to the past.

4.4.2 Trend in changes in frequency of droughts

To assess further the influence of change in frequency of droughts on livestock feeding practices, respondents were asked to indicate how often severe droughts occurred in the area. Majority of the respondents (63.2%) indicated that droughts occurred after every one year as shown on Table 6. Huho, Ngaira and Ogindo (2011) indicated that droughts in ASAL areas had increased in frequency from once in ten years in the 1970s, to once in 5 years in 1980s, once in every 2-3 years in the 1990s and have become the norm since 2000. Similar observation has been made by Oxfam (2008) who indicated that drought-related shocks used to occur every ten years, and they are now occurring every five years or less.

Table 6

Occurrence of Severe Droughts in Mailwa Sub-Location

Occurrence of severe droughts	Frequency	Percent
After every 6 months	38	27.9
After every 1 year	86	63.2
After every 2 years	7	5.1
After every 3 years	2	1.5
After every 4 years	1	.7
After every 5 years	2	1.5
Total	136	100.0

Source: Field survey, 2013.

The implication of these results is that there was high awareness among the pastoralists about the return period of droughts and expected drought cycle to recur after every one year and were most likely to apply the most appropriate livestock feeding practices in order to adapt to these changes.

Respondents were asked to indicate livestock feeding practices that they adopted to cope with changes in the frequency drought in the study area. Majority of the respondents (97.8%) indicated that livestock movement in search of pasture and water was the most important livestock feeding practice in the area. Other forms of livestock feeding practices that include use of commercial feeds and commercial hay existed on a very limited scale. This is illustrated on Table 7.

Table 7

Livestock Feeding Practices Adopted by Maasai Pastoralists to Cope With Drought

Livestock feeding practices	**Frequency**	**Percent**
Movement of livestock to other areas in search of pasture and water	133	97.8
Purchase of hay	2	1.5
Purchase of commercial feeds	1	.7
Total	136	100.0

Source: Field survey, 2013.

Similar observations have been made earlier. Munyasi et al (2012) noted pastoralists in Loitokitok district of Kajiado County managed pastures communally and grazed individually-owned livestock extensively, involving the seasonal movements of people and cattle.

4.4.3 Relationship between increase in frequency of drought and livestock feeding practices

The study hypothesized that frequency of droughts had no statistically significant influence on livestock feeding practices. Chi square test of independence at 95% level of confidence was used to test whether there was any association between changes in the frequency of drought and livestock feeding practices. This was done by cross tabulating the variables related to the frequency of severe droughts against livestock feeding practices. Results are displayed on Table 8. According to the results, 38 respondents said they noticed drought occurrence in every six months. Of these, 97.4% moved their livestock to other area as a coping strategy, while 2.6% purchased hay. Further, 86 respondents reported that they had noticed occurrences of severe

droughts every 12 months. Of these, about 97.7% moved their livestock, 1.2% purchased hay while the remaining 1.2% purchased commercial feeds as a coping strategy. The rest of the respondents reported that they moved their livestock to other areas as a coping strategy irrespective of the frequency of drought. In general results indicate that majority of the respondents (97.8%) used livestock movement a coping strategy against frequency of drought.

Table 8

Relationship between Frequency of occurrence of Severe Droughts and Livestock Feeding Practices

			Most important livestock feeding practice that you adopt to cope with drought			
		Sample (n)	**Seasonal movement of livestock to other areas (%)**	**Purchase hay (%)**	**Purchase commercial feeds (%)**	**Total (%)**
Frequency of severe droughts	After every 6months	38	97.4	2.6	0.0	100.0
	After every 12 months	86	97.7	1.2	1.2	100.0
	After every 24 months	7	100.0	0.0	0.0	100.0
	After every 36 months	2	100.0	0.0	0.0	100.0
	After every 48 months	1	100.0	0.0	0.0	100.0
	After every 60 months	2	100.0	0.0	0.0	100.0
	Sample(n)	136				

Calc. $\chi 2$= 1.168, Crit. $\chi 2$=18.307, df=10, p=1.00

Source: Field survey, 2013.

There is no statistically significant association between frequency of droughts and livestock feeding practices. This is shown by the calculated chi-square value of 1.68 (significant at 5% level since the critical value of 18.307 is greater than the calculated value of 1.68 and probability value (1.000) is greater than 0.05. This outcome may be explained by fact that despite awareness of increased frequency of droughts by majority of the respondents, the respondents may have accepted it as a normal occurrence and therefore took no action to respond to it. This is

consistent with Galvin, Thornton, Boone and Sunderland (2004) who reported that while East African pastoralists have been able to track climate variability very well in the past, their strategies based on centuries of exposure to intra- and inter-annual droughts, as well as floods are not working now due to an inability to implement them.

4.5 Influence of Duration of Droughts on Livestock Feeding Practices

The third objective of the study was to establish the influence of duration of drought on livestock feeding practices in Mailwa sub-location of Kajiado County. The following is a presentation of the study findings.

4.5.1 Duration of droughts

Respondents were asked whether they had noticed increase in the duration of droughts within the last 10-20 years. Majority of the respondents (97.8%) indicated that there were changes in the duration of droughts in this area. The results are displayed on Table 9. According to World Metrological Organization (2006), another essential characteristic of drought is its duration where it can develop quickly in some climatic regimes, but usually require a minimum of two to three months to become established. Once a drought begins, it can persist for months or years.According to Dore (2005), increased variation in precipitation has seen wet areas become wetter and arid areas drier. These results imply that almost all the pastoralists in the study were consciously aware about the changes that have been occurring over time in relation to the duration of droughts. How long a drought persist is important to the pastoralists because it is likely to influence the availability of pastures and water for livestock use.

Table 9

Changes in Duration of Droughts

Noticed increase in duration of droughts	Frequency	Percent
Yes	133	97.8
No	3	2.2
Total	136	100.0

Source: Field survey, 2013.

4.5.2 Length of drought period

Respondents were asked to describe the length of drought period they had observed within the last 10-20 years. Majority of the respondents (72.8 %) indicated that when a drought sets in this area, it usually lasts for a period of six months to one year as shown on Table 10. According to World Meteorological Organization (2006), droughts can develop quickly in some climatic regimes, but usually require a minimum of two to three months to become established. Once a drought begins, it can persist for months or years.

Table 10

Trend in Length of Droughts in Mailwa Sub-Location

Trend in length of drought period	**Frequency**	**Percent**
0- 6 months	32	23.5
7 - 12 months	99	72.8
13 -18 months	4	2.9
19- 24 months	1	.7
Total	136	100.0

Source: Field survey, 2013

These findings indicate that pastoralists were consciously aware of the period droughts lasted in the area. As indicated earlier, movement of livestock in search of pasture and water remained the most important livestock feeding response to drought. Use of commercial feeds and hay were other emerging livestock feeding practices although on a very limited scale. This therefore means that as the length of the drought period changes, majority of the pastoralists are likely to respond by moving their livestock to areas that have adequate pastures and water while very few of them will respond by purchasing commercial feeds and hay.

4.5.3 Indicators of severe droughts

Another factor related to the duration of drought that was considered in this study was what constituted severe a drought in this area. Majority of the respondents (48.5%) pointed out that scarcity of water for livestock was the major indicator of severity of drought in this area followed by availability of pasture (42.6%) as indicated on Table 11.

Table 11
Indicators of Severity of Droughts in Mailwa Sub-Location

Indicator of severity of droughts	Frequency	Percent
Number of dry months	3	2.2
Number of livestock deaths	9	6.6
Scarcity of pasture	58	42.6
Scarcity of water for livestock	66	48.5
Total	136	100.0

Source: Field survey, 2013.

Contrary to expectations, respondents considered availability of water for livestock to be a more important indicator of severity of droughts than scarcity of pastures. This may be explained by the fact that water pans were the major sources of water for livestock in the area during the wet season. Combined effects of high evaporation rates and siltation made these pans to dry very fast at the onset of drought.

4.5.4 Occurrence of major droughts

Ability of the pastoralists to recall when the last major drought in the area occurred, where they moved their livestock to in response to this drought and the distance covered in search of pasture and water was considered as important for this study. The results are displayed on Tables 12, 13 and 14 respectively. Majority of the pastoralists (47.1%) reported that the last major drought occurred during the period 2009-2011. Categories on Table 12 are not mutually exclusive because respondents indicated the period they felt that the area experienced the most recent drought. Rainfall data collected from MRTC Isinya showed a downward trend in terms of amount of rainfall and number of rain days over the same period. This is displayed in Figures 3 and 4 respectively.

Table 12

Periods of Last Severe Droughts in Mailwa Sub-Location

Period	Frequency	Percent
2008 – 2009	47	34.6
2008- 2010	21	15.4
2009- 2010	4	2.9
2009- 2011	64	47.1
Total	136	100.0

Source: Field survey, 2013.

Livestock is grazed within Mailwa sub-location during the wet season. However during periods of severe drought, livestock is grazed in the neighbouring Tanzania. This may be explained by the fact that Mailwa is in Namanga division which neighbours Tanzania. National parks which can serve as dry season grazing areas are avoided by majority of the pastoralists because they are protected areas and pastoralists risk arrest and prosecution for trespassing.

Table 13

Grazing Areas during Severe Droughts in Mailwa Sub-Location

Grazing areas moved to during severe droughts	Frequency	Percent
In other group ranches within Kajiado County	30	22.1
In national parks	14	10.3
In areas outside Kajiado County	32	23.5
Tanzania	60	44.1
Total	136	100.0

Source: Field survey, 2013.

Distance covered in search of pasture and water during this period for most of the pastoralists (92.6%) was in excess of 100 Km. During this period, majority of the pastoralists (44.1%) said that they moved their livestock to Tanzania. Implication of these observations is that livestock movement in search of pasture and water remained the most important livestock feeding practice

to cope with drought in the study area. This is in line with Oranga (2010) who reported that water and pastures are critical for pastoral livelihoods which are characterized by frequent movements in search of water and feed during the long periods of scarcity. Hoare (2008) also observed that with no reliable supplies of permanent water, pastoralists adapt to an increasingly arid and unpredictable environment by moving livestock according to the shifting availability of water and pasture.

Table 14

Distances Covered During 2009-2011 Drought

Distance covered	Frequency	Percent
41 – 60 Km	1	0.7
61 – 80 Km	1	0.7
81 - 100 Km	8	5.9
More than 100 Km	126	92.6
Total	136	100.0

The pastoralists also reported that they have never received any assistance from either government or non-government organizations to mitigate the effects of drought on their livestock. Therefore, as the duration of drought increases, the only way out for them is to move their livestock. According to Davies and Roba (2010), moving livestock to alternative grazing zones is one of the coping strategies to mitigate the effects of drought variability used by pastoralists in Kenya.

4.5.5 Sources of water for livestock

Water is an important component of livestock feed. Availability of water for livestock is affected by the duration of drought. When asked to indicate sources of water for their livestock during both the drought and rainy season, all the respondents said that water pans and boreholes were the only sources of water for livestock during the rains and dry season respectively. ASAL areas are adversely affected by drought and the worsening effects of climate change, which have led to environmental degradation and drying up of water pans (Zwaagstra et al, 2010).

Respondents indicated that all water pans dried during periods of drought and therefore relied on boreholes to provide water for livestock use. When water pans dry during drought, pastoralists move their livestock near the only two boreholes in the area. This leads to depletion of pastures around watering points. As the duration of drought increases, pastoralists move their livestock further and further in search of pastures and reduce the frequency of watering of livestock.

4.5.6 Disappearance of pasture species

The study requested respondents to state whether there were pasture species that disappeared during periods of prolonged droughts. All the respondents said that they had observed some changes in the composition of pastures as the duration of drought increased. Asked to name the type that had disappeared most, 89.5% said that *Erikaru* (*digitaria macroblephara*) had shown the greatest reduction in proportion to other types of pastures during drought. This is shown on Table 15.

Table 15

Pasture Species that Disappeared During Prolonged Drought

Type of pasture	Frequency	Percent
Erikaru	122	89.5
Enkapuru	14	10.3
Total	136	100.0

Source: Field survey, 2013.

According to the respondents, this species although very palatable has reduced in prevalence with increase in the duration of droughts. Hartmann and Sungulle (2009) reported that according to the Maasai community, the reduction in species composition and diversity was as a result of drought variability and not over grazing *per see* as consecutive droughts and seasonal rains did not allow pasture to reach flowering and hence a reduction in biomass. According to Fay et al (2002), variability induced by altered rainfall patterns may offset elevated CO_2 effects on soil water content and leaf physiological activity hence affecting growth of grassland species.

These findings indicate that although *erikaru* (*digitaria macroblephara*) is a preferred pasture by most livestock, its availability has reduced over time due droughts. Implication of this is that increased duration of droughts is likely to alter pasture composition in the study area leading to loss of biodiversity. This may lead to concentration of less palatable pasture species a situation that may cause pastoralists to move their livestock more frequently.

4.5.7 Effect of group ranch subdivision on livestock mobility

The study sought to establish whether subdivision of Mailwa group ranch has affected livestock mobility during droughts. All respondents reported that subdivision of Mailwa group ranch was complete where some members had title deeds while the rest were in the process of acquiring theirs. When asked whether change of land ownership from communal to individual affected livestock mobility during drought, all respondents said despite subdivision, they could still move their livestock within the area in search of pasture and water. However, grazing on individually owned parcels of land required consent from the land owner. To them this has not introduced major changes as they have always sought for consent from land owners of other group ranches or even Tanzania before moving livestock. As observed by Munyasi et al (2012), pastoralists in Kajiado County managed pastures communally and grazed individually-owned livestock extensively involving seasonal movements of people and cattle. These systems are regulated by availability of water and good pastures. This conforms to the Maasai culture where sharing is a fundamental component and hence access to pastures may not be denied despite changes in land tenure. These findings indicate that despite the changes in land tenure, livestock movement in search of water and pasture still remains the most important livestock feeding practice to cope with drought in the study area.

4.5.8 Livestock/ wildlife competition for pasture and water

Livestock/wildlife conflict was considered as a moderating variable during the study. The study sought to find out whether livestock/wildlife conflict affected livestock feeding practices during drought. The findings of the study showed that livestock/wildlife conflict was a double problem for the pastoralists during periods of drought. All respondents said that group ranches acted as wildlife dispersal areas during drought where herbivorous wildlife move from the parks to graze in the group ranches thus competing with livestock for pasture and spreading of tick-borne diseases. Secondly, predatory wildlife from the parks preyed on livestock. Pastoralists graze their

livestock in the national parks despite being protected areas during drought where livestock is preyed on. According to Davies (2010), there are two main types of livestock–wildlife conflicts to consider in pastoral systems. The first is competition with other grazers for water and fodder, and the second is conflict with predators who feed on livestock. Conflict with other grazers tends to be most noticeable during periods of stress such as drought. During such periods it is common for pastoralists to move herds into protected areas in search of water and pasture. In doing so, pastoralism comes into direct competition with wildlife. However, access to protected areas during times of drought can be vital to the survival of pastoralists' herds, and can therefore have a significant impact on pastoralists' livelihoods.

These results imply that livestock/wildlife conflict is likely to affect livestock movement in search of pasture and water which is the most important livestock feeding practice adopted by pastoralists in view of increased duration of drought in the area. Movement of herbivorous wildlife from the parks into the area is likely to reduce the amount of pastures and water available to livestock leading to livestock movement to other areas. Likewise, availability and access of pastures with reduced predation is likely to encourage movement of livestock into the parks as duration of drought increases.

4.5.9 Relationship between duration of drought and livestock feeding practices

The second hypothesis of the study stated that duration of droughts has no statistically significant influence on livestock feeding practices. Chi square test of independence at 95% level of confidence was used to test whether there was a statistically significant association between duration of drought and livestock feeding practices. This was done by cross tabulating variables on Table 16 against livestock feeding practices. Results are as displayed on Table 16. Results indicate that 32 respondents reported that severe droughts lasted for a period of up to 6 months and all of them moved their livestock to other areas as a coping strategy. Majority (99) of the respondents reported that droughts lasted for a period of 7-12 months. Of these, 98% indicated that they moved their livestock to other areas, 1% purchased hay and another 1% purchased commercial feeds as coping strategies. For the 4 respondents who reported that droughts lasted between 13-18 months, 75% responded by moving livestock while the rest purchased hay as a coping strategy. In general, results indicate that majority of the respondents (97.8%) used

livestock movement as a coping strategy against duration of drought irrespective of the period drought persisted in the area.

Table 16

Relationship between Duration of Droughts and Livestock Feeding Practices.

			Livestock feeding practice adopted to cope with drought			
		Sample (n)	**Seasonal movement of livestock to other areas (%)**	**Purchase hay (%)**	**Purchase commercial feed (%)**	**Total (%)**
Trend in duration of droughts	0-6 months	32	100.0	0.0	0.0	100.0
	7- 12 months	99	98.0	1.0	1.0	100.0
	13 - 18 months	4	75.0	25.0	0.0	100.0
	19 -24 months	1	100.0	0.0	0.0	100.0
Sample (n)		136				

Calc. $\chi 2$= 16.29; Crit. $\chi 2$=12.59, df=6, p=0.012

Source: Field survey, 2013.

There is statistically significant association between duration of droughts and livestock feeding practices. This is shown by the calculated chi-square value of 16.29 (significant at 95% level since the critical value of 12.59 is less than the calculated value of 16.29 and probability value of 0.012 is less than 0.05). This can be attributed to the fact that the duration of drought affected the amount of livestock feed available in the area. This is consistent with Getahun (2007) who reported that the number, distribution and productivity of permanent pastures and water points, which are critical for livestock survival during the dry season, are bound to decline. In the absence of supplementary feeding, pastoralists in this area solely relied on natural pasture to feed their livestock. Therefore how long the drought persists affects availability of pastures and water

which in turn influence movement of livestock to other areas. This view is expressed by Hogan (2010) who reported that as pastoral systems operate in dry lands, where access to water is a limiting factor when determining herd sizes for many individuals and communities in times of drought. During periods of drought, there is insufficient supply of water to meet demand resulting in the drying of water-holes, the disruption of natural water flows and siltation of pans.

Kajiado County is one the most affected counties by the high rates of mortality with an overall livestock mortality rate of 25-40 per cent. The livestock economy is the most affected, since livestock body condition deteriorates due to the decline in pasture and the long distance trekking to water sources up to an average distance of 15km during the dry spells (Hemingway, 2007). This is in line with Oranga (2010) who reported that water and pastures are critical for pastoral livelihoods which are characterized by frequent movements in search of water and feed during the long periods of scarcity. Hoare (2008) also observed that with no reliable supplies of permanent water, pastoralists adapt to an increasingly arid and unpredictable environment by moving livestock according to the shifting availability of water and pasture. Welly (2011) noted that due to climate change, pasture quality and quantity will be affected.

Decrease in grasslands due to increases in tropical woody vegetation could reduce options for accessing dry season feeding resources. As reported by Hoare (2008), dry or wet season grazing areas no longer exist due to the proliferation of settlements leading to constrained mobility and a reduction in palatable grass and browse species. When the duration of drought increases, it is likely that the amount of this pasture species will be reduced in the area. As discussed earlier, respondents indicated that "*erikaru"* (*digitaria macroblephara*) was disappearing as a result of increased duration of drought in the study area. This type of pasture also happens to be preferred by livestock. This reduction may make pastoralists to move their livestock to other areas as other available pasture species may not provide adequate livestock feed leading to poor body condition. As the duration of drought increases, pastoralists in the study area reserve pastures ("*olopololi"*) around the homesteads to feed young stock, milking cows and the sick stock. The rest of livestock is moved away to the dry season grazing areas. Catley (2008) reported that although pastoral communities do not traditionally practice forage conservation, some pastoral

communities such as the Borana have started to set aside areas of range for standing hay reserves.

4.6 Influence of Rainfall Patterns on Livestock Feeding Practices

The fourth objective of the study was to examine the influence of changes in rainfall patterns on livestock feeding practices in Mailwa sub-location, Kajiado County. The following is a presentation of the study findings.

4.6.1 Change in rainfall patterns

Respondents were asked whether they had noticed changes in rainfall patterns during the last 10-20 years. Majority of the respondents (99.3%) said that they had experienced notable changes in rainfall patterns in the area. This is illustrated on Table 17. Welly (2011) observed that unless urgent action is taken to reduce greenhouse gas emissions, temperatures in the region will continue to rise and rainfall patterns will change.

Table 17

Changes in Rainfall Patterns in Mailwa Sub-Location.

Have you noticed change in rainfall patterns?	Frequency	Percent
Yes	135	99.3
No	1	.7
Total	136	100.0

Source: Field survey, 2013.

When asked to indicate what they thought about the changes in the amount of rainfall over the same period, all the respondents said that the amount of rainfall had reduced over the years. Famine Early Warning Systems Network**, [**FEWSNET] (2010) analysis on patterns of observed climate change during the 1960–2009 periods in rainfall and temperature indicate that large parts of Kenya have experienced more than a 100 mm decline in rainfall. According to Erickson (2010), rainfall is the most obvious indicator of drought as it is defined as a shortage of rainfall. It is a timely indicator of drought as it provides a signal few weeks before the vegetation responds, and many months before livestock dies. However the disadvantage of rainfall is that information relies on records from few scattered rainfall stations. These findings are in line with

Pinho et al (2008) view that the perception of the respondents was that rainfall had reduced while droughts were longer and more frequent. The possible explanation for this view is that due to drought variability, rainfall patterns had changed and rains were not coming at the expected time while heavy rains were being experienced out of season.

Rainfall data analysis for the period 1962-2011 obtained from the nearest weather station at MRTC Isinya displayed on Figure 2 contradicts the pastoralist's view that the amount of rainfall was on a downward trend. It indicates that although rainfall amounts varied from year to year, the general trend shows that rainfall had increased over time (by 2.350). This is in line with Sara's (2006) view that the defining characteristic of rainfall in arid and semi-arid areas is its variability from year to year, and there is no evidence that the recent sequence of localized droughts represents a permanent decline in average rainfall.

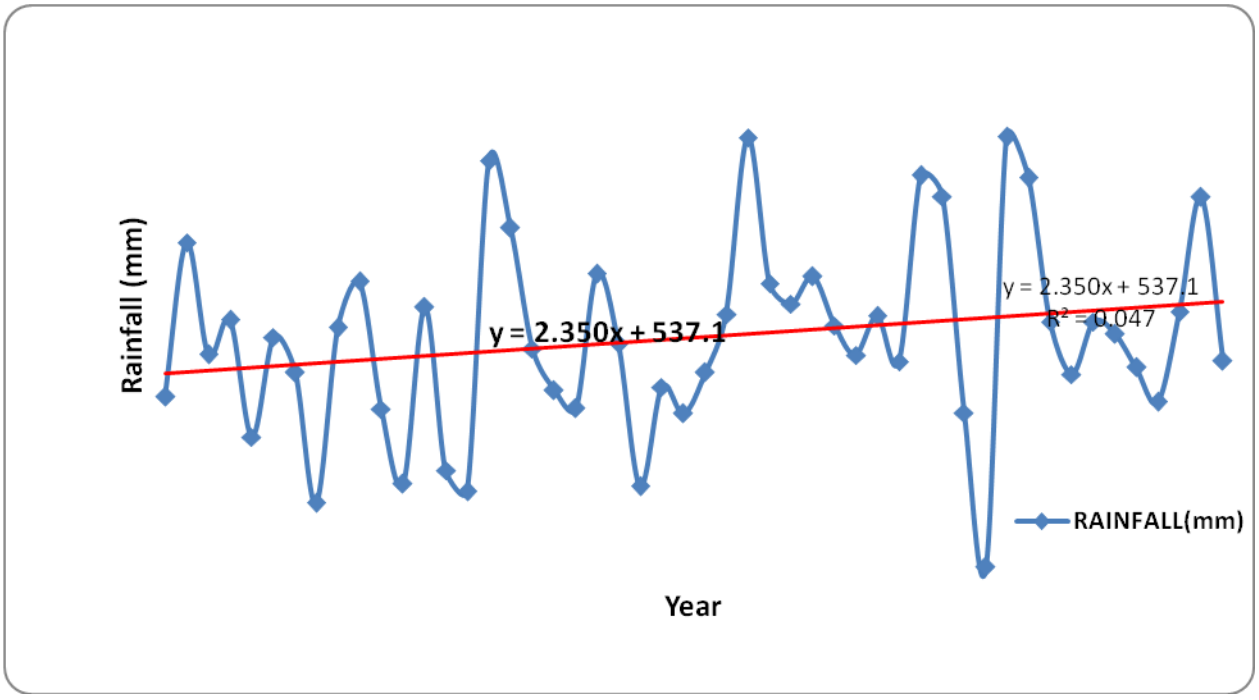

Figure 2: Variations in total amount of rainfall from 1962-2011 recorded at MRTC Isinya rain gauge station**.**

4.6.2 Onset of rainfall

Onset of rainfall in the study area was considered as an important factor in the change of rainfall patterns. Respondents were therefore asked to indicate the trend in the onset of rainfall they had

observed in the area for the last 10-20 years .Results are displayed on Table 18. Most of the respondents (58.09 %) said that the onset of rains was no longer predictable.

Table 18

Observed trend in the onset of rainfall in Mailwa sub-location

Observed trend in the onset rainfall	Frequency	Percent
Onset of rains is no longer predictable	80	58.8
Rains come earlier than normal time	5	3.7
Rains come later than normal time	51	37.5
Total	136	100.0

Source: Field survey, 2013.

The implication of these results is that pastoralists in the area can no longer predict with accuracy when rains are likely to start or end as compared to the past. The influence in the change in rainfall patterns is likely to affect seasonal movement of livestock in search of pasture and water and in turn affect livestock feeding practices.

4.6.3 Length of rainfall seasons

Respondents were asked to indicate length of rainy season in the area in a year. As indicated on Table 19, majority of the respondents (43.4%) reported that rains lasted for an average of three months in a year. This is about 90 days.

Table 19

Length of Rainy Seasons in Mailwa Sub-Location

Length of the rainy season	Frequency	Percent
4 months	51	37.5
3 months	59	43.4
2 months	15	11.0
1 month	9	6.6
Less than 1 month	2	1.5
Total	136	100.0

Source: Field survey, 2013

These findings contradict observations made at MRTC, Isinya rain gauge station which indicated that the average number of rainy days over a period of five decades was about 50 days and had declined by 0.10 as shown on Figure 3. This difference can be explained by the fact that pastoralist were not in a position to count the actual numbers of rainy days but counted the number of months they received rains irrespective of the actual number of days that rain fell within the month. This implies that even in the absence of modern equipment, pastoralists still monitor changing weather patterns although not accurately. Similar view was expressed by Western and Nightigale (2002) who observed that the most adaptive feature of pastoralism is the tracking of seasonal rains.

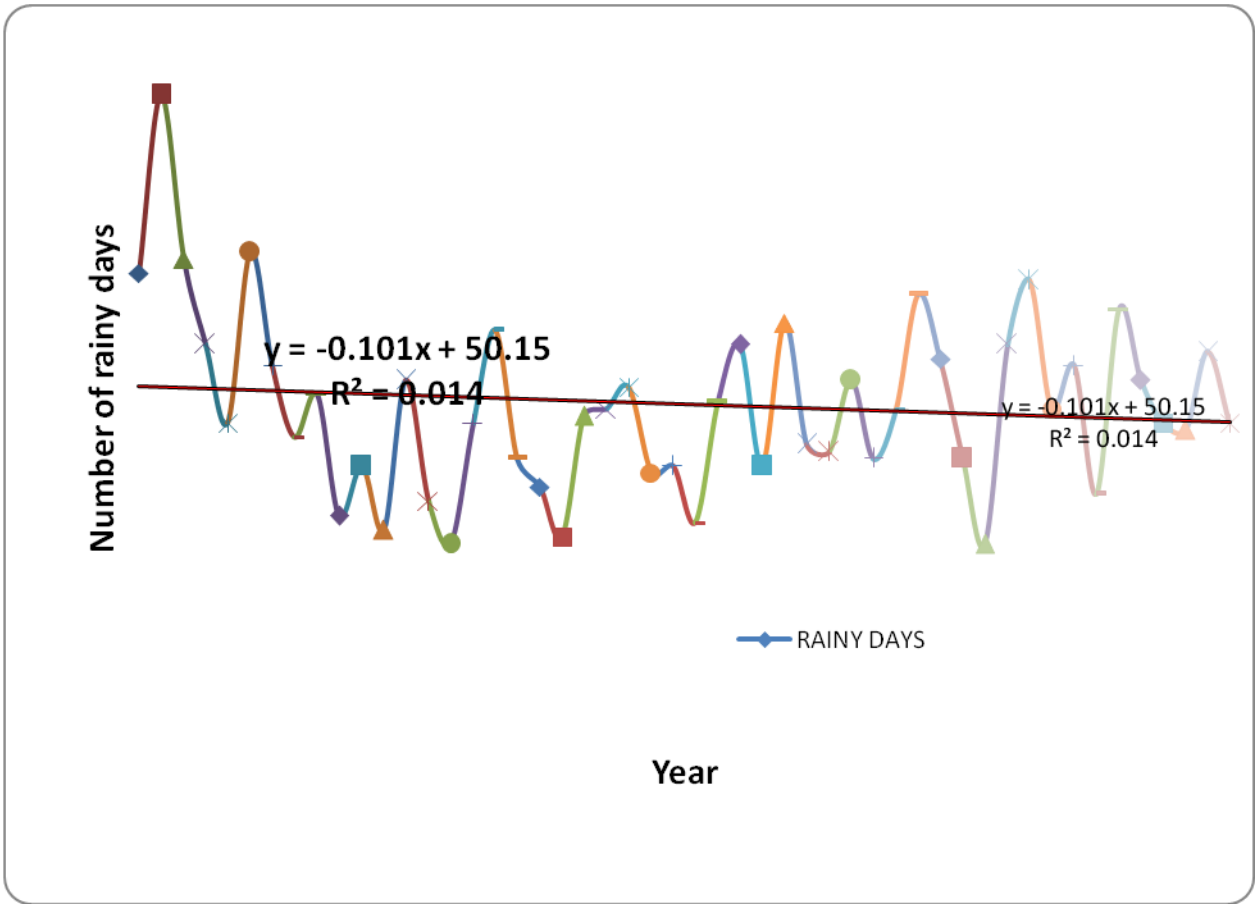

Figure 3: Variations in the number of rain days from 1962-2011 recoded at MRTC Isinya rain gauge station.

Source: Field survey, 2013.

4.6.5 Relationship between changes in rainfall patterns and livestock feeding practices

Chi square test of independence was used to test the hypothesis at $p \leq 0.05$ significance level. This was done by cross tabulating variables on Table 20 against livestock feeding practices. Results on Table 20 indicate that majority of the respondents (59) reported that rainfall in the area was generally experienced within a period of 3-4 months in a year. This means that the rainfall was distributed within this period irrespective of the number of rainy days per month and also the amount of rainfall received on each rainy day. Pastoralists in the area have no access to modern weather recording equipment hence they were not in position to indicate the exact number of rainy days for each rainy month. This scenario is explained on Figure 3 where actual number of rainy days did not exceed 60 on average in any given year. Results also showed that majority of the respondents (97.9%) used movement of livestock as a coping strategy to cope with inadequate rainfall in the area.

Table 20

Relationship between Rainfall Patterns and Livestock Feeding Practices

			Livestock feeding practice adopted to cope with drought			**Total (%)**
		Sample (n)	**Seasonal movement of livestock to other areas (%)**	**Purchase hay (%)**	**Purchase commercial feed (%)**	
Length of rainy season	4 months	51	98.0	0.0	2.0	100.0
	3 months	59	100.0	0.0	0.0	100.0
	2 months	15	100.0	0.0	0.0	100.0
	1 month	9	77.8	22.2	0.0	100.0
	Less than 1 month	2	100.0	0.0	0.0	100.0
Sample(n)		136				

Calc. $\chi 2 = 30.93$, Crit. $\chi 2 = 15.51$, df=8, p=0.001

Source: Field survey, 2013

As discussed earlier, frequency and duration of droughts in the area were on the increase. This implies that the amount of rainfall received in the area may not be adequate for good pasture

regeneration after a severe drought. This therefore indicates that the pastures that emerge after the rains are likely to be exhausted fast resulting in movement of livestock to other areas.

There is a statistically significant association between length of the rainy seasons and livestock feeding practices. This is shown by the calculated chi-squire value of 30.93 (significant at $p \leq 0.05$ significance level) since the critical value of 15.51 is less than the calculated value of 30.93 and a probability value of 0.001 is less than 0.05. A study by Getahun (2007) noted that quality, quantity and spatial distribution of natural pastures are mainly shaped by rainfall. This implies that changes in rainfall patterns are bound to result in increasingly scarce, scattered and unpredictable pastures. The result is that the number, distribution and productivity of permanent pastures and water points, which are so critical for livestock survival during the dry season, are bound to decline. Similarly, Chibinga et al (2010) adds that the day-to-day impacts of climate change such as erratic rainfall are increasing the pastoralists' inability to feed their animals. This implies that the length of the rainy season is likely to influence the amount of pasture and water available for livestock in the area and ultimately influence livestock feeding practices. End of the rainy season marks the beginning of the dry season in which the amount of pasture and water are likely to progressively decrease. This in turn may make the pastoralists to move their livestock which is the most important livestock practice adopted to cope with drought in the study area.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter gives a summary of the findings, conclusions and recommendations in line with the objectives of the study.

5.1 Summary of the Findings

The study established that traditional livestock feeding practices largely involved seasonal livestock movement in search of pasture and water. Other traditional livestock feeding practices included splitting of herds among friends and relatives and also keeping of different species of livestock. The study further established that despite the changes that have occurred as a result of drought variability, livestock movement is still the most important livestock feeding practice to cope with drought in the area. Other emerging practices included purchasing of commercial feeds and hay to feed livestock during periods of drought.

Frequency of droughts had increased within the last 10-20 years with droughts occurring after every one year. However, changes in frequency of droughts had no statistically significant association with livestock feeding practices. This may be attributed to the fact that most of the pastoralists were using coping strategies that are not likely to work due to the ever-changing effects of drought variability as a result of climate change.

Majority of the pastoralists had noticed that duration of droughts in the area had increased within the last 10-20 years. After onset, droughts were noticed to last for a period of about one year. The increase in duration of droughts may have contributed to the reduction of the amount of pasture and water. The study also revealed that scarcity of water for livestock use was most important indicator of drought. Availability of water for livestock use impacts on livestock feeding practices because pastoral systems operate in dry lands where access to water is a limiting factor when determining herd sizes for many individuals and communities in times of drought. Pastoralists covered large distances (>100 km) in search of pasture and water as the duration of drought increased. They farther and farther from the area ending in the neighbouring as the severity of drought increased. The study also established that duration of drought affected

pasture composition in the area. Study findings indicate that although *erikaru* (*digitaria macroblephara*) is a preferred pasture by most livestock, its availability has reduced over time due droughts. Implication of this is that increased duration of droughts is likely to alter pasture composition in the study area leading to loss of biodiversity. The study established that there was a statistically significant influence of duration of drought on livestock feeding practices.

With regard to influence of change in rainfall patterns on livestock feeding practices, the study established that pastoralists in Mailwa sub-location had noticed changes in rainfall patterns in the area over the last 10-20 years where onset of rains was no longer predictable. Analysis of rainfall data for last five decades indicated variations in both amounts and the number of rain days. In regard to the amount of rainfall, an upward trend was observed while the number of rainy days indicated a slight downward trend. From the study, it was found that there was a statistically significant relationship between length of the rainy season and livestock feeding practices. This is attributed to the fact that rainfall determines the quality, quantity and spatial distribution of natural pastures. Therefore, changes in rainfall patterns are bound to result in increasingly scarce, scattered and unpredictable pastures. Rainfall also influences the number, distribution and productivity of permanent pastures and water points, which are so critical for livestock survival during the dry season.

5.2 Conclusions

Based on the findings study it can be concluded that traditionally, pastoralists largely practiced seasonal livestock movement in search of pasture and water in addition to splitting of herds among friends and relatives and also keeping of different species of livestock. The study also concludes seasonal livestock movement in search of pasture and water is still a major practice by the pastoralists in addition to purchasing of commercial feeds and hay to feed livestock during periods of drought.

The study also concludes that frequency of droughts in the area had increased within the last 10-20 years with severe droughts occurring every year. However, increase in frequency of droughts had no statistically significant influence on livestock feeding practices.

The study concludes that duration of drought in the area had increased over the last 10-20 years lasting for a period of 7-12 months on average after onset and statistically significant influenced livestock feeding practices in the area. Increased duration of droughts affected pasture quantities and composition, availability of water for livestock and the distance covered by pastoralists in search of pasture and water.

The study also concludes that rainfall patterns in the area have changed over the last 10-20 year with unpredictable onset of rainy season and reduced duration of precipitation. Rainfall data indicated there were variations in both amounts and rain days. Length of the rainy season had a statistically significant relationship with livestock feeding practices. This is attributed to the fact that rainfall determines the quality, quantity and spatial distribution of natural pastures. Therefore, changes in rainfall patterns are bound to result in increasingly scarce, scattered and unpredictable pastures. Rainfall also influences the number, distribution and productivity of permanent pastures and water points, which are so critical for livestock survival during the dry season.

5.3 Recommendations

Based on the conclusions of the study, makes the following recommendations.

i) Up scaling of traditional drought coping strategies related to livestock feeding that have been used in the past and succeeded.
ii) The study recommends policy interventions that promote adoption of technologies that enhance harvesting and storage of natural hay that can be used to feed livestock during periods of drought, adoption of improved drought tolerant livestock breeds like camels that are more resilient to drought induced shocks and enhancement of livestock off-take during drought to reduce livestock mortality.
iii) Development of more water harvesting facilities to increase the amount of water available in area for livestock during periods of prolonged droughts.
iv) Management of herd sizes to numbers that can be sustained by the available livestock feed resources hence reducing distances covered in search of pasture and water.

5.4 Recommendations for Further Study

The main aim of the study was to determine the influence of drought variability on livestock feeding practices. The study recommends that:

i. A similar study should be done in other parts of the country where pastoralism is practiced for comparison purposes and to allow for generalization of findings on the influence of drought variability on livestock feeding practices.

ii. Identification of climate analogue sites that aims to help pastoralist assess the impacts of progressive climate change on livestock feeding practices. This will allow researchers to better understand which pastoralism systems can survive specific climatic and other conditions. The tool locates sites where the climate today is similar to that predicted for another location in the future, enabling pastoralists and policymakers to determine how to adapt to anticipated changes.

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APPENDICES

APPENDIX A: INTERVIEW GUIDE

Interview Guide Code Number_____

County _____District_____ Division _____

Location _____Sub-location_____

Dear Sir / Madam

I am James M. Gikaba, a Master's student from Egerton University carrying out a study on influence of drought variability on livestock feeding practices of Maasai pastoralists in Kajiado County. I am requesting you as the household head to participate in the study by providing the required information to the best of your ability. Responses will be confidential and will only be used for the purpose of this study. Your cooperation will be highly appreciated.

SECTION A: DEMOGRAPHIC INFORMATION

1. Name (Optional)……..
2. Gender

a) Male [ ] b) Female [ ]

3. Marital status:

a) Single [ ] b) Married [ ] c) Divorced [ ] d) Separated [ ] e) Widow [ ] f) Widower [ ]

4. Age(in years)
   a) Less 30 yrs. [ ] b) 31 -40 [ ] c) 41 – 50 [ ] d) 51- 60 [ ] e) 61 – 70 [ ] f) 71- 80 [ ] g) More than 80 [ ]
5. How many persons have been living in your household for at least the six months? (household size)
   a) 1 – 5 [ ] b) 6 – 10 [ ] c) 11- 15 [ ] d) 16 -20 [ ] e) More than 20 [ ]
6. What is your education level?
   a) Not gone to school [ ] b) Primary level [ ] c) Secondary level [ ]
   d) College level [ ] e) University level [ ]
7. What is the status of land ownership in Mailwa group ranch?
   a) Complete subdivision where all members have title deeds [ ]

b) Complete subdivision where some members have title deeds [ ]

c) Communal ownership [ ]

d) Others (specify)_____

8. Which is the main type of livestock that you keep?

a) Indigenous cattle (zebu) and shoats [ ]

b) Improved (crosses) cattle and shoats [ ]

c) Shoats [ ]

d) Dairy cattle [ ]

e) Camels [ ]

f) Others (specify)_____

9. Do you do any cultivation?

a) Yes [ ] b) No

i) If yes, what size of land do you cultivate?

a) Less than 1 acre [ ] b) 1-2 acres [ ] c) 3- 4 acres [ ] d) More than 5 acres [ ]

ii) Which type of crops do you grow?

a) Maize and beans [ ] b) Maize [ ] c) Beans [ ] d) Vegetables [ ]

e) Others (specify) _____

SECTION B: CURRENT AND TRADITIONAL LIVESTOCK FEEDING PRACTICES

10. Which were traditional livestock feeding practices in this area?

_____

_____

_____

11. Among traditional livestock feeding practices named in no. 10 above, which ones are still being applied?

_____

_____

_____

12. Which are the livestock feeding practices that have emerged within the last 10- 20 years?

_____

_____

_____

SECTION B: FREQUENCY OF DROUGHTS

13. Have you noticed changes in frequency of droughts within the last 10-20 years?

    a) Yes [ ]

    b) No [ ]

    If yes, how often do severe droughts occur?

    a) Drought occur after every 6 months [ ]

    b) Drought occur after every 1 year [ ]

    c) Drought occur after every 2 years [ ]

    d) Drought occur after every 3 years [ ]

    e) Drought occur after every 4 years [ ]

    f) Drought occur after every 5 years [ ]

    g) Others (specify)_____

14. How does an increase in the frequency of droughts affect livestock feeding practices in this area?

    a) Livestock movements in search of pasture and water increases [ ]

    b) More pasture is reserved around the homesteads (*olopololi*) [ ]

    c) Use of supplementary feeds increases [ ]

    d) Relief livestock feed supplies is increased [ ]

    e) Others (specify) _____

SECTION C: DURATION OF DROUGHTS

15. Have you noticed changes in duration of droughts within the last 10-20 years?

    a) Yes [ ]

    b) No [ ]

If yes, how can you describe the trend?

a) Droughts last for less than3 months [ ]
b) Droughts last for 3- 6 months [ ]
c) Droughts last for 6 months - 1 year [ ]
d) Droughts last for 1 -2 years [ ]
e) Droughts last for more 2 years [ ]
f) Other observations (specify) _____

16. Which is the most important indicator of severity of drought in this area?

a) Number of dry months [ ]
b) Number of livestock deaths [ ]
c) Pasture condition [ ]
d) Scarcity of water for livestock [ ]
e) Others(specify) _____

17. During which period did the last major drought occur in this area?

a) 2008 – 2009 [ ]
b) 2008- 2010 [ ]
c) 2009- 2010 [ ]
d) 2009- 2011 [ ]
e) Other period (specify)_____

18. What is the main source of water for livestock in this area during drought periods?

a) Rivers [ ]
b) Springs [ ]
c) Shallow wells [ ]
d) Water pans [ ]
e) Boreholes [ ]
f) Others (specify)_____

19. How does the subdivision of the group ranch on livestock mobility during drought?

_____

_____

_____

20. Which is the most important action that you take to cope with inadequate water for livestock during drought?
    a) Move livestock to areas near water sources [ ]
    b) Reduce amount of water given to livestock [ ]
    c) Reduce frequency of watering livestock [ ]
    d) Transport water to livestock in dry season grazing areas [ ]
    e) Others (specify) _____
21. Do prolonged droughts bring about wildlife-livestock conflict?
    a) Yes [ ]
    b) No [ ]

    If yes, describe the situation

    _____

    _____
22. What is the main source of livestock feed during the drought in this area?
    a) Natural pasture [ ]
    b) Planted pasture [ ]
    c) Crop residues [ ]
    d) Commercial feeds [ ]
    e) Others (specify)_____
23. Have you noticed emergence of new pasture species in grazing fields during drought in the past 10-20 years?)
    a) Yes [ ]
    b) No [ ]

    If yes, which one is most common? (in vernacular)
    a) *Osankash* [ ]
    b) *Olkiramatian* [ ]
    c) *Olntrokei* [ ]
    d) *Ekampa* [ ]
    e) Others (specify)_____

24. Have you noticed pasture species that have disappeared during drought within the last 10-20 years?

    a) Yes [ ]

    b) No [ ]

    If yes, which one was the most common pasture species that has disappeared? (in vernacular)

    a) *Erikaru* [ ]

    b) *Enkapuru* [ ]

    c) *Entomunyua* [ ]

    d) *Ologorroingo* [ ]

    e) Others (specify)_____

25. Which are the most important livestock feeding practices that you adopt to cope with drought?

    a) Move livestock to other areas [ ]

    b) Purchase hay [ ]

    c) Purchase commercial feed [ ]

    d) Use of crop residues [ ]

    e) Destocking [ ]

    f) Leasing of pasture from neighbours [ ]

    g) Others(specify)_____

26. Which is the most important measure that you take to ensure young stock and milking cows have adequate feed during the drought?

    a) Reserve pasture near homesteads (*olporori*) [ ]

    b) Purchase hay [ ]

    c) Purchase commercial feed [ ]

    d) Use of crop residues [ ]

    e) Others (specify) _____

27. What is the furthest distance that you moved your livestock to in search of pasture during the last major drought?

    a) Up to 20 Km [ ]

b) 21 – 40 Km [ ]

c) 41 – 60 Km [ ]

d) 61 – 80 Km [ ]

e) 81 - 100 Km [ ]

f) More than 100 Km [ ]

28. In which areas did your livestock graze most during the last major drought?

a) In other group ranches within Kajiado County [ ]

b) In national parks [ ]

c) In areas outside Kajiado County [ ]

d) Tanzania [ ]

29. How does an increase in the duration of droughts affect livestock feeding practices in this area?

a) The time livestock stays out of this area in search of pasture and water increases[ ]

b) More pasture is reserved around the homesteads (*olpolori*) [ ]

c) Use of supplementary feeds increases [ ]

d) Relief livestock feed supplies are increased [ ]

e) Others (specify) _____

30. Are there organizations that provide assistance in terms of livestock feed during periods of drought in this area?

a) Yes [ ]

b) No [ ]

If yes, what kind of organizations are they?

a) Governmental [ ]

b) Non-governmental organizations (NGOs) [ ]

c) Faith based organizations (FBOs) [ ]

d) Community base organizations (CBOs) [ ]

e) Private companies [ ]

f) Others (specify)_____

31. What is the most important kind of assistance that these organizations provide you with?

a) Bailed hay [ ]
b) Livestock feed supplements [ ]
c) Water tankering [ ]
d) Training on pasture conservation and storage [ ]
e) Others (specify)_____

SECTION D: CHANGE IN RAINFALL PATTERNS

32. Have you noticed changes in rainfall patterns within the last 10-20 years?

a) Yes [ ]
b) No [ ]

If yes, what is the most important indicator of this change?

a) Onset of rains is no longer predictable [ ]
b) Rains come earlier than normal time [ ]
c) Rains come later than normal time [ ]
d) Other observations (specify)_____

33. How long does the main rainy season last in this area?

a) 4 months [ ]
b) 3 months [ ]
c) 2 months [ ]
d) 1 month [ ]
e) Less than 1 month [ ]
f) Others (specify) _____

34. What is the main source of water for livestock use in this area during the wet season?

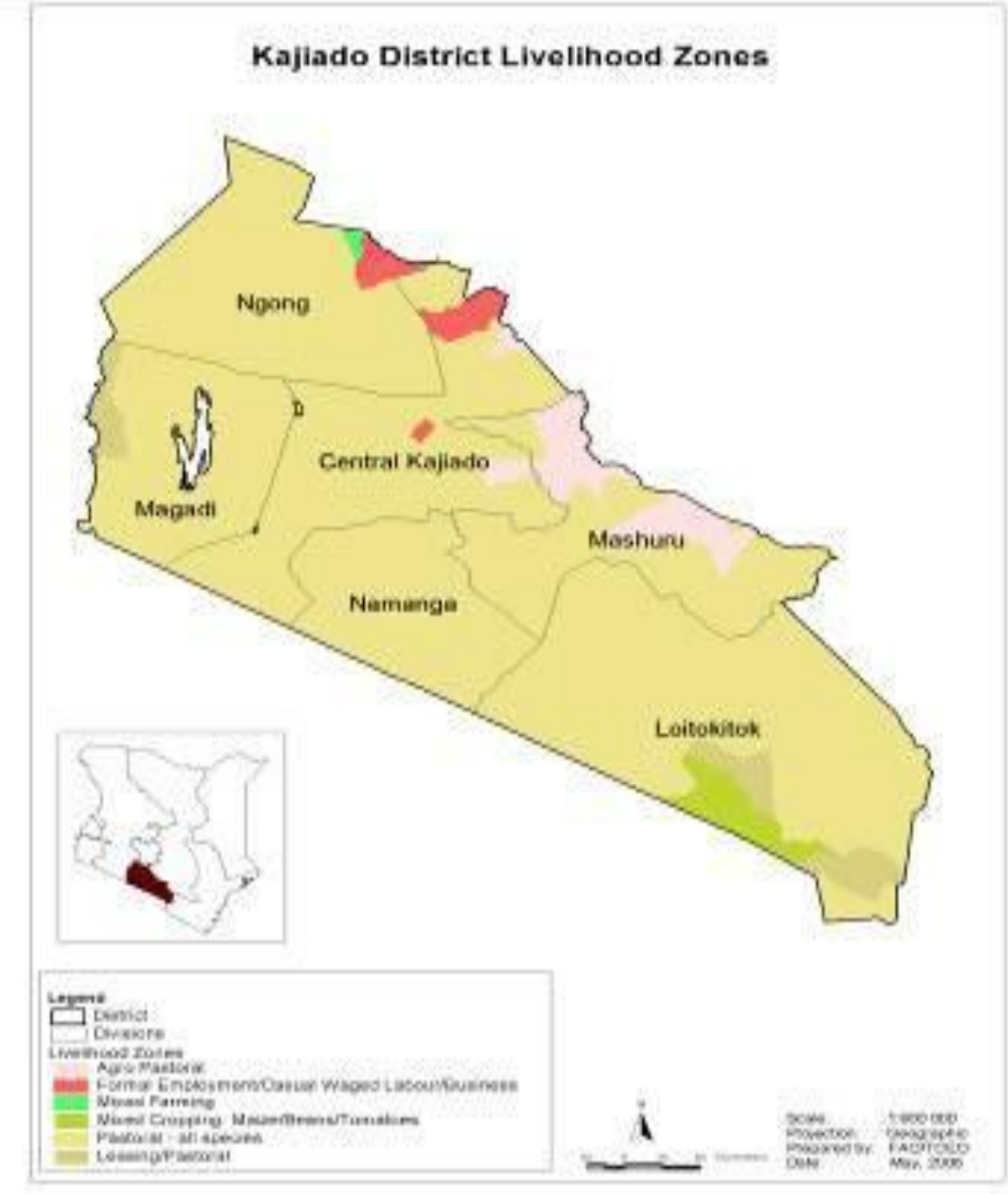
a) Rivers [ ]
b) Springs [ ]
c) Shallow wells [ ]
d) Water pans [ ]
e) Boreholes [ ]
f) Others (specify)_____

35. How does a decrease in the amount of rainfall affect livestock feeding practices in this area?

a) Livestock movement in search of pasture and water increases [ ]
b) More pasture is reserved around the homesteads (*olpolori*) [ ]
c) Use of supplementary feeds increases [ ]
d) Relief livestock feed supplies are increased [ ]
e) Others (specify) _____

Thank you very much for giving me your time and God bless

APPENDIX B: KAJIADO DISTRICT LIVELIHOOD ZONES



APPENDIX C: LETTER OF RESEARCH AUTHORIZATION

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/17/013/37**

Date: **15th July 2013**

James M. Gikaba
Egerton University
P.O Box 536-20115
Egerton.

RE: RESEARCH AUTHORIZATION

Following your application dated **10th July, 2013** for authority to carry out research on ***"Influence of Drought variability on Livestock feeding practices by Maasai Pastoralists in Mailwa sub-location of Kajiado County, Kenya."*** I am pleased to inform you that you have been authorized to undertake research in **Kajiado Central District** for a period ending **31st December, 2013.**

You are advised to report to **the District Commissioner, District Education Officer and District Agricultural Officer, Kajiado Central District** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. M. K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The District Commissioner
The District Education Officer
The District Agricultural Officer
Kajiado Central District.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

APPENDIX D: RESEARCH PERMIT

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Research Permit No. *NCST/RCD/17/013/37*

THIS IS TO CERTIFY THAT:

Date of issue *15th July, 2013*

Prof./Dr./Mr./Mrs./Miss/Institution *James M. Gikaba*

Fee received *KSH. 1000*

of (Address) *Egerton University P.O Box 536-20115, Egerton.*

has been permitted to conduct research in

Location *Kajiado Central*

District

Province *Rift Valley*

on the topic: *Influence of Drought variability on Livestock feeding practices by Maasai Pastoralists in Mailwa sub-location of Kajiado County, Kenya.*

for a period ending: *31st December, 2013*

Applicant's Signature

For Secretary
National Council for
Science &Technology

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

GPK6055t3mt10/2011

(CONDITIONS—see back page)