CLIMATE CHANGE ADAPTATIONS BY LIVESTOCK FARMERS IN NTOROKO DISTRICT, UGANDA

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ARTS IN GEOGRAPHY DEGREE OF KYAMBOGO UNIVERSITY

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DECLARATION

I, Wahimba Joseph do hereby declare that this dissertation entitled: **Climate Change Adaptations by Livestock Farmers in Ntoroko District** is my original work and has never been submitted to any institution for any award.

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This is to satisfy that this dissertation by Wahimba Joseph entitled "Climate Change Adaptations by Livestock Farmers in Ntoroko District" has been submitted with the approval of the following supervisors.

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DEDICATION

This research project is devoted to my beloved wife BiiraYoniya and children Asingya Linnet, Apipawe Festo, and Kabugho Claire for their moral and financial support. I also dedicate it to my friend Mr. Thembo Biatsi Absalom for all his support in this project.

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LIST OF ABBREVIATION

ACCRA	:	Africa Climate Change Resilience Alliance
CC	:	Climate Change
CH_4	:	Methane
CO_2	:	Carbon dioxide
GHGs	:	Green House gases
GoU	:	Government of Uganda
IPCC	:	Intergovernmental Panel on Climate Change
MDGs	:	Millennium Development Goal
MWLE		Ministry of Water Land and Environment
N_20	:	Nitrous oxide nitrous oxide
NAMA	:	Nationally Appropriate Mitigation Actions
NDSER	:	Ntoroko District State of Environment Report
NDWD	:	National Directorate of Water Development
NEMA	:	National Environment Management Authority
NGOs	:	Non-Government Organizations
SPSS	:	Statistical Package of Social Sciences
UNFCCC	:	United National Frame Work Convention on Climate Change

ABSTRACT

The study "Climate Change Adaptations by Livestock Farmers in Ntoroko District" analyzed the extent of climate variability and examined the factors that influence farmers' choice of specific adaptations to Climate Change in Ntoroko District. The study's specific objectives were to determine trends in climate variability in Ntoroko District, to determine the climate change adaptations used by livestock farmers in Ntoroko District, and to investigate the factors influencing livestock farmers' choice of adaptations to climate change in Ntoroko District. A cross-sectional survey research design was employed where qualitative and quantitative methods were used. 351 respondents from a population of 4011 were sampled using a simple random sampling technique. The study used a questionnaire, documentary review, and observation to collect data on the variables of the study. Data collected was analyzed using Linear Regression, Cross-tabulation, and Multivariate in terms of tables and graphs respectively. The findings on climate shown that the mean annual rainfall amounts for Ntoroko District decreased for the period 1988 to 2018, varying from 95.8mm to 43.8mm. This decrease was statistically insignificant indicating that the area was no evidence of climate change in annual rainfall pattern for the period of study. In addition, analysis of mean annual maximum temperature for the study area for the period 1990 to 2018 showed a positive/increasing trend that was statistically significant. The results further revealed that most dominant adaptation practices to climate change used by livestock farmers in Ntoroko were stocking of animal drugs supported by (95.5%) herd mobility (67.6%) and mixed animal rearing (66.8%). Additionally, the Multivariate Regression Model revealed that access to training on climate change followed by monthly income, access to information, and membership to the social group were the most significant factors that positively influenced farmers' choice of adaptations to climate change while the least significant factor was education status of the household head. The study recommended that farmers should be provided with meteorological information on rainfall and temperature trends that may aid in the planning of adaptations to a varying climate. The existing adaptation practices such as stocking animal drugs and mixed animal rearing should be supported and encouraged with the aim of increasing livestock farmers' resilience to climate variability and change. Finally, there should be improved access to training on adaptation, monthly income, and membership to a social group. This would therefore reduce climate change hazards and be a means to support livestock farmers' adaptions to climate change in Ntoroko District.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Climate change refers to a change that is accredited straight or circuitously to human actions that adjust the structure of the global or regional atmosphere and which in accumulation to natural variation is observed for a considerable time (United Nation Framework on Climate Change (NFCC, 2015). Climate change has progressed from being an assumption to realism. Confirmation from Intergovernmental Panel on Climate Change (IPCC, 2014a) is tremendously considerable that Climate Change is now a genuineness. Escalation in the maximum temperature, the number of hot days, and the heat index has been observed at a global scale.

Anthropological actions raise the number of greenhouse gases (GHGs) such as Carbon dioxide, methane, nitrous oxide, and halocarbon in the atmosphere, which has backed numerous worldwide climate change effects. These effects comprise greater food uncertainty, escalating of sea levels, enlarged manifestation and greatness of life-threatening weather actions like floods, drought and heat waves, more species disappearance, reduced biodiversity, and the extent of vector-borne infections universally (IPCC, 2014b).

There is rising confirmation that climate change rising temperature, altered rainfall patterns, and intensified occurrence of hazardous weather events such as drought and floods are likely to weaken livestock harvests and escalation of production risks in many world areas. If left unchecked, climate change is expected to subordinate global per capita Gross Domestic Product (GDP) by 20% threatening food security (Stern, 2006). For instance, studies conducted in Australia by Henery, Charmley, Eckard Gaughan & Hegarty (2012) confirm that high temperatures during summer distress the grassland with is the chief fodder basis for dairy cows which in turn leads to a decline in milk production and livestock output in general.

Herero & Thornton (2015) wrote that developing nations are susceptible to climate change because of their ecological localities, low income, and great dependence on weather delicate sectors such as farming. The same study also reported that, the consequences of climate change in Kenya, Tanzania, South Africa, and Ethiopia are already vivid. Studies conducted by Kimaro, Siobhanm & Jenny-Ann (2011), Mandleni (2011) also disclosed that livestock farmers testified destructive effects of climate change on cattle output. Numerous persistent drought periods result in deficiency of pasture and water leading to cattle death, reduction in milk output, and occurrence of infections such as contagious bovine pleuropneumonia and tick-borne diseases. (Desalegn, 2013).

Ministry of Water Land and Environment [MWLE] (2007) reported that whereas in the past decades, the regularity of drought in Uganda averaged one per decade. In the last decade only, over seven drought phases have been witnessed. The same report stressed that the erratic rain seasons have triggered an escalation in the incidence of food and water shortages in the country with the worst hit area being the dry cattle corridor that stretches from the Uganda-Tanzania border to the Karamoja region. Other country reviews have reported the loss of livestock from the shortage of water, relocation of traditional pastoralists and herders to adjacent districts or game reserves that have led to land battles (National Directorate of Water Development, [NDWR] 2005).

In Uganda mostly, it is very likely that climate change will slow the advancement to millennium development goal (MDGs) and realization of vision 2040 (Uganda Climate Change Country Report, 2017). Livestock farming in Uganda being chiefly reliant on water and pasture is greatly susceptible to climate variations for example. ARCC (2010) reports that climate change led to the loss of 13.9 million livestock in the Karamoja region in only 2015.

Effects of climate change indicate that local climate variation that people have previously experienced and adjusted to is shifting and this adjustment is observed at comparatively great speed than the ability in which they can adjust (UNFCC 2015). Concerning that, Stern, (2006) calls for crucial combined actions against climate change that includes adaptation and improving the adaptive ability to support the indigenous societies to cope with climatic threats mainly with livestock production. Concrete governance with the power to influence across the sectors, and determination to tackle these limitations will be crucial to respond efficiently to climate change (Hepworth & Goulden 2008).

According to Adger, Arnell &Tompkins, (2005) adaptation to climate change is any modification in ecological, social, or economic systems in reaction to real or anticipated climatic stimuli or and their effects that regulate damage or exploit valuable opportunities. Some studies have shown that in many areas, farmers have engaged in adaptation alternatives to building resilience to the effects of climate change. Thornton & Herero (2015), & Zizinga et al., (2017) found out that the adaptation practices as used by farmers include, supplementing livestock feed, stock loaning between relatives and friends, changing planting dates, selling of the stock during shocks among others.

While acquaintance with climate change threats may be similar for societies in diverse geographical localities, different societies adapt differently due to prevailing disparities in social, economic, and institutional settings. Additionally, while studies such as (Adger 2003) have acknowledged the socio-economic factors of adaptation to climate change, great consideration in climate change adaptation studies have been given to crop production at the expense of livestock (Nabikkolo, 2016). In addition, there has been inadequate attention to emerging creativities such as skills and strategies that are designed to structure the adaptive capacity of livestock farmers to climate change and variability. For these motives, this study needed to determine adaptation practices to climate change and the factors influencing livestock farmers' adaptation in Ntoroko District to enhance their adaptive capacity to climate change.

1.2 Statement of the Problem

Climate change is gradually being documented as a universal challenge to livestock output systems in Africa. According to Omondi (2014), the cumulative occurrence of dangerous weather events associated to climate change is now deteriorating livestock production in most of the pastoral communities. Concerning Uganda, Zizinga et al. (2017) reported the occurrence of climate change in the western rift valley system where Ntorko District lies. This has been detected through increased temperature and variations in rainfall patterns over the last few decades. (Zizinga et al., 2017). Such variability has been associated with climatic threats like prolonged drought, floods and erratic rainfall. These consequences threaten livestock farming which forms a basic source of livelihood of over 70% of the population in Ntoroko District (National Population Census, 2014).

Whereas livestock farmers for long have used indigenous ways of adjusting to shocks and strain imposed by harsh ecological circumstances, the cumulative regularity of dangerous weather events is now bringing new challenges that constrain livestock farming. According to the report by Ntoroko District State of Environment Report (NDSER, 2018), 5000 cattle died in the dry season of 2017 in Rwebisengo Sub County alone due to a shortage of water and pasture. The report further indicates that a farmer can lose an average of 50 cattle in every dry season, a situation that was not happening before.

In the face of continuously changing climate and the associated effects, it was necessary to determine the extent of climate variability in Ntoroko District, the adaptation measures used by livestock farmers to mitigate climate variability, and examining the factors that influence the farmers' choice of adaptation practices.

1.3 General Objective of the Study

The general objective of the study was to determine the magnitude of climate variability and examine the factors that influence farmer's choice of specific adaptations to Climate Change in Ntoroko District.

1.3.1 Specific Objectives

i) To determine the trends in climate variability in Ntoroko District.

ii) To determine the climate change adaptations used by livestock farmers in Ntoroko District.

iii) To examine the factors influencing livestock farmers' choice of adaptations to climate change in Ntoroko District

1.4 Research Hypotheses

i) There is no significant change in rainfall and temperature pattern between 1988-2018

ii) Selling of herds is not the most dominant adaptation practice to climate change used by the livestock farmers in the study area

iii) The education status of the household head is not the most significant factor influencing the choice of adaptations to climate change among livestock farmers.

1.5 Significance of the Study

The results of this study would be useful to livestock farmers by increasing their awareness and alertness about climate change and be able to adapt better practices and cope with climate change effectively.

The results of this study were anticipated to give direction for policymakers both in Ntoroko and in other regions of Uganda in their involvements and action to enable a change to sustainable adaptation practices.

It would further provide a worthwhile guide to international and local donor agencies interested in climate change mitigation and adaptation in their donation of grants and funds for environment and resource management studies. Other scholars would have a good base to look at climate change studies.

1.6 Limitations of the Study

Accessing climatic data on rainfall and temperature was difficult because the area under study does not have a working weather station. This challenge was handled by the researcher traveling to the Kasese weather station, which has records of the climate with similar characteristics to that of Ntoroko. This is because Kasese and Ntoroko are located in the rift valley floor experiencing similar microclimatic conditions.

Most of the respondents expected to be given money by the researcher to deliver the required data. In dealing with this situation, the researcher explained the benefits and the purpose of the study to the community and mentioned that it was not to benefit the respondents financially. This made the respondents freely provided information that was required by the researcher.

The study involved traveling from home to home which was so problematic to the researcher. However, this challenge was dealt with by prior booking of a motorcycle that was used to tour the selected villages and homes of the livestock farmers.

1.7 Scope of the Study

The study was carried out in Ntoroko District located in Western Uganda. It is bordered by the Democratic Republic of Congo in the West and North, Hoima District to the North East, Kibale District to the East, Kabarole District to the South, and Bundibugyo to the South West. Out of ten sub-counties in the district, the study was carried out in the three sub-counties of Butungama, Rwebisengo, and Bweramule. These sub-counties were selected because they are predominantly livestock farming areas with over 75% of the households solely depending on livestock for their livelihoods (National Population Census, 2014). The area also experiences long periods of drought usually occurring in January to April of every year.

The study precisely examined the trends in climate variability for the period 1988 to 2018, it also determined climate change adaptation practices, and examined the factors influencing climate change adaptation among the livestock farmers. Data for the study was collected in May and June 2019.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of studies conducted by other researchers on the topic being investigated. Literature has been reviewed on the concept of climate change, trends in climate variability, and effects of climate change on livestock, adaptation practices to climate change, as well as the factors influencing livestock farmers' choice of particular adaptations to climate change.

2.1 Concept of Climate Change

According to the United National Frame Work Convention on Climate Change [UNFCCC] (2010), climate change is defined as an adjustment of climate which is credited directly or indirectly to human activity that changes the composition of the global and or regional atmosphere and which is in addition to natural climate variability is observed over comparable times. IPCC (2014a) defines climate change as a change in the state of the climate that can be acknowledged (e.g. by using statistical tests) by change in the mean and the variability of its properties, and that persists for an extended period usually decades or longer.

While the Earth's climate is regularly changing and global climate transpires naturally, and the prospect of climate change may be more rapid than at any time in the last 1,000 years. The majority of the world's scientists who study this topic conclude that this anticipated climate change would be distinct from former climate change because of anthropological actions. Consequently, climate change is the slow change in the composition of the global atmosphere, which is triggered directly and indirectly by numerous anthropological actions in addition to natural climate variability over time (Koehler & Goddard, 2010)

Additionally noticed that the atmosphere has an effect like a greenhouse on the earth's atmosphere. The energy from the sun reaching the earth is balanced by the energy that the earth radiates back to space. Greenhouse gases (GHGS) trap some of the energy that the earth discharges into space. These Greenhouse gases (GHGS) in the atmosphere perform as regulators controlling the earth's climate. Without this natural greenhouse consequence, the average temperature on earth would be -18%c instead of the current +15% consequently life would be unbearable.

The key GHGS in our atmosphere are water vapor, carbon dioxide (CO_2), methane (CH_4), halocarbons that are used as refrigerants, and nitrous oxide (N_20). Since 1750, the atmospheric applications of carbon dioxide, methane, and nitrous oxide have amplified by nearly 31%, 15%, and 17% respectively. Modern industry and lifestyle have led to raised levels of prevailing GHGs such as carbon dioxide, methane, and nitrous oxide and in some cases, completely new GHGs such as halocarbons. Current rates of escalation per year are 0.5% for carbon dioxide, 0.6% for methane and 0.3% for nitrous oxide. According to IPCC (2007) report, 90 – 95% of climate change is expected to have been triggered by anthropological action.

2.2 Trends in Climate Variability

Climate perhaps the most vital resource in the world, crucial for the wellbeing of all resources has constantly varied naturally. The intensifying concentrations of greenhouse gases (GHGs) in the earth’s atmosphere, resulting from both economic and demographic progression since the industrial revolution are superseding natural variability and leading to possibly irretrievable climate change. Temperatures witnessed have shown an immense warming trend in Africa since the 1960's (IPCC 2007). Although these trends are seen to be constant over the continent, the changes are not identical for instance; there have been decadal warming rates of 0.03ºC in African tropical forests, and 0.1ºC to 0.3ºC in South Africa.

Studies specify that in South Africa and Ethiopia, minimum temperature has intensified marginally faster than maximum or mean temperature (Conway, 2004.and Bernbabuccier al., 2013) between 1961 and 2000. There was also a rise in the number of warm spells over southern and western Africa and a decline in the number of tremendously cold days. In East Africa, there is an indication that the temperature rise has shrunk the extent of ice pitches on Mt. Kilimanjaro by about 80% (Boko et al., 2007) and Mt. Ruwenzori by 91% (Tylor 2013). In the 21st century, Uganda's temperature has intensified by up to1.5ºC across much of the country with typical rates of around 0.2ºC per decade. Studies show that global mean surface temperatures are anticipated to increase between 1.0ºC to 6ºC by 2100 (Xiadong et al, 2006, Schmidhumber and Tubiello 2007 et al., ACCRA 2010). An assessment is done by IPCC (2007) estimated arise of 1.8ºC to 4.0ºC by 2100 with tropical undergoing the fundamental rise because of persistent droughts and dry spells and direct exposure of the region to sun's rays throughout the year. Nevertheless, these temperature observations show variable outcomes and support the need to comprehend the anticipated changes at the local level.

IPCC, (2007) report shows that due to raised temperature, rainfall is also anticipated to rise by 5% to 40% by 2100 whereas others indicate a shrinkage on average by 10% to 40% (Warshima & Akasaka, 2010). The intensity of precipitation events is expected to escalate on average by -8% to + 46% by the 2090s and this will be largely noticed in tropical and high latitude regions which are also estimated to experience a universal increase in precipitation because of high evapotranspiration (IPCC 2007). In general, rainfall is anticipated to rise over the African continent (Mohamed & Azan 2012) with the exclusion of southern Africa, and parts of the horn of Africa.

The climate forecasts developed for Uganda using the models used in IPCC, (2014b) indicate a rise in the near-surface temperature for the country. This rise is in the order of +2 in the next five years; in the order of +2.5 in the next 80 years under Representative Concentration Pathway (RCP) 4.5, and in the order of +2.5 in the next 50 years, and in of +4.5 in the next 80 years. The models also predict an insignificant decline in entire annual rainfall in most of the country with marginally wetter conditions over the west and northern and northwestern parts of the country. The decline in rainfall in most parts of Uganda, combined with considerably wetter seasons, will result in significantly drier conditions for the rest of the year/longer-wet season that extends from September, October, and November towards December, January, and February. This is combined with a substantial rise particularly during the March, April, May, and June, July August Seasons (National Environment Management Authority [NEMA], 2009).

In addition, ACCRA's (2010) report on climate trends in Uganda revealed significant decrease in the total annual rainfall in Bundibugyo and Gulu Districts between 1972 and 2015. Similar findings were reported by previous studies conducted by Omondi (2014) in North-Western Kenya, George (2013) in Paicho Sub County, Gulu District. Omondi (2014) further concluded that in the semi-arid land of Kenya more reliable rainfall is received in September to December short season compared to March to May long rainy season between 1970-2012. These changes required several adaptation approaches to combat the subsequent effects including drought, floods, pests, diseases, and loss of resources and livelihoods specifically in pastoral communities (National Environment Management Authority (NEMA, 2009).

The trends of climate variability and prospect prediction necessitate advanced consideration to wisely scheme and propagate suitable reactions at local levels. Despite the indications in overall trends of rainfall and temperature in Africa and Uganda particularly, this information may not be relied upon to make policy and management conclusions due to generality over a large scale. Thus, this appeals for specific location analysis to recognize where vulnerability is at peak in order to support local-level decision making on adaptation.

This study, therefore, was to address this information gap by providing realistic proof of annual rainfall and temperature variability in the context of Ntoroko District for the period of 31 years from 1988 to 2018. Precision on variability by particular agroecology was vital to support susceptible communities to design suitable adaptation approaches to the advanced climate irregularities.

2.3 Effect of Climate Change on Livestock

Gerber et al., (2013) shown that climate change distresses livestock output and food security. Livestock output is frequently impacted due to infections, and water availability especially in arid and semiarid areas. In addition, climate change will distress the nutritional content of livestock products, which are one of the providers of global calories, proteins, and necessary micronutrients.

Mader, Frank, Harrington, Hahn & Nienaber (2009) show that raised temperature has been found to change livestock mortality, yield, reproductive efficiency, and other performances. Again, this is not regionally persistent with increased temperature aiding livestock in colder regions but destructive in hot zones.

Backlund, et al., (2008) reported that closely 5000 head of cattle died due to heatwaves in 1995 and 1999 in the United States. Furthermore, the study has shown that deviations in climate diminish summer season milk output and conception rates in dairy cows in warmer zones. Climate change also modifies feed supplies through effects on forages and crops.

Reilly et al. (2003) affirm that the grass growth would be altered by climate change. In addition to the above, climate change can shrink pasture production used as the fodder of livestock. The properties of climate change on livestock infections depend on the ecological region, land use type, disease characteristics, and animal vulnerability (Thornton et al., 2009). Animal strength can be affected directly or indirectly by climate change, particularly by rising temperatures (Nardone, Ronchi, Lacetera, Ranieri & Bernabucci 2010). The direct effects are related to the increase of temperature, which increases the prospective for sickness and death. The same study the indirect effects are linked to the effects of climate change on microbial communities (pathogens or parasites), dissemination of vector-borne diseases, food-borne diseases, host resistance, and fodder and water adequacy.

2.4 Climate Change Adaptation Practices

Adaptation measures involve production and management system alterations, breeding strategies, institutional and policy changes, science and technology progresses, and altering farmers' sensitivity and adaptive capacity (IFAD, 2010; USDA, 2009). Research is therefore needed on assessments for realizing these adaptation actions and modifying them based on location and livestock system.

2.4.1 Selling of Animals during Harsh Climatic Conditions

A study carried out by Feleke, Berhe & Hoag (2016) in Southern and Central Tigray, Ethiopia found that selling of animals during shocks followed by home feeding was the most dominant adaptation approaches practiced by livestock farmers. It was found that livestock farmers sell off some of their animals towards anticipated life-threatening drought events and replace them after during the normal weather conditions. This is done to fetch good prices for their animals and avoid heavy animal losses that are likely to be caused by droughts.

2.4.2 Tree Planting

According to Feleke, Berhe & Hoag (2016) tree planting is one of the major techniques used by farmers to adapt to climate changes in the Nile Basin of Ethiopia. Vegetation like trees and grass is valuable because the roots safeguard the soil from erosion. Trees are valuable during floods and droughts, and many trees together might lower temperatures in the near area, and give fresh air, and shade. Jose (2009) also wrote that establishing trees alongside crops and pastures in a mix as a land management approach can help maintain the balance between agricultural production, environmental protection, and carbon sequestration to offset emissions from the sector. He adds that agroforestry may increase productivity and increase the quality of air, soil, and water, biodiversity, and nutrient cycling.

2.4.3 Mixed Animal Rearing

The rearing of mixed species of animals was reported as one of the coping and risk management strategies employed by many pastoral households in the Turkana region, Kenya to promote the use of heterogeneous environments and meet different socioeconomic requirements. Turkana pastoralists stock their herds with a combination of cattle, camels, donkeys, goats, and sheep. The high population of goats and sheep is attributed to drought tolerance and social-cultural roles. In addition, goats and sheep can be easily sold for cash to meet the basic needs of pastoral households. Their values go beyond the production of meat but are also based on a full set of amenities such as the supply of meat, blood, hides and they are asset value of saving and cultural symbolism (Omondi, 2014).

2.4.4 Mixed Cattle Breeds

The approach of mixed cattle breeds can help animals increase their tolerance to heat stress and diseases, and improve their reproduction, growth, and development (Rowlinson, Steele & Nefzaoui 2008). Consequently, the challenge is in increasing livestock production while sustaining the valuable adaptations offered by breeding strategies, all of which need further research (Thornton et al., 2008).

In addition, policy measures that increase adaptive capacity by enabling the application of adaptation schemes will be necessary (United Nations International Strategies for Disaster Reduction, 2014). For example, developing international gene banks could improve breeding programs and serve as an insurance policy, just like what has been done for plants with the In-Trust plant collections in the CGIAR gene banks (Thornton et al., 2008). This would be a major advance that needs substantial investment and international partnership to prosper.

2.4.5 Herd Mobility

Historical and present copying mechanisms to climate variability and extremes in many pastoral regions of Africa include long-term and short-term relocations in pursuit of water and pasture (Epstein, 2000). Humans may change their actions to manage altered climatic conditions or if essentially transfer. Dadi (2007) reveals that livestock farmers in the highlands of Ethiopia migrate a couple of times in a year in search of pasture for their animals. He highlights that these farmers have permanent farms in places, but parts of the year, they move their families and their livestock to other areas and then come back several months later as a general coping strategy (Dadi, 2007).

2.4.6 Rainwater Harvesting

According to Nordic Development Fund, (2013) and FAO, (2011), rainwater harvesting has been one of the main approaches for living with a varying climate in various parts of Africa. In addition, Zayed, Keshta & Attia (2018) reported that rainwater collection increases resilience to climate change effects on water accessibility, aids local business development, and increases urban livelihood. The same study also reveals that rainwater harvesting from buildings only in Egypt could support 8240 persons for drinking yearly, and a full supply of water for other activities respectively.

Reviewed texts (Herero et al., 2015, Nardone et al., 2010 & Hivlek et al., 2014) disclose that climate change adaptation approaches usually practiced by farmers are diversification of livestock and crop varieties, changes in mixed livestock systems, tree planting, changes in animal breeding, selling of animals, rainwater harvesting, stocking of animal drugs, and irrigation among others. Although this Literature is vital to the current study, the scholars only handled these strategies in different countries with different climatic zones and conditions and different agro-ecological settings but not in Ntoroko District, which is the concern of the current study.

2.5 Factors Influencing Climate Change Adaptation Practices

Literature reveals that farmers' adaptation to climate change is subjective to certain characteristics known as factors of adaptation (Engle, 2007). These factors are described below;

2.5.1 Education

A high level of education is assumed to be linked with access to information on improved technologies and high output (Chanillor, Ewert, Arnald, Simelton & Fraser, 2015). Indication from several sources indicates that there is progressive association concerning the education level of the household head, and application of enhanced technologies on adaptation to climate change (Maddison, 2006). Deressa et al., (2009), indicate that highly educated farmers are more likely to adapt better to climate change. However, their findings were inconsistent with Osasogie & Omorogbe, (2018) of Benue State, Nigeria whose study revealed that education was negatively correlated and unconnected to adaptation.

2.5.2 Farming Experience

A study conducted by Osasogie & Omorogbe (2018) in Benue state, Nigeria found a positive coefficient between farming experience and adaptation to climate change. This means a farmer with more years of farming experience is expected to have more knowledge concerning adaptations against climate change hazards. Feleke, Berhe, & Hoag (2016) in Southern and Central Ethiopia also reported a significant influence of farming experience on adaptation mechanisms. The study further reveals that farmers with longer periods of experience were more likely to understand climate change and its negative significances and are more prepared to react to these properties through diverse adaptation practices.

2.5.3 Level of Income

It is usually imagined that the carrying out of new technologies requires adequate financial security (Hardee & Mutunga, 2007). Omondi (2014) also found out that there is a positive correlation between income and adaptive capacity. The same study further stressed that higher-income level farmers adapt to climate change more than their counterparts.

2.5.4 Land Size and Ownership

A study conducted by Timothy, (2013) in Southern Kalahari reveals that the well-off livestock farmers who owned large pieces of private land and large herds of livestock use land and livestock as a guarantee to access loans. These loans were used to purchase extra stock feeds and medicine for vaccinating livestock. Additionally, the study revealed that funds are made available for rich farmers to purchase animal breeds that are more resistant and adaptive to climate change. On the contrary, the same study reveals that lack of access to land for some livestock farmers was the biggest barrier to source livelihood. Shortage of land was a barrier in the sense that the government had also imposed user rights on communal land that prohibited big herds. The amount of traditional knowledge that households had on keeping livestock was constrained by these limitations and this affected their livelihood strategies hence depressing their adaptive capacity to climate change (Timothy, 2013). Similar findings were also reported by Tarivinga, Visser & Zhou, (2016) in Eastern Cape Province, South Africa, and George, (2013) in Gulu District, Uganda that households that have more land are more likely to adapt than their counterparts who have small landholdings.

2.5.5 Access to Credit

Availability of credit facilities the cash constraints and permits farmers to buy inputs such as fertilizer, improved varieties, and irrigation facilities. Investigation on the adaptation of agricultural technologies shows that there is a positive relationship between the levels of adaptation and the availability of credit (Yirga, 2007). According to Turivinga,Visser & Zhou (2016), access to credits facilities gives numerous choices to finance adaptation approaches like supplementary irrigation improved hybrids and fertilizer application.

2.5.6 Membership to Social Group

Sorre, kurga & Musebe (2017) who conducted a study in Busia County, Kenya reported that social capital exists in association with individuals, groups, and organizations within the community. The significance of social linkages during the time of strain is well acknowledged for both communities and enabling collective activities (Adger, 2003). Social groups that contain farming groups, such as One-Acre fund women and men groups, and Faith-based groups provide an advantage to the group members, Katungi (2007) report also revealed that private collective linkages are important because they act as channels for fiscal transfers that may reduce farmers' credit constraints.

2.5.7 Access to Agriculture Extensional Services

Several studies conducted in various parts of Africa revealed that access to agriculture extensional services by rural farmers positively conditions their ability to spread adaptation strategies across several adaptation ranges. This in turn adds to farmer's use of various adaptation approaches (Turavinga, Visser & Zhou, 2016 and Nomcebo et al., 2017). The same studies further reported that access to agriculture extensional services helps farmers through training that supports them to improve their farming practices. Opposed to that, Mutunga, Ndungo & Muebo (2018) who conducted a study in Kitui County Kenya, revealed that access to agriculture extensional services has no significant influence on climate change adaptation among the smallholder farmers.

2.5.8 Access to Information

Access to information motivates the possibility of adapting to climate change. An individual exposed to climate information such as through new visions, magazines, television, radios, and others is expected to take instant action to cope with risks linked to climate change. Many studies also report that access to information on crop and livestock output and climate encourages farmers in making decisions to adjust to climate change. According to Patz, Campbell-Lendrum, Holloway & Foley (2012), there is a strong positive relationship between access to information and the adaptation behavior of farmers.

In Ethiopia and Nigeria, Studies concluded that various factors influence farmers' adaptation to climate; these include the level of education, level of income, land ownership, age of household head among others (Desalegn 2013 Some & kone 2016). These factors are however not very far from those that influence climate change adaptations among the livestock farming communities, though being conducted with attention to crop production. In contrast, however, these studies were conducted in Nigeria and Ethiopia with socio-economic and institutional settings different from those of Uganda. Given that climate change adaptation is place-based due to dissimilarities in the physical environment of different communities, there is a need to examine the factors influencing adaptations by livestock farmers in Uganda with specific attention to Ntoroko District.

2.6 Conceptual Framework

In the conceptual framework, the researcher acknowledged that climate change is expressed through rainfall and temperature variability that results in scarcity of water and pasture, and heat stress. To moderate the effects of climate variability, farmers use different adaptation measures such as selling off herds, tree planting, mixed animal rearing, mixed cattle breeds, herd mobility, rainwater harvesting, rearing a manageable number of animals, and stocking of animal drugs. However, the choice to adapt to climate change is subjective to factors such as level of education, farming experience, income levels, land ownership and size, group membership, access to credit, access to training on climate change, access to extension services, and access to information on climate change.

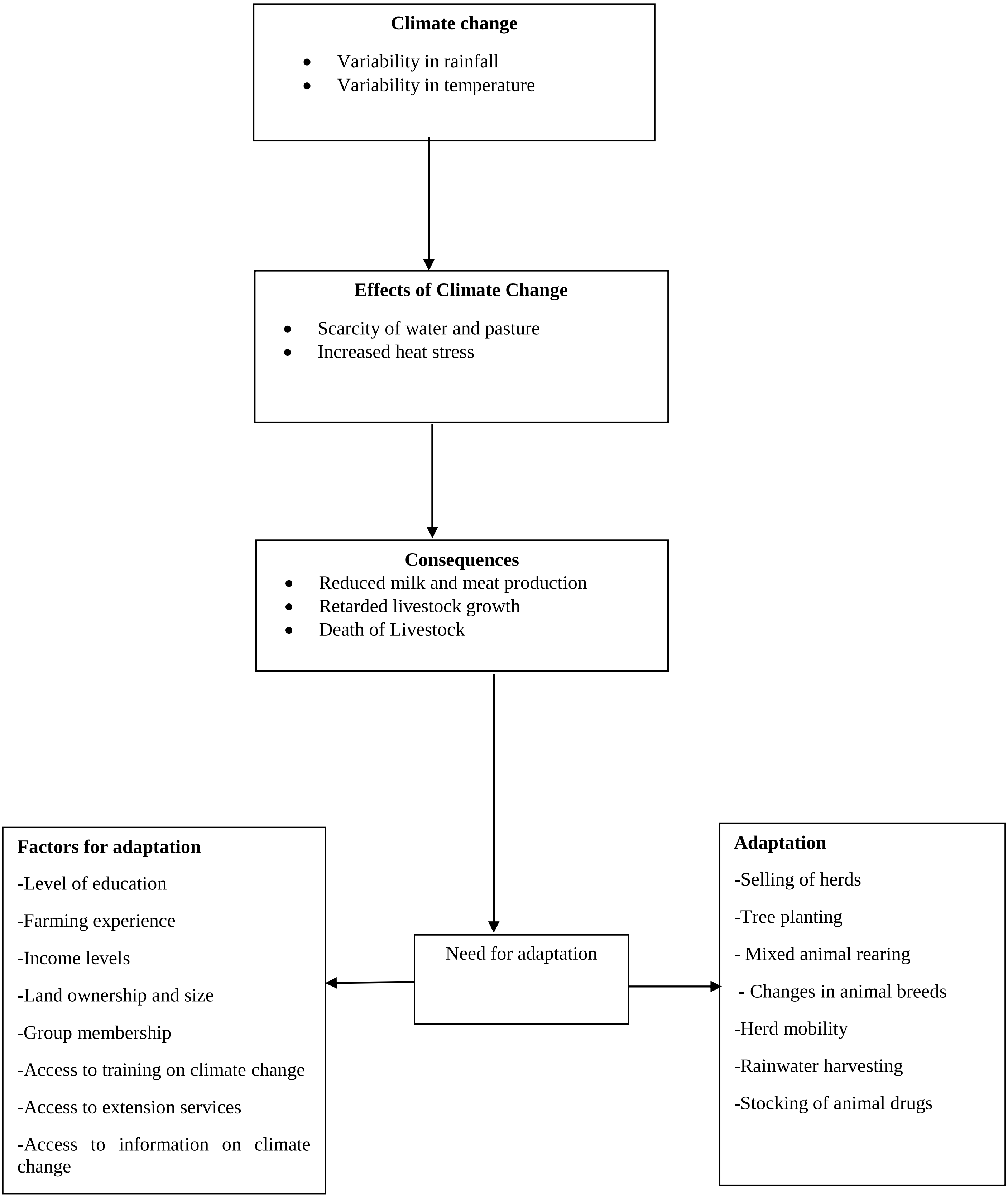

Figure 2.1: Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents information about the study area, research design, study population sample size, sampling techniques, data collection methods, and data analysis.

3.1 Study area

3.1.1 Location

The study was carried out in Ntoroko District situated in the Western rift valley region of Uganda with a coordinate of 1.041^0 latitudes and 30.481^0 longitudes. Ntoroko covers a total area of 11236 km^2 (477sq mil) with an elevation of 640 m (2100ft) above sea level. Ntoroko District is bordered by the Democratic Republic of Congo to the west and north, Hoima District to the North West, Kibale to the east, Kabarole District to the south, and Bundibugyo District to the South West. Out of 10 sub-counties in the district, the study will cover three sub-counties of Rwebisengo, Butungama, and Bweramule Sub Counties. The area was purposely selected because over 80% of the population solely depends on livestock farming that entirely depends on natural resources like water pasture, which are delicate to climate change.

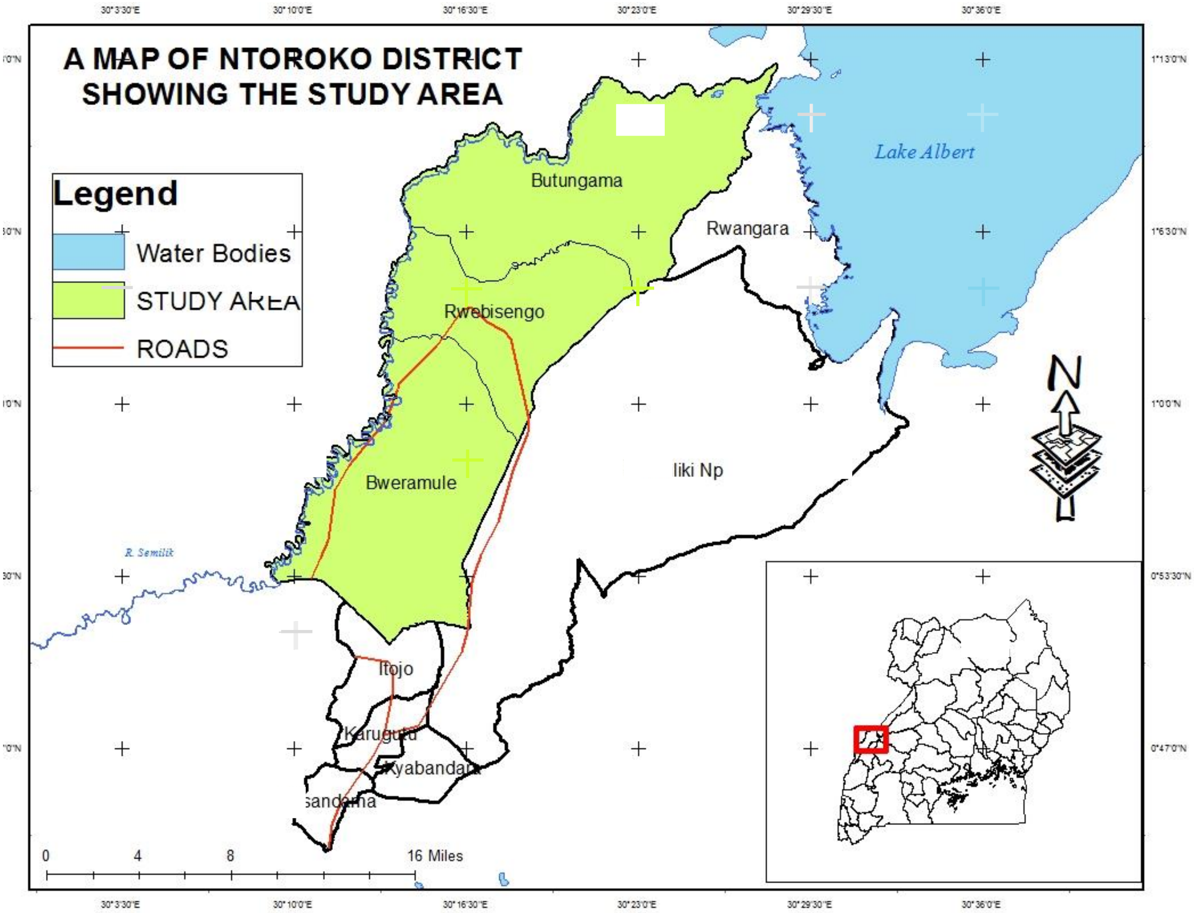

Figure 3.1: Location of the study area

3.1.2 Climate

Rwebisengo, Bweramule, and Butugama Sub Counties are part of the western rift valley system that stretches from Lake Malawi in Tanzania and runs through Western Tanzania, Burundi, and Rwanda to Western Uganda. The region generally receives convectional rainfall ranging from 7500 – 1200 mm per annum. The region receives much rainfall between September and November while little rain is received between April and May. The area is dry from December to Match and June to August 27, 2021. The area experiences mean monthly maximum temperature ranging from 29^0C - 34.3^0C and mean monthly minimum temperature of 18.8^0C -12^0C.

3.1.3 Relief and Attitude

The relief of the area is largely flat due to its location in the rift valley floor with an altitude of 2100 meters above sea level.

3.1.4 Drainage

The study area is bordered by River Semliki in the West which is the major river draining the area. The area is also crossed by various seasonal swamps that generally dry up during the dry season.

3.1.5 Vegetation

The area is characterized by short Savanna grassland that has been overgrazed almost leaving the soil unprotected.

3.1.6 Soils

The area is covered by loam, sand-loam, and clay soils that support the growth of pasture for livestock during the rainy season. However, the soils are too porous and do not retain water for long during the dry season.

3.1.7 Land Use

The chief land use practice in the study area is livestock farming. Animals like cattle, goats, and sheep are reared. Fishing is also another important economic activity that is carried out in the area since it neighbors River Semliki. This is also carried in seasonal swamps as they start drying up.

3.1.8 Ethnicity

The study area is chiefly occupied by Batuku who speak the Rutuku language which is closely related to Rutoro. This is the prime language of the area.

3.2 Research Design

The cross-sectional survey research design was used by this study. This involved a survey of livestock farmers on whom quantitative data on adaptation practices was collected, as well as the factors that influence their choice of adaptations to climate change. The survey questions were prepared in the English language and later explained in the local language (*Rutuku*) during data gathering. This was then encoded into SPSS in the English language for data processing and analysis.

3.3 Area Sample

The study was conducted in three sub-counties in Ntoroko District. The three sub-counties include Butungama, Rwebisengo, and Bweramule. These three sub-counties were purposively selected because they are mainly cattle-keeping areas. Two parishes from each of the three sub-counties were purposively sampled in which respondents were selected. These include Nyakasenyi and Kasungu Parishes from Butungama Sub County, Rwamabale and Rukaba Parishes from Bweramule Sub County and, Majumba and Makondo from Rwebisengo Sub County. In each of these parishes, two villages were chosen to make a total number of 12 villages. The villages include Kibimbiri, Nyakabira, Rukora A, Rukora B, Majumba 1, Majumba 11, Ibale, Makondo, Kenyange, Kimara, Majojo, and Makindo. These villages from each of the selected parishes were chosen using simple random sampling by lottery method.

3.4 Sampling of Participants

According to UBOS, (2017), there are 1,341 households in Butungama Sub County, 1,430 households in Rwebisengo, and 1,242 households in Bweramule Sub County making a total of 4,011 households in three sub-counties. Therefore, 4,011 made the study population from which the sample size was determined. Considering Krejicie and Morgan's (1970) table of sample size determinant (see appendix G) the study sampled 351 households out of

4,011study population to make up a sample size. At the village level, at least 29 households were selected using simple random sampling. This sampling technique was used because every member had equal chances of representing the population under study.

3.5 Methods of Data Collection and Analysis

Primary data was collected from the field where different techniques were engaged depending on the nature of each objective. The methods included questionnaires, documentary reviews, and observation.

3.5.1 Establishing Trends in Climate Variability

The data on climate change trends mainly on rainfall, and maximum and minimum temperature trends was collected using documentary review. Rainfall and temperature data for the period from 1988-2018 was collected from the Kasese weather station managed by Uganda National Meteorological Authority (UNMA). This was used to analyze trends and variability in climate in Ntoroko District. The Kasese weather station was selected since Ntoroko has no working weather station. In addition, the rainfall and temperature records at the Kasese weather station are a fair representation of the Albertine homogenous climatic region in which Ntoroko lies. Rainfall and temperature data were then presented in line graphs to check whether there were changes in rainfall and temperature trends.

3.5.2 Establishing Climate Change Adaptation Practices and Investigating the Factors Influencing the Choice of Adaptations

To collect data on adaptation practices to climate change, observation, and questionnaire methods were used. The observation technique was used to collect data on the observable features of the study using human eyes. The data obtained by observation was recorded with reference to the observation checklist shown in Appendix A

The questionnaire, which was the main data collection method in this study, was used to collect data on climate change adaptations adopted by livestock farmers, and the factors influencing their adoption. This was arranged in a way that some questions from which answers would be indicated by ticking and /or writing short notes (Appendix C). This precisely targeted household respondents (livestock farmers). Copies of the questionnaire were promptly given by the researcher and research assistant to the respondents and waited until they were answered and then returned with them.

3.5.3 Data Analysis

After a successful data collection exercise, the data was sorted and coded. A Statistical Package for Social Sciences (SPSS) (version 16) was used to analyze the data using frequency tables, and percentages.

Data on Objective 1 was analyzed using the Linear Regression statistical model. This was used to fit the observed data into a trend line for each of the variables covering the entire study period. The modeling is based on the Ordinary Least-Square (OLS) regression that is useful in testing the relationship between variables over time. The time is considered as the independent variable (x) while the climatic elements (rainfall and temperature) are dependent variables (Y). The slope of the regression line qualified OLS trends and significance was tested at 0.05 significant level (α) based on the null hypothesis. The OLS model is shown by the equation

$$Y = \alpha + \beta X + \varepsilon \qquad (1)$$

Where:

Y = the dependent variable (rainfall and temperature)

X = the independent variable (time)

α = the intercept

β = the slope coefficient for independent variable (relationship between X & Y variables)

ε= the random error

Data collected on objective two was analyzed using cross-tabulation to determine the most dominant adaptation practices to climate change.

Objectives three was analyzed using the Multivariate Regression Model. This Model provides analysis for multiple dependent variables by one or more factor variables. The model was, therefore, suitable for this study with several dependent variables. The model is donated by the formula;

$Y_i = 1 \text{ if } X'\beta i + \varepsilon i > 0$

$Y_i = 0 \text{ if } X'\beta i + \varepsilon i \leq 0, \; i = 1, 2, 3 \ldots n$

Where *Yi* is a vector of dependent variables (each serves as an adaptation choice). For this study, adaptation practices include stocking of animal drugs, herd mobility, mixed animals rearing, rainwater harvesting, rearing a manageable number of animals, planting of trees, selling of animals during shocks, and mixed cattle breeds. *X′* is a vector of the factors that may affect the farmer's choice of particular adaptation practice; *βi* is the estimated coefficient, which is the rate of change in the *Y* (the dependent variables) as *X* (independent variable) changes. *εi* is a random error term and *n* is the number of observations with zero mean(s) and unitary variance. In this case, the farmers' contextual background shapes their choice on how to adapt to climate change. Thus, the choice of a particular adaptation practice is subject to contextual backgrounds. For this study, the contextual background includes factors such as education status, land ownership, monthly income, training on climate change, information on climate change, credit facilities, farming experience, access to extension services, and membership to the social group.

In the multivariate model, the coefficients' values (*βi*) which is the rate of change in the *Y* (the dependent variables) as *X'* (independent variable) changes holding other factors constant were used to interpret the results. When the coefficient (*βi*) is negative, it shows that the dependent and independent variables have an inverse relationship, and when it has a positive coefficient, there is a positive relationship. In addition to the Coefficients, the significance values were used to ascertain whether a specific factor significantly influenced adoption at a significance value of 5% or 0.05. Multivariate Regression Model was used to test the hypothesis that "education status of a household head is not the most significant factor influencing the choice of adaptations to climate change among the livestock farmers". The multivariate model has been used by researchers to analyze similar studies on livestock farmers' decision to select adaptation alternatives in response to climate change (Feleke Berhe, & Hoag 2016).

CHAPTER FOUR

PRESENTATION OF STUDY FINDINGS

4.0 Introduction

This chapter presents the results and interpretations of the data concerning the study objectives.

4.1 Trends in Climate Variability

This subsection analyses the climatic variables of interest to the study. These include the mean annual rainfall, maximum and minimum temperature for 31 years (1988-2018) and 29 years (1990-2018) respectively. This study aimed to analyze the climate data as stated above to determine the magnitude of variability in these elements. The data analyzed were collected from the Kasese weather station and the results are presented as seen below:

4.1.1 Trends in Mean Annual Rainfall Variability

Results for the data collected on the mean annual rainfall variability for Ntoroko District for 31 years is presented in figure 4.1

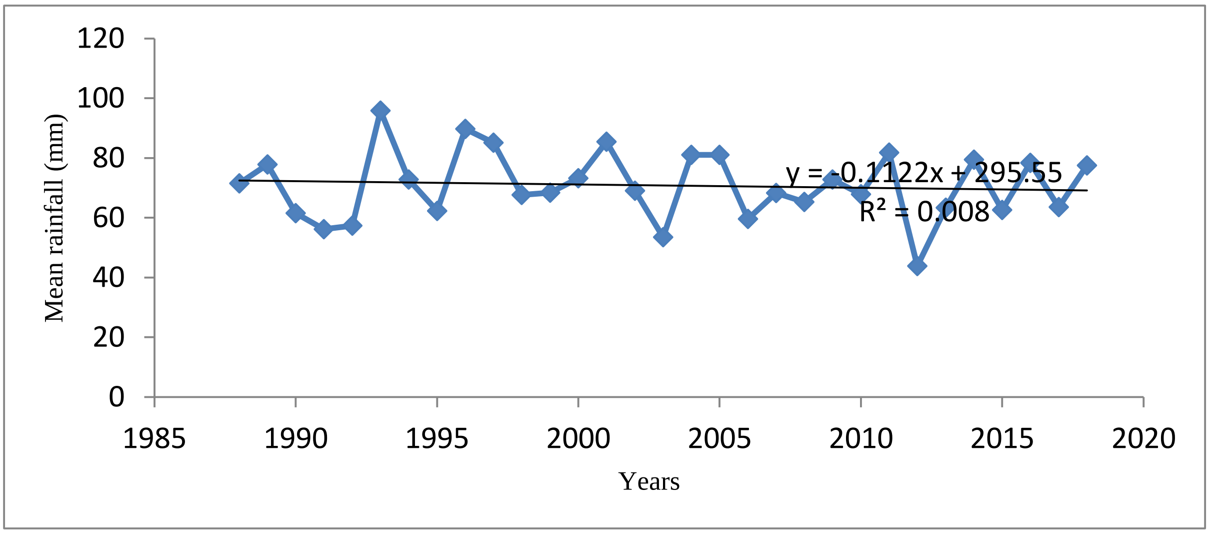

Figure 4.1: Mean annual rainfall from 1988 to 2018

Results presented in figure 4.1 indicate that the mean annual rainfall for Ntoroko District between 1988 and 2018 was progressively varying in decreasing trend with the peak of 95.8mm in 1998. The lowest value of 43.8mm was noted in 2012. The trend indicated a reduction with a negative slope value of -0.1122 while the coefficient value R^2 = 0.008. This is an indicator of relatively low insignificant variation with time.

Linear regression statistical results for mean annual rainfall from 1988 to 2018

Linear regression statistical analysis was run on mean annual rainfall and the results are presented in table 4.1.

Table 4. 1: Linear regression statistics results for mean annual rainfall from 1988 to 2018

Variable	Regression equation	R^2	P value
Mean annual rainfall	Y= -0.1122X + 293.552	0.008	0.633

Significant at 0.01 and 0.05 probability level

Results revealed a negative (decreasing) trend in annual rainfall that was not strong (R^2=0.008) and statistically insignificant since the P-value (p=0.633) was above 5% as presented in table 4.1. This means that annual rainfall for the period of 1998 to 2018 slightly decreased with a small margin that may not have serious negative effects on livestock farming.

4.1.2 Annual average Rainfall Deviations from the Long Term (normal) mean (70.7mm) between 1988 and 2018

Results indicate that the deviations of annual rainfall amounts from the long-term mean of 70.7mm ranged from -37.9mm to +38.4mm as illustrated in figure 4.2.

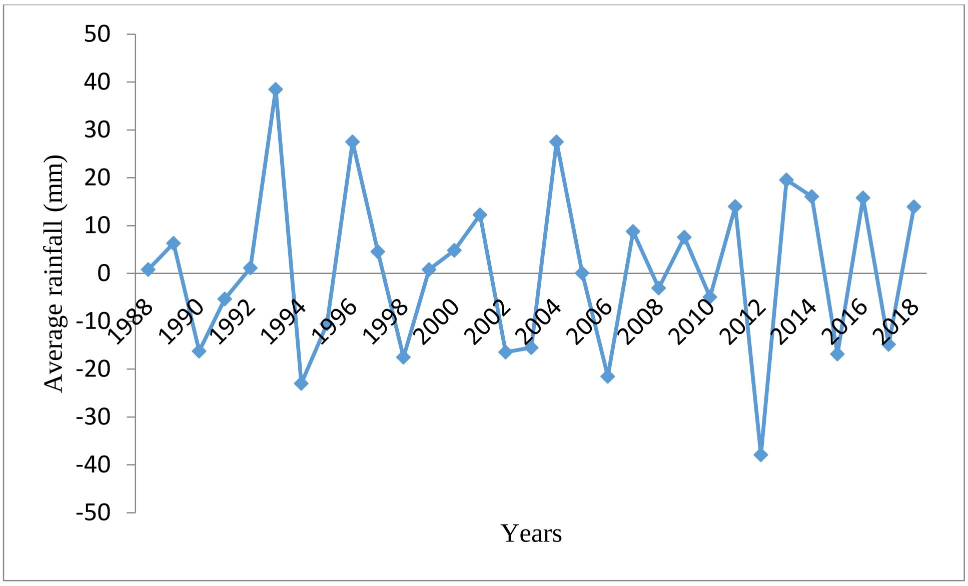

Figure 4. 2: Mean annual Rainfall Deviations from the normal mean (70.7mm) between 1988 and 2018

As shown in figure 4.2, results reveal that the annual average rainfall amounts that were above the long term mean were documented in the years 1988, 1989, 1993, 1996, 1997, 1999, 2000, 2001, 2002, 2004, 2005, 2007, 2009, 2011, 2013, 2014, 2016 and 2018. The annual rainfall amounts that deviated far above the long-term mean were noted in 1993 with 38.4mm, 2004 with 27.5mm, and 1996 with 27.4mm. The years 1988, 1992, and 2005 recorded the annual rainfall amount that deviated by insignificant from the long-term mean of 0.8 mm, 0.9 mm, and 0.05 mm respectively. Figure 4.2 further indicates that the amounts of rainfall that were below the long-term mean were observed in the years of 1990,1991, 1994, 1995, 1998, 2002, 2003, 2006, 2008, 2010, 1012 2015, and 2017.

As observed in figure 4.2 therefore 19 out of 31 years recorded the annual mean rainfall that was above the normal meanwhile only 12 years recorded the annual mean rainfall that was below the normal mean. This denotes that there were more years with above-normal rainfall than those with mean rainfall below the normal mean. However also 3 years recorded annual rainfall amounts that were far much below the normal mean of 23 mm in 1994, 21.5 mm in 2006, and 37.9 mm in 2012. On the other hand, the 2 years of 2008 and 2010 recorded annual mean rainfall amount that was marginally lower than the normal mean of 3.1mm and 4.9 mm respectively. This implies that mean annual rainfall is generally fluctuating over time combined with larger and minor deviations from the long-term mean.

4.1.3 Seasonal rainfall trends for Ntoroko District from 1988 to 2018

To analyze the seasonal rainfall trends, the calendar year was divided into four seasons. The divisions according to Uganda National Meteorological Authority (UNMA, 2019) include December to February (DJF), March to May (MAM), June to August (JJA), and September to November (SON) as presented in fingers 4.3 to 4.6. Accordingly, results show that the DJF and JJA are dry seasons that recorded an average rainfall of 39.9mm and 46.8mm respectively that was below normal average rainfall, whereas MAM and SON are rainy seasons where above-normal rainfall average of 94.8mm and 114.3mm respectively were observed.

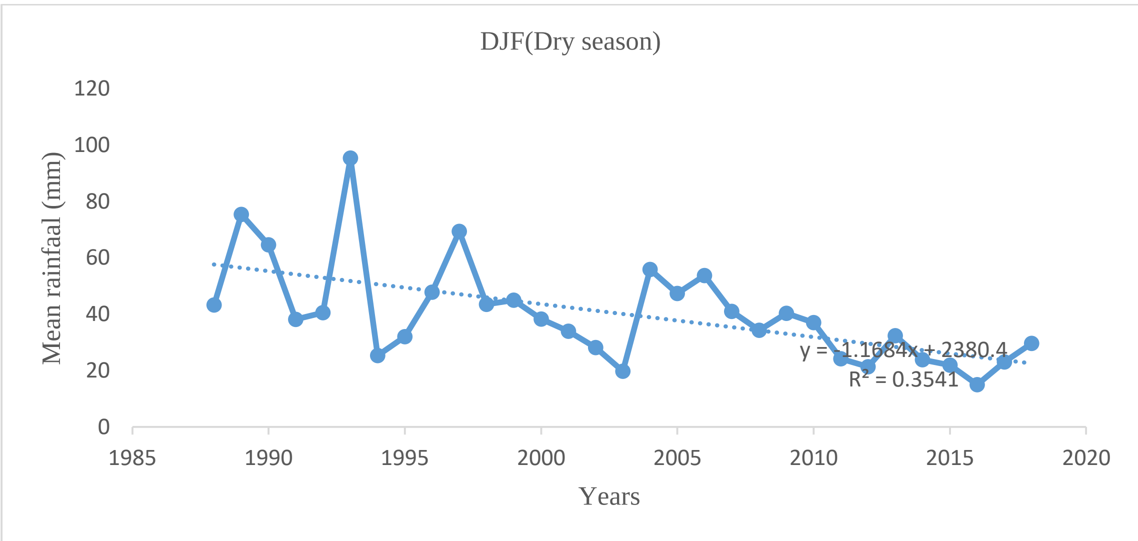

Figure 4. 3: DJF Seasonal rainfall trends for Ntoroko between 1988 and 2018

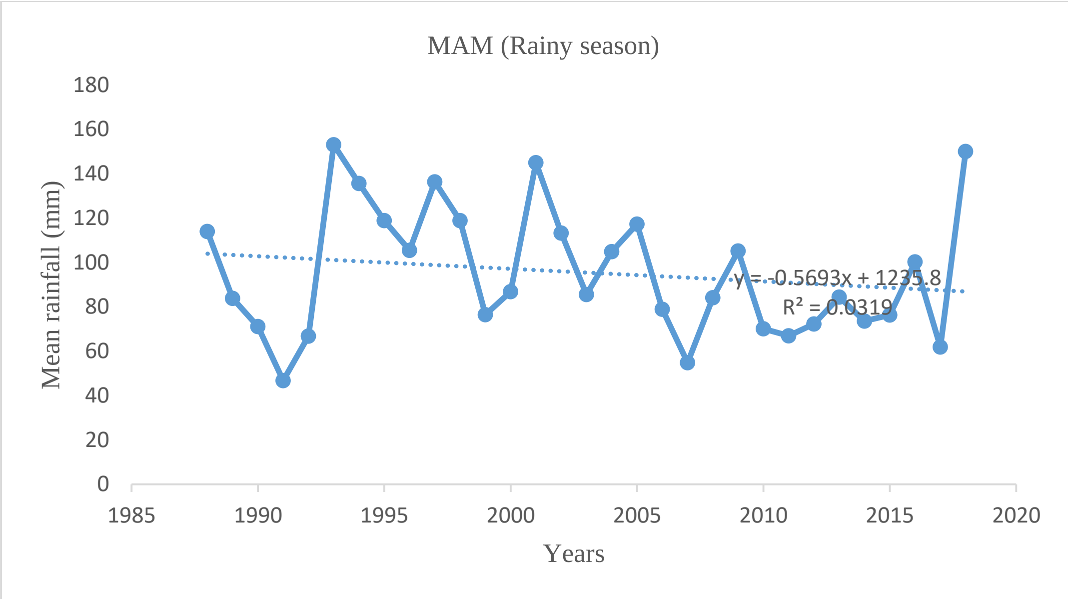

Figure 4. 4: MAM Seasonal rainfall trends for Ntoroko between 1988 and 2018

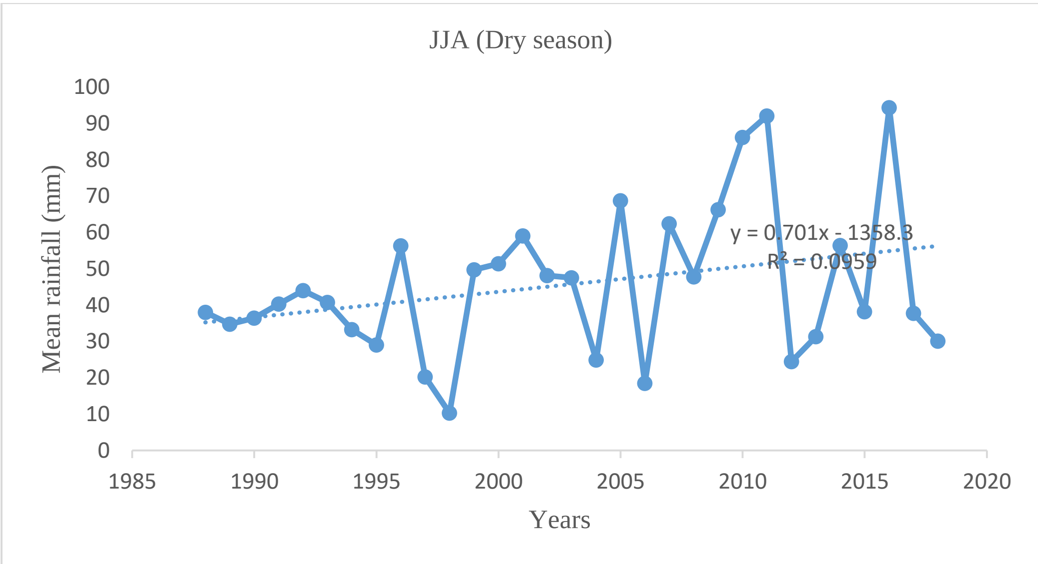

Figure 4. 5: JJA Seasonal rainfall trends for Ntoroko between 1988 and 2018

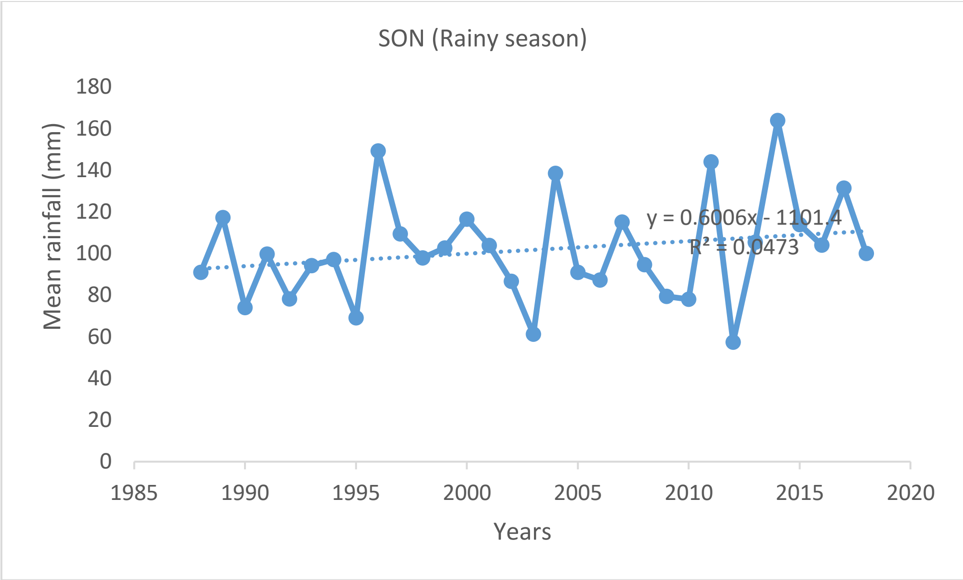

Figure 4. 6: SON Seasonal rainfall trends for Ntoroko between 1988 and 2018

As observed in figures 4.3 to 4.6, findings of seasonal rainfall for Ntoroko between 1988 and 2018 indicate negative trends for December to February (DJF) and March to May (MAM) while July to August (JJA) and September to November SON showed positive trends.

Figure 4.3 indicates a decreasing trend with a negative value of -1.1684/year and the coefficient value of R^2 =0.3541 in the January to February (DJF) seasonal rainfall amounts received in Ntoroko District between 1988 and 2018. As further observed in figure 4.3 the highest mean rainfall amount of 95mm (above normal) in the DJF season was recorded in the year 1993 whereas the normal rainfall averages of 75mm, 46.4mm, 69.3mm, 55.8mm were received in the years of 1989, 1990, 1997, 2004 and 2006 respectively.

The rest of the years in the DJF season recorded average rainfall that was far below normal with the lowest averages of 15mm and 23.2mm observed in the years of 2016 and 1994 respectively. The wettest month in DJF seasonal rainfall was December with 59.4mm and the driest was January with 28.1mm recorded.

It is therefore this rainfall shortage supplemented with the high maximum temperature that has led to lack of water and pasture, animal pests and, diseases and ultimately high animal mortality rates that occur in the dry season of every year as most respondents reported it across the area of study.

Figure 4.4 also revealed a decreasing trend in the March to May (MAM) seasonal rainfall amounts received in Ntoroko District between 1988 and 2018. The trend revealed a negative slope value of -0.5689 and a linear fitting coefficient R^2=0.0473.

Figure 4.4 further reveals that all the years in MAM seasonal rainfall between 1988 to 2018 recorded normal and above normal rainfall averages ranging from 54.8mm to 153.0mm except the year 1991 that recorded below normal average rainfall of 46.7mm. In this season, the highest average rainfall of 114.3mm was observed in April while the lowest average rainfall of 84.2 mm was recorded in March.

Figure 4.5 indicates an increasing trend with a positive value of 0.701/year and the coefficient value of R^2 =0.0959 in JJA Seasonal rainfall in Ntoroko District between 1988 and 2018.

Figure 4.5 further reveals that the JJA season recorded the highest (above normal) average rainfall of 94mm and 92mm in the years 2016 and 2011 respectively. Normal rainfall averages of 56.3 mm, 59.0 mm, 68.7mm, 62.4 mm, 66.2 mm, and 56.6 mm were observed in the years 1996, 2001, 2005, 2007 2009, and 2014 respectively. While other years in this season recorded below normal average rainfall, with the lowest of 18.5 mm and 24.9 mm recorded in the years of 2006 and 2004 respectively. The month of August was recorded as the wettest month in the JJA Seasonal rainfall with 63.8 mm, while July with 26.2mm was considered the driest.

Figure 4.6 also revealed an increasing trend in the September to November (SON) seasonal rainfall amounts received in Ntoroko District between 1988 and 2018. A linear trend indicates an increase with a positive value of 0.6006/year and the coefficient value of R^2 =0.0473.

In addition, figure 4.6 reveals that for all the years, the SON season recorded normal and above normal rainfall averages ranging from 57.4 mm received in 2012, to 163.9 mm in 2014. In this season, the month of November recorded the highest average rainfall of 113.4 mm while September recorded the lowest amount of 88.1 mm.

According to Uganda National Meteorological Authority (UNMA) (2019), the rainfall amount below the long-term mean are considered to be below normal and under this range, there are high chances of socio-economic activities being strained. On the other hand, rainfall amount that is in the range of 75% to 125% of the normal mean is considered normal, while the rainfall that is above 125% of the normal mean is considered to be above normal. Thus under the range of normal and above normal rainfall conditions, various economic activities are expected to be adequately supported. This means that Ntoroko District received normal rainfall that is supposed to sustain livestock farming. However, variability in rainfall of individual months and years that creates rainfall deficiencies have negative effects on livestock production that needs serious attention to improve livestock farmers' adaptive capacity to climate variability.

Linear regression statistics results for mean seasonal rainfall from 1988 to 2018

The Linear regression statistical analysis was run on mean seasonal rainfall to determine the significant level in either increase or decrease in rainfall trends as presented in table 4.2

Table 4. 2: Linear regression statistical test for seasonal rainfall from 1988 to 2018

Season	Regression Equation	R^2	P Value
DJF (dry season)	Y = -1.168X + 238.41	0.334	**0.000**
MAM (long rainy season)	Y = -0.569X + 1235.760	0.032	0.336
JJA (dry season)	Y = 0.701X - 1358.269	0.096	0.0900
SON (short rainy season)	Y = 0.601X - 1101.372	0.042	**0.0240**

Significant at 0.01 and 0.05 probability level

The result of the Linear regression statistical test for seasonal rainfall (Table 4.2) reveals that the DJF season experienced a negative (decreasing) rainfall trend and the decrease in average rainfall was not strong (R^2 <0.5) but statistically significant (P =0.000). Furthermore, the MAM season also reveals a negative (decrease) in average rainfall that was not strong (R^2 <0.5), and insignificant (P =0.336). On the other hand, the JJA season reveals an increasing trend that was not strong (R^2 <0.5) and insignificant (p =0.0900) whereas the SON season revealed positive (increasing) rainfall trends that were significant (P =0.0240) as indicated in table 4.2. This implies that the decrease in the DJF and the MAM seasonal rains leads to scarcity of water and pasture and the associated effects like high animal mortality rate that during the seasons. On the other hand, increase in the JJA and the SON seasonal rains led to the flooding of the area which is eventually associated with animal diseases like foot and mouth diseases. These results can be used to guide and direct the livestock farmers and various decision-making agencies to design adaptation practices suitable for a particular season in order to minimize animal loss.

4.1.4 Trends in Maximum Temperature Variability

The data collected on trends in maximum temperature variability from 1990 to 2018 in Ntoroko District was analyzed as presented in figure 4.7.

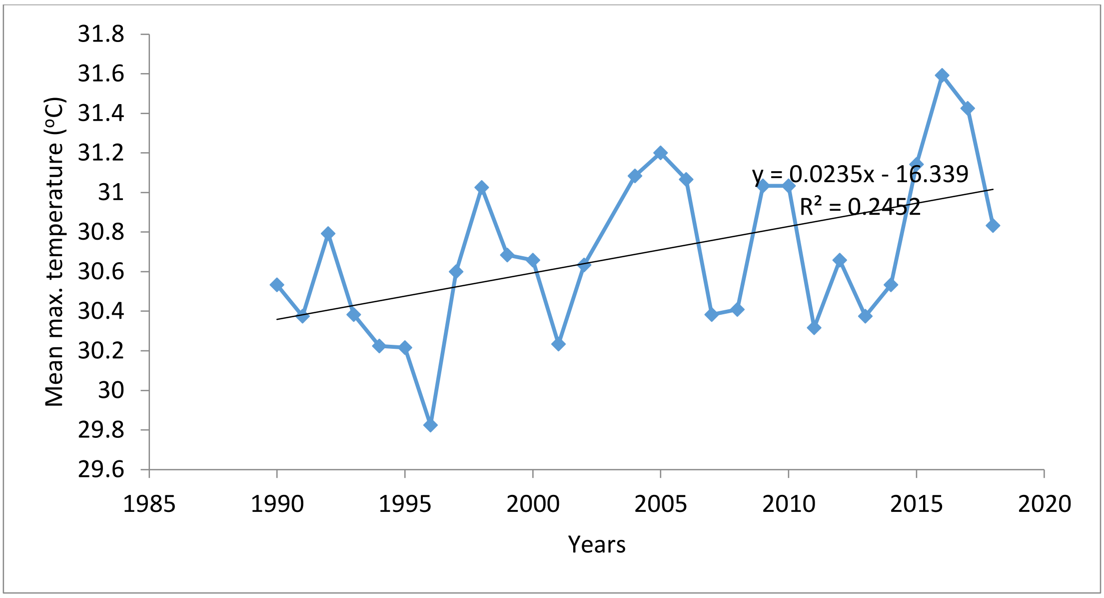

Figure 4. 7: Mean annual maximum Temperature variability for Ntoroko district from 1990 to 2018

As observed in figure 4.7, maximum temperature indicates an increasing fluctuating trend from 1990 to 2018. The trend revealed a positive slope value of 0.0532/year with a linear fitting coefficient R^2=0.2456. The highest temperature value of 31.1°C was recorded in 2016 and the lowest of 29.8°C in 1996.

Linear regression statistical results for mean annual maximum temperature from 1990 to 2018

Linear regression statistical analysis was run on mean maximum temperature and results are presented in Table 4.3.

Table 4. 3: Linear regression statistic results for mean annual maximum temperature from1990 to 2018

Variable	Regression Equation	R Squared	P-Value
Mean annual max. temp.	Y = 0.023X - 16.339	0.245	0.007

Significant at 0.01 and 0.05 probability level

The result of the Linear regression statistical test for maximum temperature (Table 4.3) reveals that the mean annual maximum temperature experienced a positive (an increasing) trend and the increase in average maximum temperature was not strong (R^2 <0.5) but statistically significant (P =0.007).

The significant increase in maximum temperature between 1990 and 2018 implies that the climate of Ntoroko District is taking a changing trend. The increase in temperature increases the risks of animal diseases because of certain species that survive as disease vector such as biting flies and ticks are more likely to survive in hotter environment. Therefore, the increase in temperatures potentially affects livestock farming that entirely depends on water and pasture in Ntoroko District.

Annual mean maximum temperature deviations from the long term mean (30.7°C) between 1990 and 2018

Results indicate that the deviations of annual rainfall amounts from the long-term mean (30.7°C) ranged from -0.8°C to1.1°C as illustrated in figure 4.8.

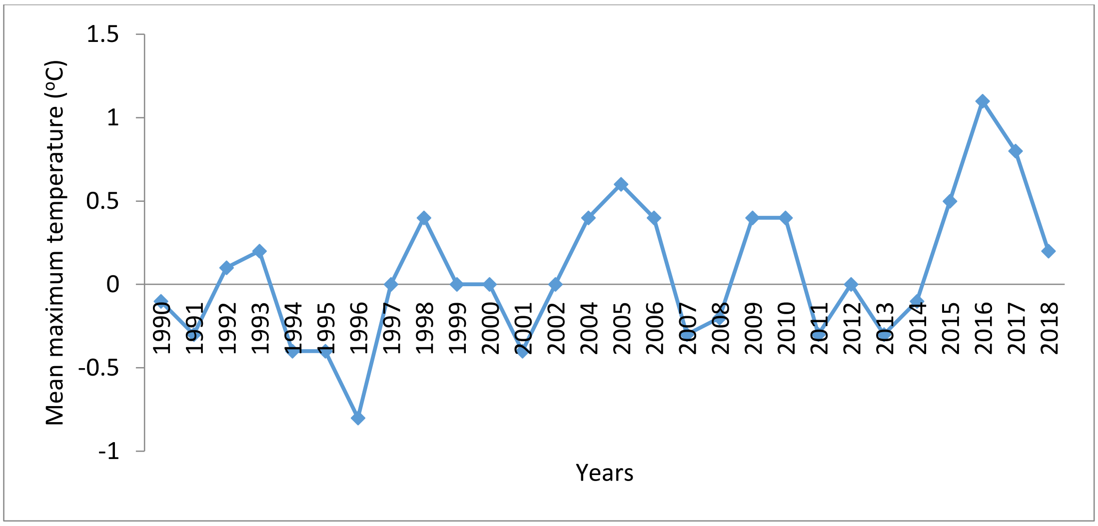

Figure 4. 8: Mean Annual maximum temperature deviations of Ntoroko District from the long term mean (70.7°C for the period 1990 2018

Figure 4.8 indicates that the mean annual temperature above the long-term mean was recorded in the years 1992, 1993, 1998, 2004, 2005, 2006, 2009, 2010, 2015, 2016, 2017, and 2018. The annual average maximum temperature that deviated far above the long-term mean was recorded in 2016 and 2017 with deviations of 1.1°C and 0.8°C respectively. The years whose average maximum temperature did not deviate from the long-term mean were 1997, 1999, 2000, and 2012. Figure 4.8 further indicates that the annual average maximum temperature that was below the long-term mean was observed in the years 1990, 1991, 1994, 1995, 1996, 2001, 2007 2008, 2011, 2013, and 2014. The annual average maximum temperature that deviated far below the long-term mean was recorded in 2012 with deviations of 0.8°C. This indicates that temperature is generally changing over time as shown by increased and decreased deviations from the normal mean.

4.1.5 Seasonal maximum temperature trends for Ntoroko district from 1990 to 2018

To analyze the seasonal maximum temperature trends, the calendar year was divided into four seasons of DJF, MAM, JJA, and SON for the period between 1990 and 2018. Findings are shown in figures 4.9 and 4.12.

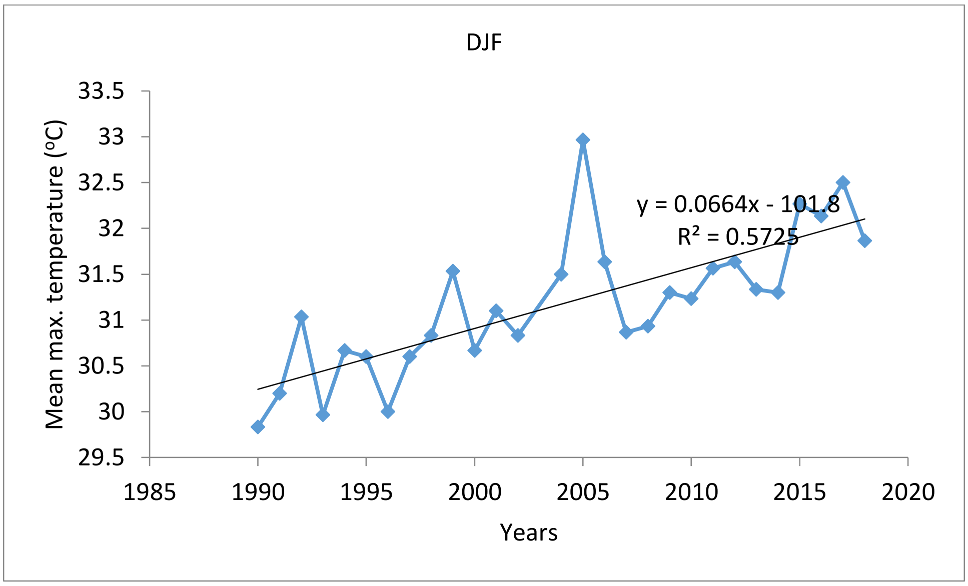

Figure 4. 9: DJF Seasonal maximum temperature trends for Ntoroko between 1990 and 2018

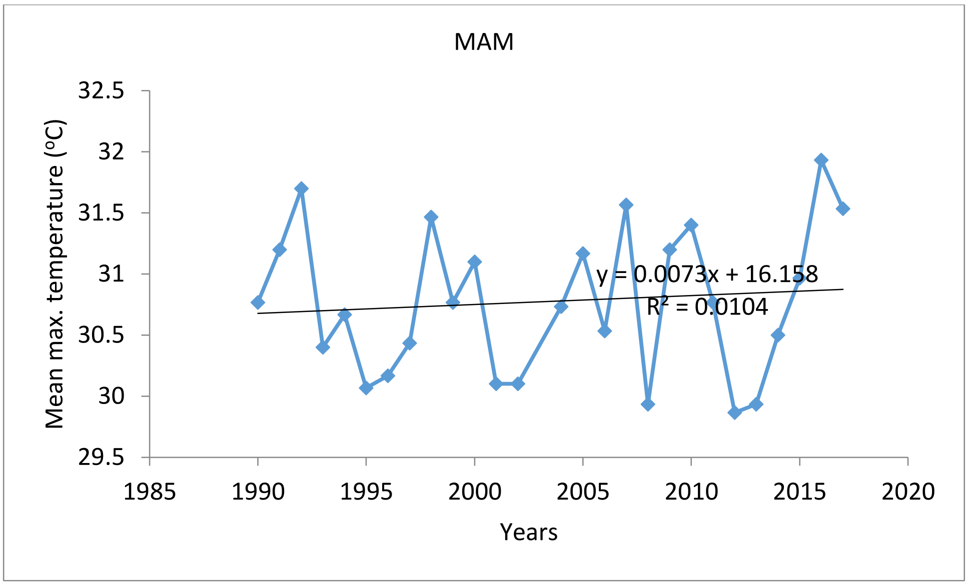

Figure 4. 10: MAM Seasonal maximum temperature trends for Ntoroko between 1990 and 2018

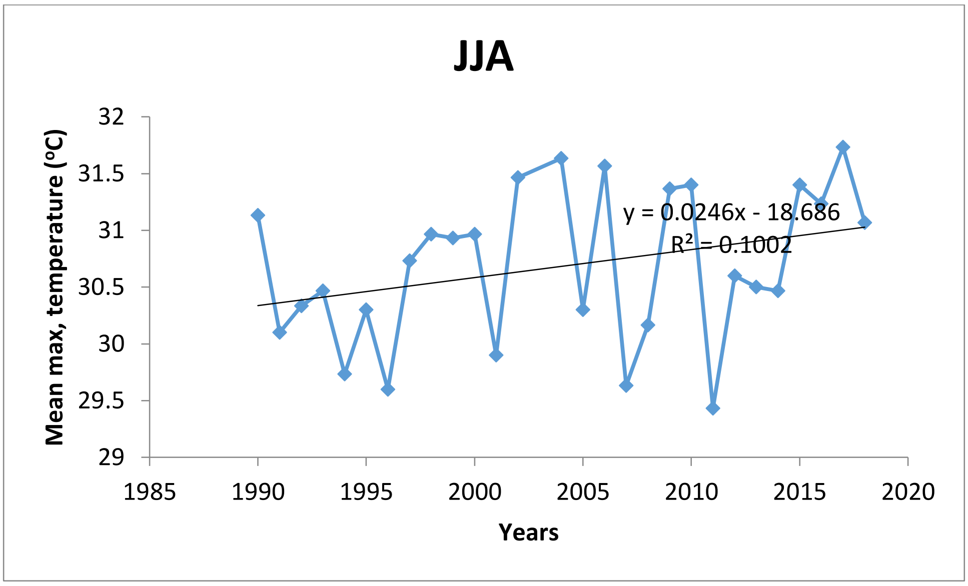

Figure 4. 11: MAM Seasonal maximum temperature trends for Ntoroko between 1990 and 2018

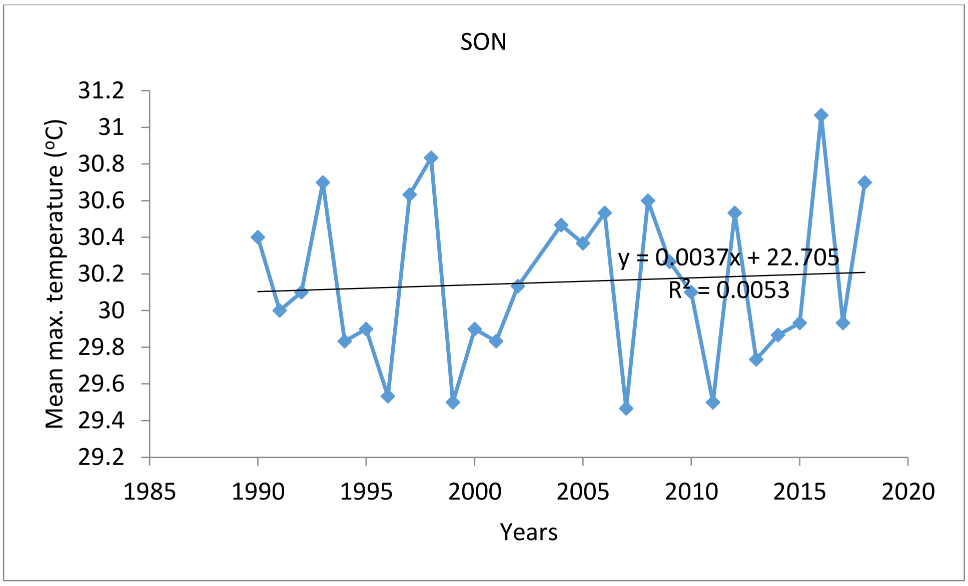

Figure 4. 12: MAM seasonal maximum temperature trends for Ntoroko between 1990 and 2018

The results for seasonal maximum temperature for Ntoroko between 1990 and 2018 indicate positive trends. Figure 4.9 to 4.12 indicates results of the D JF, MAM July JJA, and the SON seasons as recorded from the weather station. The DJF seasonal mean maximum temperature as presented in Figure 4.9 indicates the highest value of 32.5°C was observed in 2017 while the lowest value of 29.8°C was recorded in 1990. The trend has shown an increase with a positive slope value of 0.0664/year while the value of the fitting coefficient is R^2 =0.5868.

Figure 4.10 shows the observed MAM seasonal mean maximum temperature for Ntoroko from 1990-2018. The results indicate that the highest value of 31.9°C was recorded in 2016 and the lowest value of 29.7°C occurred in 2018. The trend in the MAM seasonal mean maximum temperature over the period indicates a slight increase in the slope with a positive value of 0.0073/year and a coefficient of R^2 = 0.0104. This is an indication of relatively low linear fitting but generally a slight increment with time.

The JJA seasonal mean maximum temperature as illustrated in Figure 4.11 indicate that Ntoroko had the highest temperature value of 31.7°C in 2017 and the lowest value of 29.4°C in 2015. The trend showed an increase with a slope value of 0.0246/year with a linear fitting coefficient R^2 = 0.1002.

Figure 4.12 shows the results of the SON seasonal mean maximum temperature for Ntoroko from 1990-2018. The graph displays the highest of 30.7°C that was observed in 2018 and the lowest of 29.9°C recorded in 1995, 2015, and 2017. The trend of seasonal mean maximum temperature showed an increase with a slope value of 0.0037/year and a fitting coefficient value of R^2 = 0.0053. As observed in figures 4.9-4.12, seasonal maximum temperatures have been fluctuating in an increasing trend from 1990 to 2018.

Linear regression statistical results for seasonal maximum temperature from1990 to 2018

The linear regression statistical analysis was run on mean seasonal temperature and the results are presented in table 4.4.

Table 4. 4: Linear regression statistic results for seasonal maximum temperature from 1990 to 2018 climatic periods

Season	**Regression Equation**	**R Squared**	**P-Value**
DJF	Y= 0.066X-101.796	0.5868	**0.000**
MAM	Y= 0.005X+22.705	0.006	0.953
JJA	Y= 0.025X-18.686	0.100	0.101
SON	Y= 0.011X+22.688	0.013	0.953

Significant at 0.01and 0.05 probability level

Findings of linear regression analysis as indicated in table 4.4 reveal that the DJF seasonal maximum temperature trends recorded an increase that was strong (R^2=0.5868) and statistically significant ($p<0.001$). Furthermore, MAM, JJA, and SON seasonal maximum temperature reveal increasing maximum temperature trends that were not strong and statistically insignificant as indicated in the table. This implies that the seasonal maximum temperature entirely increased between the years 1990-2018 in Ntoroko District.

The existence of a significant increase in DJF seasonal maximum temperature between 1990 and 2018 implies that climate change is taking place in Ntoroko District. As observed elsewhere, warming temperatures affect key sectors, especially the livestock production system which is the predominant land use activity in Ntoroko District. The findings of this study are therefore very crucial in planning adaptation options in response to the effects of increasing temperature concerning livestock farming.

4.1.6 Trends in Minimum Temperature Variability

Data on annual average minimum temperature for 29 years (1990-2018) for Ntoroko District was collected and analyzed. The results are presented in figure 4.13.

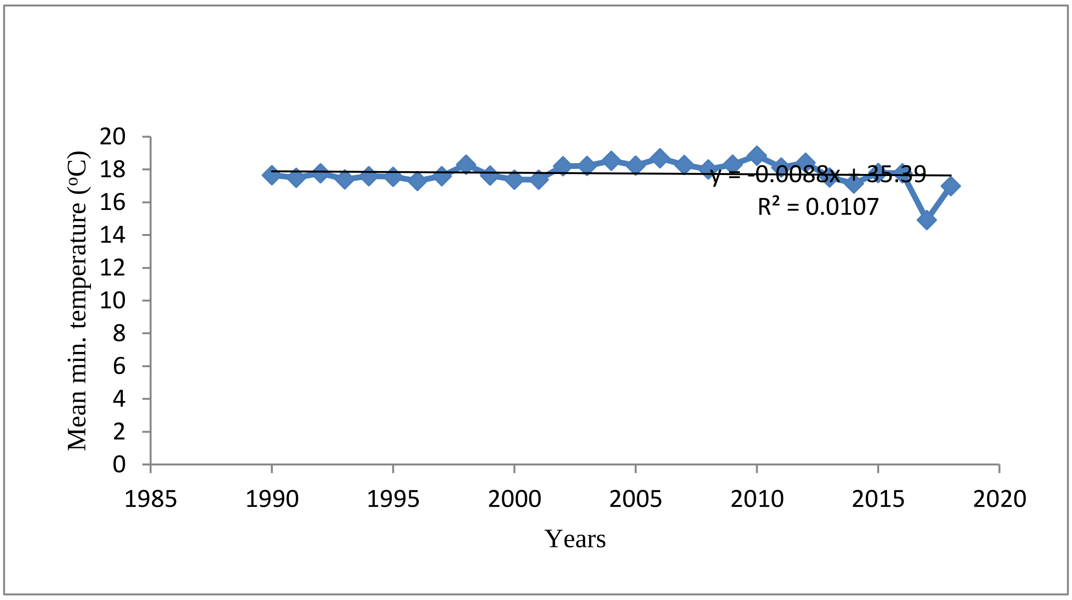

Figure 4. 13: Mean minimum temperature climatic periods from 1990 to 2018

Results in figure 4.13 illustrate that the mean annual minimum temperature between 1990 and 2018 exhibits a negative trend. The data indicates that the highest value of 18.9°C in mean annual minimum temperature was recorded in 2009 and the lowest of 14.9°C in 2017. The changes in the mean annual minimum temperature indicated a decrease in the slope with a negative value of -0.0088 and a coefficient value of R^2 =0.0107.

Linear regression statistical results for mean annual minimum temperature from 1990 to 2018

The linear regression analysis was run on the mean annual minimum temperature changes from 1990 to 2018. Results are shown in Table 4.5.

Table 4. 5: Linear regression statistic results for mean annual for minimum temperature from 1990 to 2018

Variable	Regression Equation	R Squared	P-Value
Mean Annual min. temp. (1990 to 2018)	Y = -0.0088X + 35.39	0.0107	0.593

Significant at 0.01and 0.05 probability level

Results in table 4.5 reveal that there was a negative (decreasing) trend in minimum temperature and that the decrease was not strong (R^2=0.0107), and statistically insignificant (P=0.593). This means that the annual minimum temperature did not portray evidence of climate change in Ntoroko District but only a varying progression.

4.1.7 Annual minimum temperature deviations from the long term mean (17.7°C) between 1990 and 2018

Results indicate that the deviations of annual minimum temperature from the long-term mean (17.7°C) ranged from -2.8°C to1.1°C as illustrated in figure 4.14.

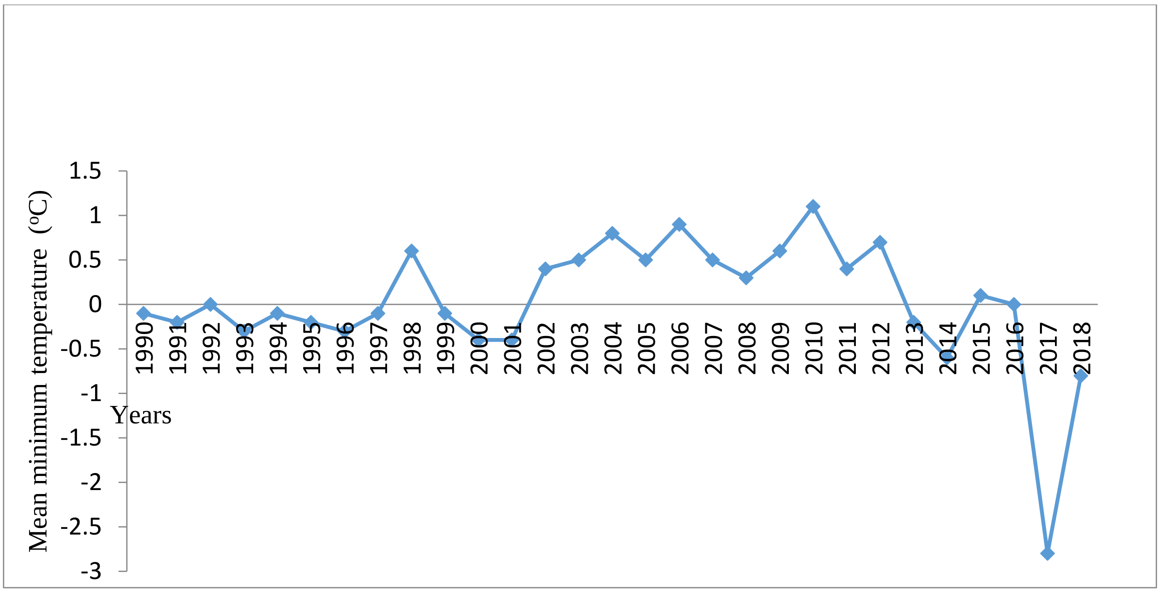

Figure 4. 14: Mean annual minimum temperature deviations from the long term mean (17.7oC) indicated as 0 in the figure for the period 1990 and 2018

Figure 4.14 indicates that the years that recorded average minimum temperature above the long-term mean were 1998, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2015. The annual average minimum temperature that deviated far above the long-term mean was recorded in 2010 with deviations of 1. 1°C, while the years that recorded minimum temperature that did not deviate from the long-term mean were 1992 and 1993 1994, 1995, 1996, 1997, and 2016. Figure 4.14 further shows the annual average temperature that was below the long-term mean was recorded in 1990, 1991, 1994, 1995, 1996, 1997, 1999, 2000, 2013, 2014, 2017, and 2018. The annual average minimum temperature that deviated far below the long-term mean was recorded in 2017 with a deviation of 2.8°C. This implies that minimum temperature was not constant for the period 1990-2018 but changed over time by both higher and lower deviations from the long-term mean.

4.1.8 Seasonal and monthly minimum temperature trends

Analysis of the seasonal minimum temperature trends was carried out and the calendar year was divided into four seasons that is, December to February (DJF), March to May (MAM), July to August (JJA), and September to November (SON) for the entire climatic period (1990 to 2018). Results are presented in figures 4.15 to 4.18.

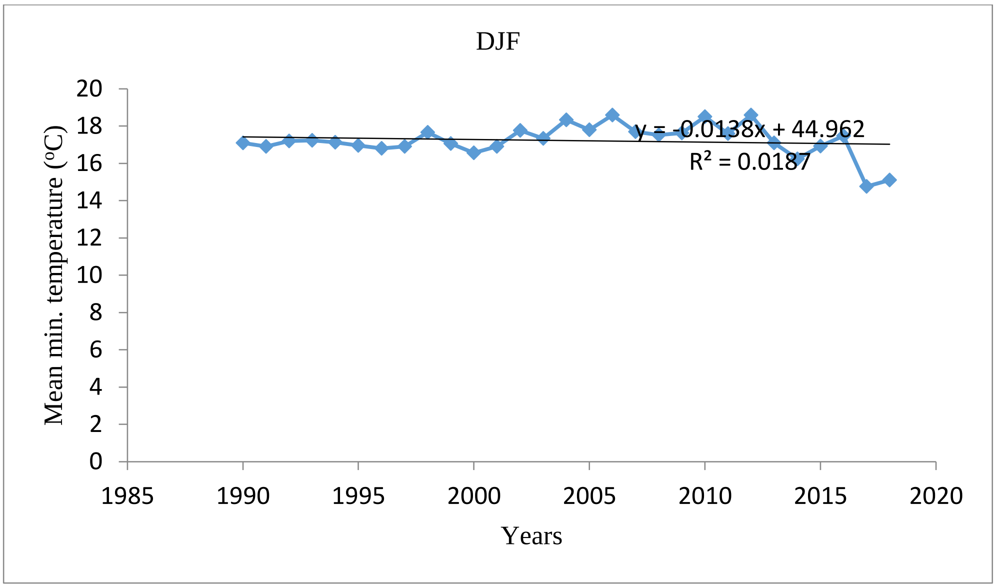

Figure 4. 15: DJF seasonal mean minimum temperature variations from 1990- 2018

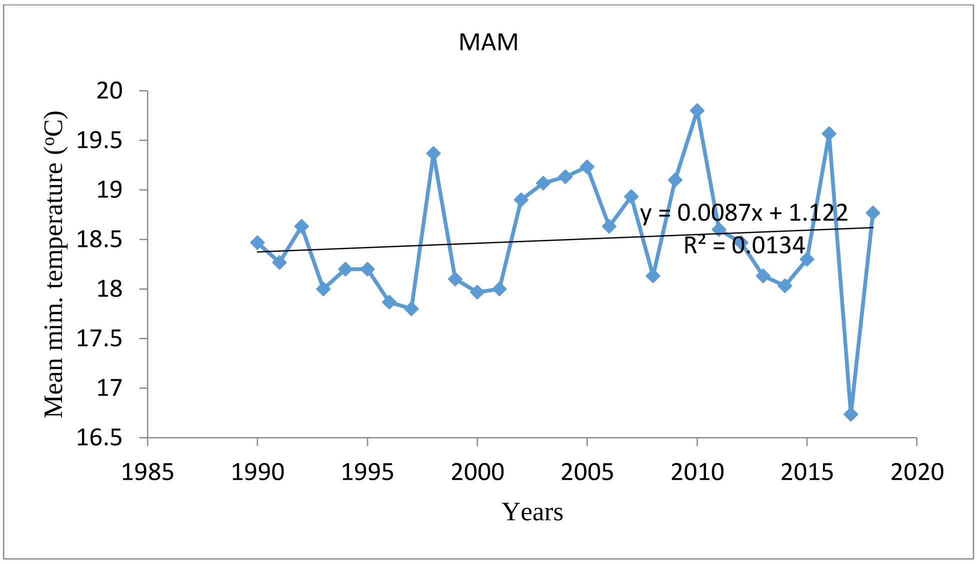

Figure 4. 16: MAM seasonal mean minimum temperature variations from 1990- 2018

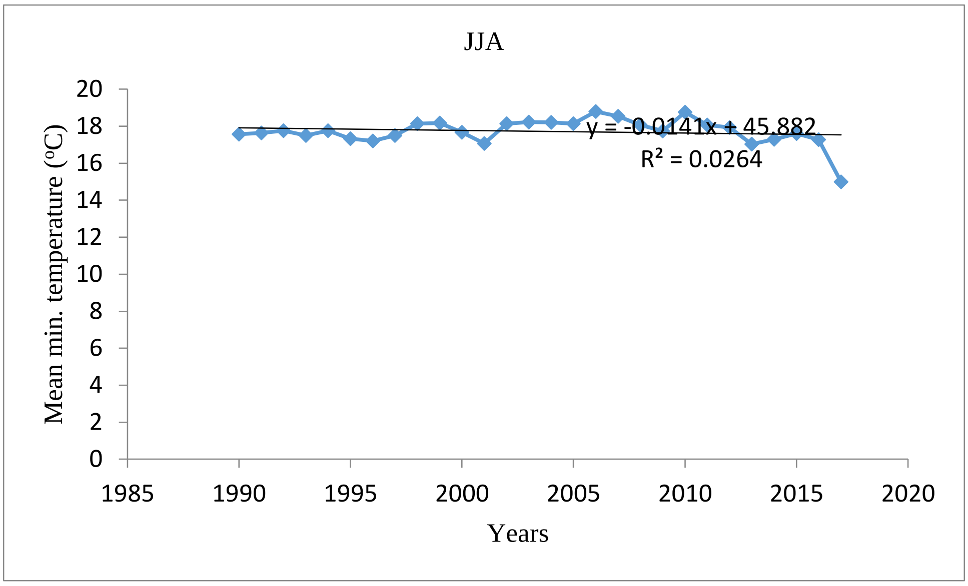

Figure 4. 17: JJA seasonal minimum temperature variations from 1990- 2018

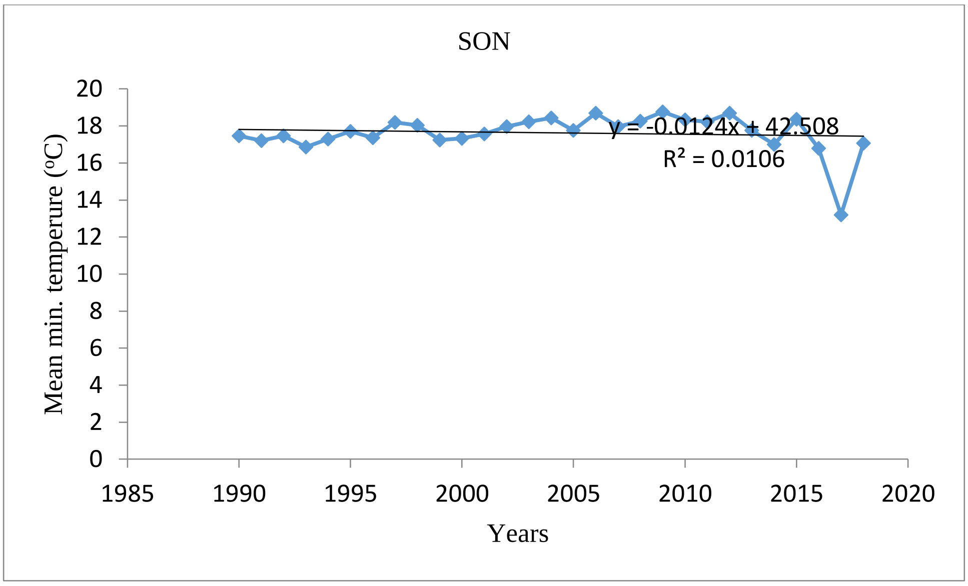

Figure 4. 18: SON seasonal mean minimum temperature variations from 1990- 2018

DJF, JJA, and SON seasonal minimum temperature for Ntoroko between 1990 and 2018 show negative trends with time while MAM exhibits positive trends as illustrated in figures 4.15 to 4.18.

The DJF seasonal mean minimum temperature between 1990 to 2018 as shown in Figure 4.15 illustrates that the highest value of 18.3°C was observed in 2004. The lowest value of 14.7°C was recorded in 2017. The trend indicated a decrease with a negative slope value of -0.0138 while the value of fitting coefficient R^2 =0.0187.

Figure 4.16 shows that MAM seasonal minimum temperature recorded the highest value of 19.5°C in 2016 while the lowest value of 16.7°C was recorded in 2017. The trend has shown an increase with a positive slope value of 0.0087 while the value of fitting coefficient R^2 =0.0134.

Figure 4.17 shows that JJA seasonal mean minimum temperature for Ntoroko from 1990-2018 was 18.7°C as the highest value recorded in 2010, while 15°C was the lowest value occurring in 2017. The Trend of changes in this season over the period indicates a decrease in the slope with a negative value of 0.00141 and a coefficient of R^2 = 0.0264.

Figure 4.18 shows the results of the SON seasonal mean minimum temperature for Ntoroko from 1990-2018. The plot shows that the highest of 18.7°C was observed in 2010 and the lowest of 13.2°C was recorded in 2017. The trend of seasonal mean minimum temperature showed a decrease with a slope value of -0.0124 and a fitting coefficient value of R^2 = 0.0106.

Table 4. 6: Linear regression statistic results for seasonal minimum temperature from 1990 to 2018

Season	**Regression Equation**	**R^2**	**P Value**
DJF	Y= -0.014X + 0.44.94.662	0.019	0.48
MAM	Y= 0.009X +1.122	0.013	0.55
JJA	Y= -0.018X + 54.969	0.044	0.27
SON	Y= -0.012X + 42.508	0.011	0.595

Significant at 0.01and 0.05 probability level

Table 4.6 indicated that the DJF, JJA, and SON seasonal minimum temperature trends recorded a decrease that was statistically insignificant at P>0.05. It was only the MAM season that reveals an increasing trend in seasonal maximum temperature. However, none of these seasons detected either a significant increase or decrease in minimum temperature. This implies that the study area experienced a slight change in seasonal minimum temperature trends between 1990 and 2018 in Ntoroko district.

4.2 Adaptation Practices to Climate Change used by Livestock Farmers in Ntoroko District

Respondents were asked if they had done anything to cope with the negative effects of climate change. Results in table 4.6 indicate that in the area of study all (351) respondents had undertaken several adaptation practices in response to climate change and each farmer was found using more than one practice. Adaptation practices reported having been adopted by livestock farmers across the study areas include stocking animal drugs as the most common with 95.7% followed by herd mobility with 68.3% and mixed animals rearing with 67.5%. Other adaptation practices are rearing the manageable number of animals with 56.4%, planting of trees with 30.7%, selling of animals during shocks with 23.9%, rainwater harvesting with 14.2%, and mixed cattle breeds with 13.9% as the least adaptation practices seen in Table 4.7. This means that farmers in the study area had advanced different adaptation practices to respond to the effects of climate change.

Table 4. 7: Climate Change Adaptation Practices used by Livestock Farmers in Ntoroko District (no = 351)

Adaptation practices	Frequency	% of response
Stocking of animal drugs	336	95.7
Herd mobility	240	68.3
Mixed animal rearing	237	67.5
Rearing manageable number of animals	198	56.4
Tree planting	108	30.7
Selling of animals during shocks	84	23.9
Rainwater harvesting	50	14.2
Rearing mixed cattle breeds	49	13.9

Source: field Data. Note that a farmer can adopt more than one adaptation practice.

4.2.1 Distribution of Climate Change Adaptation Practices

This section analyses the spatial distribution of adaptation practices in the study area.

Cross tabulation was run for the distribution of adopters in the different villages to determine the most dominant climate change adaptation practices in the area of study. The results are shown in Table 4.8.

Table 4. 8: Cross-tabulation of village and climate change adaptation practices

Name of village		Stocking of animal drugs	Tree planting	Rearing local cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals
Kibimbiri	Count	24	6	6	19	4	4	21	10
	%	80	20	20	63.3	13.3	13.3	70	33.3
Nyakabira	Count	26	24	8	25	7	9	21	15
	%	86.6	80	26.6	83.3	23.3	30	70	50
Rukora A	Count	28	5	0	30	8	20	30	30
	%	93.3	16.6	0	100	26.6	66.6	100	100
Rukora B	Count	29	11	7	30	9	13	30	29
	%	96.6	36.6	23.3	100	30	43.3	100	96.6
Majumbi 1	Count	30	4	2	23	3	6	26	20
	%	100	13.3	6.6	76.6	10	20	86.6	66.6
Majumbi 11	Count	25	12	2	20	6	6	21	20
	%	83.3	40	6.6	66.6	20	20	70	66.6
Ibale	Count	30	12	5	24	4	11	19	22
	%	100	40	16.6	80	13.3	36.6	63.3	73.3
Makondo	Count	27	3	1	12	2	1	11	7
	%	90	10	3.3	40	6.6	3.3	36.6	23.3
Kenyange	Count	30	16	5	13	3	5	14	12
	%	100	53.3	16.6	43.3	10	16.6	46.6	40
Kimara	Count	30	4	1	4	3	5	4	8
	%	100	13.3	3.3	13.3	10	16.6	13.3	26.6
Majojo	Count	30	5	2	10	0	0	9	8
	%	100	16.6	6.6	33.3	0	0	30	26.6
Makindo	Count	30	5	10	10	0	4	13	15
	%	100	16.6	33.3	62.5	0	13.3	43.3	50
Total	Count	336	107	49	237	50	84	240	199
	%	**95.7**	**30.7**	**13.9**	**67.5**	**14.2**	**23.7**	**68.3**	**56.4**

Source: field Data.

4.2.1.1 Stocking of Animal Drugs

The Findings in Table 4.8 indicate that stocking of animal drugs is the most dominant adaptation practice in Ntoroko with 95.7% out of 351 adapters and it is practiced in all sampled villages across the area of study. This practice dominates in Majumba I, Ibale, Kinyange, Kimara, Majojo, and Makindo villages by all adapters, followed by Rukora A with

96.6%, Rukora B with 93.3%, Makondo 90.0%, Nyakabira with 86.6%, and Majumbi II with 83.5%. The village with the least adapters is Kibiriri with 80.0%. However, the majority of the respondents reported that farmers' low-income levels, high prices of animal drugs and inaccessibility to formal credit facilities are the major limitation for this practice.

To establish whether stocking animal drugs was carried out in response to climate change, farmers were asked to state the reasons for stocking drugs, and the findings are shown in table 4.9.

Table 4. 9: Reasons for choosing to the stock of animal drugs

No	**Reason**	**Frequency**	**Percentage**
1	For regular spraying and treatment of animals to control pests ticks and tsetse flies, and diseases caused by high temperatures such as anthra	89	26.2
2	For proper maintenance of animal health during heavy rains	53	15.7
3	Reduces animal mortality rates during harsh climatic conditions	103	31.3
4	For quick animal maturity	70	20.8
5	Encouragement by animal health workers	21	6.2
	Total	**336**	**100**

Source: field Data.

Findings in Table 4.9 revealed that 73.2% of the respondents practice stocking animal drugs for climate change adaptation as seen in the reasons 1-3 as given in the table. On the other hand, reasons 4-5 representing 27.0% of the participants were not linked to climate change. Therefore, the responses choosing stocking animal drugs were greatly related to climate change meaning that the practice is done to adapt to climate change. To back up that claim, Plate1 indicates livestock farmers spraying animals in Nyakabira village, Bweramule Sub County.

Plate 4.1: Photograph showing farmers spraying animals in Nyakabira village, Bweramule Sub County

Source: field Data.

4.2.1.2 Herd Mobility

The Findings in Table 4.8 indicate that herd mobility is the second most dominant adaptation practice in Ntoroko with 68.3% out of 351 respondents and it is practiced in most of the sampled villages in the area of study. This practice dominates in Rukora A, and Rukora B with 100% adapters, followed by Majumbi I with 86.6% Majumbi II, Nyakabira, and Kibimbiri with 70%, Ibale 63.3%, Kenyange 46.6%, Makindo 43.3%, Makondo 36.6%, Majojo 30% and it is least done in Kimara with 13.3% of the adapters. Herd mobility includes seasonal movements of livestock farmers with their animals during drought periods that occur in January to March and June to August when water and pasture are scarce. Some farmers reported that they move with their animals to the Democratic Republic of Congo across River Semliki and others move to North Rwenzori Game Reserve to look for water and pasture.

Farmers who reported to have used this practice were revealed to have experienced low animal mortality rates during the dry seasons compared to those who do not practice it. However, it was found out that herd mobility is mostly practiced by male livestock farmers while female farmers are not able to move far away from their homes due to the domestic works that limit them from leaving their homes for some months. It was also revealed that conflicts overland due to increased human population and theft of the animals from the grazing area also other challenge for this practice.

To determine whether hard mobility was carried out to adapt to climate change, farmers were asked to give their views concerning herd mobility and the results are shown in Table 4.10

Table 4. 10: Reasons for choosing herd mobility

No	**Reason**	**Frequency**	**Percentage**
1	Search for water and pasture during the dry season	131	54.3
2	Move to free flood areas during heavy rains	42	17.5
3	Running away from misfortunes such as unexpected animals deaths caused by thunder lightning	34	14.2
4	Lack of enough land for grazing animals	33	13.8
	Total	**240**	**100**

Source: field Data.

From Table 4.10, it can be seen that 86.2% of the respondents represented by reasons 1-3 reported that they choose herd mobility due to climate-related risks; while only 13.8% representing reason No.4 did it for other reasons than adapting to climate change. This implies that herd mobility is widely practiced in response to climate change.

4.2.1.3 Mixed Animal Rearing

Mixed animal rearing was reported as the third most dominant climate change adaptation practice adopted by 67.5% of the participants (Table 4.8). Results reveal that mixed animal rearing dominates in Rukara A and Rukora B by all participants followed by Nyakabira with

83.3%, Iabale with 80%, Majumba I with 76.6%, Majumba II with 63.3%, Makindo with 62.5%, Kenyange with 43.3%, Majojo with 33.3% and Makondo with 30%. Mixed animal rearing is least practiced in Kimara with only 13.3%. Findings revealed that the animals reared that are mixed include cattle, goats, and sheep. The types of livestock kept mainly consist of local breeds such as small East Africa Zebu Cattle and Small East African Goats. However, majority of the respondents reported that land shortage is a major limiting factor for this practice. To ascertain whether mixed animal rearing is practiced in response to climate change, farmers were asked why they prefer the practice and the reasons are presented in table 4.11.

Table 4. 11: Reasons for choosing mixed animal rearing

No	Reasons	Frequency	Percentage
1	Goats and sheep are tolerant to high temperatures compared to cattle	92	38.8
2	Goat and sheep are tolerant to animal diseases caused by harsh climatic conditions compared to cattle	59	24.9
3	Low maintenance costs of goats and sheep during harsh climatic periods compared to cattle	24	10.1
4	Goats and sheep are easily compatible with money used to meet daily livelihood expenditure than cattle	47	19.9
5	Encouragement from friends	15	6.3
	Total	**237**	**100**

Source: field Data.

Table 4.11 indicates that mixed animal rearing was largely done to adapt to climate change. This was evidenced by the majority of the respondents (73.8%) who gave reasons 1-3 which were linked to climate change compared to 26.2% whose reasons (no. 4-5) were for other reasons which were not linked to climate change.

4.2.1.4 Rearing Manageable Number of Animals

Findings presented in table 4.8 reveal that rearing a manageable number of animals was practiced by 56.4% of the households. Results indicate that this practice dominates in Rukora

A village with all respondents, followed by Rukora B with 96.6%, Ibale with 73.3%, Majumbi I and Majubi II with 66.6%, Nyakabira and Makindo with 50%, Kenyange with 40%, Kabimbiri with 33.3%, Kimara and Majojo with 26.6%. Results further reveal that the practice is least done in Makondo with 23.3% of the respondents. Findings further show that this practice is increasingly adopted because livestock farmers are changing from communal land tenure to individual tenure system. It is increasingly becoming expensive and causing conflicts over grazing lands to those with large herds who go to graze in other people's lands, especially during drought periods when pasture and water become scarce.

To establish whether rearing a manageable number of animals is practiced in response to climate change, livestock farmers were asked why they take up this practice, and their views are presented in Table 4.12

Table 4. 12: Reasons for choosing the manageable number of animals

No	Reasons	Frequency	Percentage
1	To avoid high expenses incurred in maintaining animals health during the harsh climatic condition	82	41.2
2	Lack of enough land for grazing animals	71	35.7
3	Encouragement from animal health workers	46	23.1
	Total	**199**	**100**

Source: Field Data.

Findings in Table 4.12 indicate that 76.9% of the respondents adopt rearing a manageable number of animals due to in response to climate change. This is presented by reasons 1-2 given by the respondents. However, only 23.1% of the respondents carry out the practice due to other factors other than adapting to a varying climate. Therefore, it was concluded that rearing of a manageable number of animals is to largely adopt in response to climate change in Ntoroko District.

4.2.1.5 Tree Planting

Table 4.8 revealed that tree planting was practice by 30.7% of the livestock farmers. The practice most dominates in Nyakabira with 80%, Kenyange with 53.3%, majubi and Ibale 40%, and Rukora B with 36.6%. Tree planting was also practiced in Kibimbiri with 20%, Rukora A and Majojo with 16.6%, Majumbi I and Kimara with 13.3%, and it is least done in Makondo with 10% of the adapters. Through field observation, it was found out that the most common types of tree species planted and maintained were the acacia and sliver fan palm trees (see plate 4.2).

However, the majority of the respondents revealed that the major problems hindering the progress of tree planting are bush burning and overgrazing. During drought periods, bush burning is a rampant practice that destroys the planted trees. Overgrazing also destroys the ruminant trees that would have survived bush fires. Short periods between droughts that do not allow tree growth recovery and inaccessibility to tree seedling by farmers were other limiting factors reported to hinder this practice. All these factors discourage the farmers to fully engage in this adaptation practice with multiple advantages such as the provision of livestock shade, soil conservation, and biodiversity.

To find out whether the choice of tree planting was made in response to a changing climate, the participants were asked to give their views concerning the practice and the result is indicated in table 4.13.

Table 4. 13: Reasons for choosing tree planting

No	Reasons	Frequency	Percentage
1	Provision of shade to animals during the dry season	63	58.3
2	For wind-breaking	22	20.4
3	Provision of firewood	15	13.9
4	Provision of sap to make alcohol	8	7.4
	Total	**108**	**100**

Source: field Data.

Table 4.13 reveals that reasons 1-2 representing 78.7% of the participants indicate that tree planting was practiced due to climate-related while 21.3% of the participant gave reasons which were not climate change-related as shown in reasons 3- 4. The researcher, therefore, concludes that tree planting is largely done to adapt to climate change in Ntoroko District.

Plate 4.2: Photographs showing Silver fan palm trees in Kenyange village, Butugama Sub County

Source: field Data.

4.2.1.6 Selling of Animals or Marketing during Shocks

The Findings in Table 4.8 reveal that selling of animals or marketing during shocks was reported to have been adopted by only 23.9% of adapters. It was most dominant in Rukora A village with 66.6%, Rukora B with 43.3% of the adapters, Ibale with 36.6%, Nyakabira with 30%, Majumbi I and Majumbi II with 20% Kenyange and Kimara with 16.6%, Makindo with

13.3% and least done in Makondo village with 3.3%. It was not practiced in Majojo village. However, the respondents reported that the major challenge for this practice is that the animals fetch low prices during extreme weather events. Thus farmers prefer to participate in the normal time market.

To find out whether the practice is done to cope with climate change, the respondents were asked the reasons why they sell their animals during harsh climatic conditions and the results are presented in Table 4.14.

Table 4. 14: Reasons for choosing selling of animals during shocks

No	Reasons	Frequency	Percentage
1	Weak animals are sold because they cannot survive dry seasons	30	35.8
2	To avoid heavy animal loss caused by heat stress	37	44
3	To reduce the number of animals to remain with the manageable numbers during dry seasons	17	20.2
	Total	**84**	**100**

Source: field Data.

Results in table 4.14 indicate that all the reasons (1-3) reported by the respondents are linked to climate. This implies that the adoption of selling animals during climatic shocks is an adaptation to climate change though few farmers practice it.

4.2.1.7 Rain Water Harvesting

This practice involves the use of metallic and plastic water tanks that are installed on iron sheet roofed houses to collect rainwater (see plate 4.3). Table 4.8 indicates that 14.2% of respondents practiced rainwater harvesting. This adaptation practice is dominant in Rukora B, Rukora A, and Nyakabira with 30%, 26%, and 23.3% respectively. This is followed by majumbi II with 20% Kibimbiri and Ibale with 13.3%, and it is least done in Majumbi I, Kenyange, and Kimara villages with 10% of the respondents in each of these villages. Rainwater harvesting is not done in Majojo and Makindo villages. However, findings revealed that this practice is limited by low levels of farmers' incomes and lack of water harvesting equipment. Through field observation, it was found out that most farmers still live in grass-thatched houses that cannot enable them to harvest rainwater. To find out whether water harvesting is done to cope with a changing climate, livestock farmers were asked the reasons for choosing this practice and the reasons are presented in table 4.15.

Table 4. 15: Reasons for choosing rainwater harvesting

No	Reasons	Frequency	Percentage
1	Provision of water to animals during the dry season	31	62
2	Reduce the burden of carrying water from a long distance for domestic use.	7	14
3	Provision of water for domestic use	12	24
	Total	**50**	**100**

Source: field Data.

Table 4.15 reveals that 62% of the respondents representing reason No.1 practiced rainwater harvesting for climate-related reasons, while 38% of the respondents representing reasons 2-3 were not climate-related. This implies that rainwater harvesting is done in response to climate change in Ntoroko District. Plate 4.3 shows a rainwater harvesting plastic tank in Kibimbiri village, Bweramule Sub County.

Plate 4.3: Photograph showing rainwater harvesting plastic tank in Kibimbiri village, Bweramule Sub County

Source: field Data.

4.2.1.8 Rearing of Mixed Cattle Breeds

As observed in table 4.8 rearing of mixed cattle breeds was the least adopted climate change adaptation practiced by only 13.9% of respondents. The practice was found dominating in Makindo Village with 33.3%, followed by Nyakabira with 26.6%, Rukora B with 23.3%, Kibimbiri 20.0%, Ibale with 16.6%, Kenyange with 16.6% Majumbi I, Majumbi II, and Majojo with 6.6% in each of these villages, and it was least done in Kakondo and Kimera with 3.3% in each village. To ascertain whether rearing of mixed cattle breeds is practiced as an adaptation to climate change, livestock farmers were asked the reasons for choosing this practice and several reasons were reported as presented in table 4.16.

Table 4. 16: Reasons for rearing mixed cattle breeds

	Reasons	**Frequency**	**Percentage**
1	Local cattle breeds are more resistant to harsh climatic conditions than crossbreds	7	14.3
2	Local cattle breeds are more resistant to animal pests and diseases caused by weather changes.	6	12.2
3	local cattle breeds can walk a long distance in search of water and pasture compared to Crossbreds	20	40.8
4	Cross cattle breeds are kept for high meat and milk production	8	16.4
5	Cross cattle breeds were supplied by the government under wealth creation	5	10.2
6	Cross cattle breeds mature faster than the local breeds	3	6.1
	Total	**49**	**100**

Source: Field Data.

From table 4.16 it can be noted that 67.3% of the participants keep local cattle breeds to respond to climate change as revealed in reasons 1-3 given by the respondents. Only 32.7% keep cross cattle breeds due to factors other than climate change as indicated in reasons 4-6. Therefore, it was concluded that rearing mixed cattle breeds is largely practiced to adapt to climate change in Ntoroko District.

4.3 The Factors Influencing the Livestock Farmers' Choice of Different Adaptations to Climate Change

This section discusses the factors that influencing livestock farmers' choice of multiple adaptation practices in response to climate change in Ntoroko District. In this study, factors that were analyzed include land ownership, income levels, farming experience, education status, and membership to the social group, access to credit, access to extension services, access to information on climate change, and access to training on climate change adaptation as presented in the following subsections.

4.3.1. Access to Credit

Access to credit facilities was assumed to influence livestock farmer's choice of adaptations to climate change. Data collected on this variable was analyzed and the results are presented in tables 4.17.

Table 4. 17: Do you Have access to credit?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	46	13.0	13.0	13.0
	No	305	87.0	87.0	100.0
	Total	351	100.0	100.0	

Source: Field Data.

Findings in Table 4.17 reveal that most farmers did not have access to credit services to aid in adaptations to climate change as 87.0% of respondents who had no access to credit services had reported. Only a small number of 13.0% of the respondents reported that they had received credits to aid their adaptation practices. This implies that most farmers are not benefiting from credit facilities and this has a negative impact on their adaptation practices. To establish whether access to credit facilities motivates livestock farmers to adopt various adaptations to climate change further analysis was conducted and the findings are presented in table 4.18.

Table 4. 18: Relationship between access to credit and farmers' adoption of adaptation practices (no =351)

Access credit		Adaptation practices								
		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number	10	03	10	0	12	0	06	05	46
	%	21.7	6.5	21.7	0	26.1	0	13.0	11.0	100.0
No	Number	122	0	0	80	0	14	92	0	308
	%	39.8	0.0	0.0	25.9	0.0	4.5	29.8	0.0	100.0
Total	Number	130	03	10	80	12	14	98	05	351
	%	37.5	0.8	2.8	22.5	3.4	3.9	27.6	1.4	100.0

Source: Field Data.

As observed in table 4.18, 21.7% out of 46 respondents who have access to credit, practice stocking of animals drugs. 6.5% plant trees, 21.7% practice mixed cattle breeds, 11.0% practice rearing the manageable number of animals, 26.1% practice rainwater harvesting, and 13.0% practice herd mobility. On the other hand, findings show that farmers who had access to credit did not practice selling animals during shocks and mixed animal rearing. This means that access to credit does not affect the adoption of the two adaptation practices above. The findings further show that 39.8% out of 309 respondents who have no access to credit, adopted stocking of animal drugs; 25.9% practiced mixed animal rearing, and 4.5% adopted selling of animal during shocks while none of the adopters who have no access to credit services practiced tree planting, rearing mixed cattle breeds, rearing the manageable number of animals, and rainwater harvesting. However, though the number of those who had access to credit was small, the results in table 4.17 show that those who accessed credit facilities adopted more than those who did not. It was therefore concluded that access to credit influenced the choice of adaptations to climate change.

4.3.2 Membership to Social Group

Membership to the social group was another variable that was assumed to influence the choice of climate change adaptation practices. Data collected on this variable was analyzed and the results are presented in Table 4.19.

Table 4. 19: Do you belong to any social group?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	28	7.9	7.9	7.9
	No	323	92.1	92.1	100.0
	Total	351	100.0	100.0	

Source: Field Data.

The findings shown in table 4.19 indicate that majority of the respondents representing 92.1% did not belong to any social group. Only 7.9% had belonged to social groups such as Livestock Farmers' Association, Savings and Credits Associations, and Women Groups Associations. This implies that social grouping is not a common practice among the livestock farmers in Ntoroko District. To examine whether membership to social group influences the choice of adaptations to climate change, data collected on this variable was further analyzed and the results are presented in Table 4.20.

Table 4. 20: Relationship between membership to the social group and farmers' adoption of adaptation practices (no =351)

Membership to the social group		Stocking animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number %	10 35.7	0 0.0	06 21.4	04 14.3	03 10.7	02 7.1	03 10.7	0 0.0	28 100
No	Number %	157 48.0	12 3.7	38 11.6	5 1.5	0 0.0	0 0.0	115 35.2	0 0.0	323 100
Total	Number %	166 47.0	12 3.4	44 12.4	09 2.5	03 0.8	02 0.6	118 33.2	0 0.0	351 100

As observes in table 4.20 findings indicate that 35.7% out of 28 respondents who belong to social groups practice stocking of animal drugs, 21.4% practice mixed cattle breeds, 14.3% practice mixed animal rearing, 10.7% practiced rainwater harvesting, 7.1% practiced selling of animal during shocks, and 10.7% practice herd mobility. On the other hand, findings show that farmers who belong to social groups did not practice tree planting and rearing the manageable number of animals in response to climate change. This implies that membership in the social group does not influence these adaptation practices. The findings further show that 47.0% out of 327 respondents who did not belong to any social group adopted stocking of animal drugs, 3.7%, tree planting, 11.6% mixed cattle breeds, 1.5% mixed animal rearing, and 35.2% adopted herd mobility. While none of the adopters who did not belong to social groups practiced selling animals during shocks, having a manageable number of animals, and rainwater harvesting. However, though the number of those who belong to social groups was small, the results in table 4.20 show that respondents who belong to social groups adopted varied practices more than those who did not. This implies that membership in a social group influences the choice of adaptations to climate change.

4.3.3 Households' Education Status

The education status of the household of a livestock farmer was another variable that was expected to influence livestock stock farmer's choice of adaptations to climate change. This study categorized education as not educated, and educated, whereby the respondents who were under the category of not educated were those who had primary seven and below, and those who were above primary seven were considered as educated. The data collected on this factor was analyzed and the results are presented in Table 4.21.

Table 4. 21: Education status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not education	219	62.8	62.8	62.8
	Educated	132	37.2	37.2	100.0
	Total	351	100.0	100.0	

Source: Field Data.

Results presented in table 4.21 indicate that the respondents who were not educated formed 62.8% while those who were educated formed 37.2%. This implies that livestock farmers who were not educated dominated the study area. The analysis of the data collected on the education status of the participants was done to find out whether the education status of a household livestock farmer influences the choice of various adaptations to climate change and the results are presented in Table 4.22.

Table 4. 22: Relationship between education status and farmers' adoption of adaptation practices

(no =351)

Education status		Stocking animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Not educated	Number	60	34	18	32	20	4	33	22	223
	%	26.9	15.5	8.1	14.3	9.0	1.8	14.8	9.6	100
Educated	Number	63	10	06	12	03	0	06	32	132
	%	47.7	7.6	4.5	9.1	2.3	0.0	4.5	24.2	100
Total	Number	120	43	24	34	23	4	39	54	351
	%	38.0	12.4	6.8	9.6	6.5	1.1	11	15.2	100

As observed in Table 4.22, 26.9% out 223 respondents who have not been educated practice stocking of animal drugs. 15.5% plant trees, 8.1% practice mixed cattle breeds, 9.6% practice rearing the manageable number of animals, 9.0% rainwater harvesting, 14.8% practice herd mobility, 1.8% selling of animals during shocks, and 14.3% mixed animal rearing. The findings further show that 47.7% out of 132 respondents who are educated adopted stocking of animal drugs, 9.1% practiced mixed animal rearing, 7.6% practiced tree planting, 4.5% rearing mixed cattle breeds, 24.2% rearing the manageable number of animals, 2.3% rainwater harvesting, and 24.2% practiced selling of animal during shocks. It was further revealed that, none of the respondents who are educated practiced selling animals during shocks. Results presented in the table show that both educated livestock farmers and those who are not educated adopted varied adaptation practices in response to climate change. This implies that the education status of a livestock farmer has no much influence on the choice of adaptations to climate change in Ntoroko District.

4.3.4 Land Ownership

Land ownership was another factor that was thought to influence the choice of adaptations to climate change. Data collected on this factor was analyzed and the results are presented in Table 4.23.

Table 4. 23: Do you own land?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	333	94.9	94.9	94.9
	No	18	5.1	5.1	100.0
	Total	351	100.0	100.0	

The findings shown in Table 4.23 indicate that 94.9% out of 351 respondents owned land while only 5.1% did not own land. This implies that the majority of the livestock farmers representing 94.9% own land in Ntoroko District. To examine whether land ownership influences the choice of adaptations to climate change, data collected on this factor was further analyzed and the results are presented in Table 4.24.

Table 4. 24: Relationship between land ownership and farmers' adoption of adaptation practices (no =351)

Land ownership		Stocking animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number %	81 24.0	108 32.0	14 4.2	35 10.4	33 9.8	0 0.0	47 14.0	19 5.6	337 100
No	Number %	08 44.4	0 0.0	0 0.0	0 0.0	0 0.0	02 11.1	6 33.3	02 11.1	18 100
Total	Number %	86 25.1	107 30.4	14 4.0	35 9.9	33 9.2	02 0.6	53 14.9	21 5.9	351 100

Findings observed in table 4.24 indicate that 24.0% out 337 respondents who own land practiced stocking of animal drugs, 32.0% practiced tree planting, 4.2% practiced mixed cattle breeds, 10.4% practiced mixed animal rearing, 9.8% rainwater harvesting, 14.0% practiced herd mobility and 5.6% adopted rearing the manageable number of animals. On the other hand, findings show that farmers who own land did not practice selling animals during shocks in response to climate change. This means that land ownership does not influence this adaptation practice. The findings further show that 44.4% out of 18 respondents who did not own land adopted stocking of animal drugs, 11.1% selling of animal during shocks, 33.3% adopted herd mobility and 11.1% adopted rearing manageable number of animals, while none of the adopters who do not own land practiced tree planting, mixed cattle breeds, mixed animal and rainwater harvesting. Results in table 4.24 indicate that farmers who own land adopted varied practices more than those who did not. This implies that land ownership influences the choice of adaptations to climate change in Ntoroko District.

4.3.5 Monthly Income Levels

To examine the influence of income on the choice of adaptation practices, the data collected on the monthly incomes of the respondents were analyzed and the results are presented in Table 4.25.

Table 4. 25: How much money on average do you earn in a month in Uganda shillings?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 100000	31	8.7	8.7	8.7
	100000-300000	144	40.8	40.8	49.6
	300001-500000	166	47.6	47.6	97.2
	Above 500000	10	2.8	2.8	100.0
	Total	351	100.0	100.0	

Source: Field Data.

As observed in Table 4.25, 8.7% of the respondents reported that they earned a monthly income of less than 100,000/=, those who earned 100000-300000/= were 40.8%, next was

47.6% respondents who earn 300,001-500,000/= while 2.8% of the respondents reported that they earn more than 500,000/= per month. This implies that 50.4% of the respondents earned a monthly income of 300,001/= and above. Farmers were asked about the sources of income they use to finance adaptation practices and the results revealed that the major source of livestock farmers' income is the selling of animal products such as milk, cheese, and animals themselves. This was reported by 93.5% while only 6.5% of the participants reported that their income is got from other sources such as fishing and papyrus products. This implies that there are few income-generating activities as evidenced by 93.5% of the respondents whose major source of income is the selling of animal products in Ntoroko District. To ascertain whether farmers' income influences the choice of adaptations to climate change, further analysis was done and the results were presented in table 4.26.

Table 4. 26: Relationship between monthly income and farmers’ adoption of adaptation practices

(no =351)

Monthly income		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Below 100000	Number	13	0	10	0	0	0	06	2	31
	%	41.9	0.0	32.2	0.0	0.0	0.0	19.4	6.5	100.0
100000-300000	Number	47	04	0	0	0	10	39	45	145
	%	32.4	2.7	0.0	0.0	0.0	6.8	26.8	14.8	100.0
300001-500000	Number	50	12	10	19	17	0	28	33	169
	%	42.8	0.0	5.9	11.2	10.1	0.0	16.6	19.5	100.0
Above 500000	Number	2	1	1	1	0	1	2	2	10
	%	20.0	10.0	1.0	10.0	0.0	10.0	20.0	20.0	100.0
Total	Number	112	17 6	21 10	20 44	17 17	11 10	73 86	80 36	351
	%	31.5	4.8	5.9	5.6	4.8	3.1	21.1	23.2	100.0

As observed in Table 4.26, 41.9% out of 31 respondents whose monthly income was below 100,000/= practiced stocking of animal drugs. 32.2% practiced mixed animal rearing, 19.4%

practiced herd mobility and 5.6% adopted rearing the manageable number of animals to respond to climate change while none of the respondents whose monthly income was below 100,000/= practiced tree planting, mixed cattle breeds, mixed animal rearing, rainwater harvesting and selling of animal during shocks. Results in table 4:24 further show that 32.4% of respondents whose monthly income was 100,000-300,000/= practiced stocking of animal drugs. 2.7% adopted tree planting, 16.5% mixed animal rearing, 6.8% selling animals during shocks, 26.8% herd mobility 14.8% adopted rearing the manageable number of animals while none of the farmers whose monthly income was 100,000-300,000= adopted mixed cattle breeds and rainwater harvesting. Further analysis shows that 42.8% of respondents with monthly income between 300,001 and 500,000= practiced stocking of animal drugs. 5.9% practiced mixed cattle breeds11.2% mixed animal rearing, 10.1% rainwater harvesting, 6.8% selling animals during shocks, 16.6% herd mobility, and19.5% adopted rearing the manageable number of animals while none of the respondents who earned 300,001-500,000/= practiced tree planting, rearing mixed cattle breeds and selling animals during shocks. On the other hand, 20.0% of the respondents whose monthly income was above 500,000/= adopted stocking of animal drugs, herd mobility, and rearing the manageable number of animals, while 10.0% plant trees, mixed animal rearing, rearing mixed cattle breeds, and selling animals during shocks. On the other hand, none of the participants whose monthly income level was above 500,000/= adopted rainwater harvesting. It can be observed that the livestock farmers who earn a monthly income of 300,000/= and above were found adopting varied adaptation practices more than those who earn less than that, implying that higher-income earners adopted more than lower-income earners. This means that high-income levels greatly motivate the farmers to adopt multiple adaptations to climate change in Ntoroko District. It is therefore recommended that livestock farmers should be encouraged to engage themselves in diversified income-generating activities in addition to livestock farming to improve their income levels hence enhancing adaptability to climate change.

4.3.6 Farming Experience

This variable was expected to influence the choice of different adaptations to climate change among the livestock farmers in Ntoroko District. The data collected on farming experience was analyzed and the results are presented in tables 4.27.

Table 4. 27: How long have you been a livestock farmer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 10 years	12	3.4	3.4	3.4
	10-20 years	78	22.5	22.5	25.9
	20-30 years	170	48.5	48.5	74.4
	30 Years and above	91	25.6	25.6	100.0
	Total	351	100.0	100.0	

Source: Field Data.

Findings in Table 4.27 reveals that only 3.4% had been livestock farmers for less than 10 years. 22.5% had between farmers for 10-19 years, 48.5% respondents had been livestock farmers for 20-30 years, and 25.6% had been livestock for farmers more than 30 years and above, this implies that a big number (74.1%) have been livestock farmers for more than 20 years implying that they had enough experience in livestock farming. To examine whether farming experience influences adaptation choices to climate change, the data collected on this factor was further analyzed and the results are presented in Table 4.28.

Table 4. 28: Relationship between farming experience and farmers' adoption of adaptation practices

(no =351)

Farming experience		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
below 10 Years	Number	07	0	0	0	0	0	05	0	12
	%	58.3	0.0	0.0	0.0	0.0	0.0	41.7	0.0	100.0
10-20 Years	Number	22	14	0	15	0	0	20	09	80
	%	27.5	17.5	0.0	18.8	0.0	0.0	25.0	11.2	100.0
20-30 Years	Number	55	46	0	31	13	0	27	0	172
	%	32.0	26.7	0.0	18.0	7.6	0.0	15.7	0.0	100.0
above 30 Years	Number	36	12	10	17	07	0	09	0	91
	%	39.6	13.2	11.0	18.7	7.6	0.0	9.9	0.0	100.0
Total	Number	120	72	10	60	20	0	56	09	351
	%	33.8	20.6	2.5	17.8	5.6	0.0	17.2	2.5	100.0

Findings in Table 4.28 indicate that 58.3% out of 12 respondents whose farming experience was below 10 years practiced stocking animal drugs. 41.7% adopted herd mobility while none of the respondents whose farming experience was below 10 years practiced tree planting, mixed cattle breeds, mixed animal rearing, rearing the manageable number of animals, rainwater harvesting, and selling of animals during shocks. Results in the table further show that 27.5% of respondents with farming experience of 10-20 years adopted stocking of animal drugs, 18.8% mixed animal rearing, 11.2% rearing the manageable number of animals while none of them adopted rearing mixed cattle breeds selling animals during shocks, and rainwater harvesting.

Additionally, 32.0% of respondents with 20-30 years of livestock farming experience practiced stocking of animal drugs, 13.2% plant trees, 18.0% mixed animal rearing, 7.6% rainwater harvesting, 11.2% practiced rearing the manageable number of animals, while 15.7% practiced herd mobility. On the other hand, none of the participants whose farming experience was 20-30 years practiced rearing mixed cattle breeds and selling animals during harsh climatic conditions. Results in Table 4.28 further indicate that 39.6% of participants with 30 years and above of farming experience adopted stocking of animal drugs. 26.7% plant trees, 18.7% mixed animal rearing, 7.6%, rainwater harvesting, and 9.9% practiced herd mobility; on the other hand, none of the respondents whose farming experience was 30 years and above adopted selling of animals and rearing the manageable number of animals. It can be observed that the livestock farmers whose farming experience was 10 years and above adopted varied adaptation practices more than those with fewer years implying that more years in livestock farming influences the adoption of multiple adaptations to climate change in Ntoroko District. This is attributed to the fact that a farmer with many years in livestock farming is expected to acquire more competence in weather forecasting. This helps to increase the likelihood of practicing different adaptations to climate change.

4.3.7 Access to Agricultural Extensional Services

Access to extension services was expected to influence the choice of different adaptations to climate change among the livestock farmers in Ntoroko District. The data collected on accessibility to extension services were analyzed and the results are presented in Table 4.29.

Table 4. 29: Do you receive agricultural extension services?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	16.9	16.9	16.9
	No	294	83.1	83.1	100.0
	Total	351	100.0	100.0	

Source: Field Data.

Table 4.29 shows that out of the 351 respondents only 16.9% were found to be accessing agricultural extension services while 83.1% had no access to agricultural extension services. This implies that a large number of the farmers have no access to extension services.

Respondents who have access to extension services reported that these services are provided by sub-county extension workers and veterinary workers in form of supply of animals drugs for treating the sick animals, and encouragement to keep drought resistant animals breeds. Further analysis of this variable was carried out to ascertain whether access to extension services influences the choice of adaptations to climate change and the results are presented in Table 4.30.

Table 4.30: Relationship between access to extension services and farmers' adoption of adaptation practices (no =351)

Access to extension services		Adaptation practices								
		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number	14	12	0	16	11	0	0	7	60
	%	23.3	20.1	0.0	26.6	18.3	0.0	0.0	11.7	100.0
No	Number	142	0	0	37	0	0	110	0	291
	%	49.8	0.0	0.0	12.8	0.0	0.0	37.4	0.0	100.0
Total	Number	160	12	4	53	11	0	110	7	351
	%	45.1	3.3	1.1	14.9	3.1	0.0	30.1	2.0	100.0

Source: Field Data

As observed in table 4.30 results show that 23.3% out of 60 respondents who have access to extension services practice stocking of animal drugs, 20.1% plant trees,18.3% adopted rainwater harvesting, and 26.6% practice mixed animal rearing in response to climate change. On the other hand, findings show that farmers who had access to extension services did not practice selling animals during shocks, herd mobility, and rearing the manageable number of animals. This implies that access to extension services does not influence these adaptation practices. The findings further show that 49.8% out of 295 respondents who have no access to extension services adopted stocking of animal drugs. 12.8% adopted mixed animal rearing, and 37.4% adopted herd mobility, while none of the adopters who have no access to extension services practiced tree planting, selling of animals during shocks, rearing mixed cattle breeds, rearing the manageable number of animals, and rainwater harvesting. However, though the number of those who had access to extension services was small, the results in table 4.30 show that those who accessed extension services adopted varied practices more than those who did not. This implies that access to extension services influences the choice of adaptations to climate change. Therefore, efforts should focus on increasing accessibility to extension services to enhance adaptability to climate change among the livestock farmers in Ntoroko District.

4.3.8 Access to Information on Climate Change

This variable represents sources of information required to decide to choose particular adaptation practices in response to climate change such as TVs, radios, magazines, newspapers, and development agents among others. An individual exposed to climate information is more likely to take immediate action to cope with risks related to climate change. Data collected on access to information on climate change was analyzed and the results are presented in tables 4.31.

Table 4. 31: Do you Have access to information on climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	157	44.3	93.0	93.0
	No	192	55.7	7.0	100.0
	Total	351	100.0	100.0	

Source: Field Data.

As observed in table 4.31**,** 44.3% of the respondents reported that they had access to information on weather and climate update. 55.7% reported having no access to weather and climate updates apart from their observations. This means that knowledge and information on weather and climate are very low. This also implies that limited knowledge on weather and climate has contributed to most livestock farmers relying on their own experience and local knowledge in response to climate change. Farmers who are access to information were however asked to state the sources in which they get information on weather and climate updates and the results were presented in table 4.32.

Table 4. 32: What is the source of information on weather and climate updates?

Response	Frequency	Percent
Local Councils	39	24.8
Religious Institutions	16	10.3
NGOs	19	12.1
Farmer groups	33	21.0
Radio Programs	66	42.0
Total	**157**	**100.0**

Source: Field Data.

As presented in table 4.32, 42% of the participants got their updates from radio programs. Those who got information from farming groups were 21.0%, while those whose source of information was from local councils were 24.8%, those from religious institutions were 10.3%, and those from NGOs were 12.1%. This means that radio programs with 42% are the major source of information on climate and weather updates followed by local councils with 24.8%. To examine the influence of access to information on the choice of adaptation practices, further analysis was conducted and the results are presented in Table 4.33.

Table 4. 33: Relationship between access to information on climate change and farmers' adoption of adaptation practices (no =351)

Access to information on climate change		Adaptation practices								
		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number	49	23	05	35	12	14	19	0	157
	%	31.0	14.6	3.0	22.9	7.6	8.9	12.0	0.0	100.0
No	Number	89	0	0	0	0	0	107	0	196
	%	45.1	0.0	0.0	0.0	00.0	0.0	54.9	0.0	100.0
Total	Number	138	23	05	35	12	14	126	0	351
	%	38.9	6.5	1.4	9.9	3.4	3.9	35.5	0.0	100.0

Source: Field Data

As shown in table 4.33, 31.0% out of 157 respondents who have access to information on climate change, practice stocking animal drugs. 14.6% plant trees, 3.0% practice mixed cattle breeds, 22.9% practice mixed animal rearing, 7.6% rainwater harvesting, 8.9% selling of animals during shocks, while 12.0% practice herd mobility. On the other hand, findings show that farmers who had access to information did not practice rearing the manageable number of animals. This means that access to information on climate change does not influence this adaptation practice. The findings further show that 45.1% out of 196 respondents who have no access to information on climate change adopted stocking of animal drugs. 54.9% practiced herd mobility, while none of the adopters who have no access to extension services practiced tree planting, selling of animals during shocks, rearing mixed cattle breeds, mixed animal rearing, rearing the manageable number of animals, and rainwater harvesting. However, though the number of those who had access to information on climate change was small, the results in table 4.33 show that those who accessed information on climate change adopted more than those who did not. This implies that access to information on climate change influences the choice of adaptations to climate change. It is therefore concluded that access to information greatly influences the application of different adaptations to climate change. In line with this, therefore, the government should use various communication channels to convey information on climate change such as mobile phones, radio, TVs, bulletins, farmer-participatory climate workshops, and create climate information centers to increase accessibility to information that can help to enhance livestock farmers' resilience to the climate in Ntoroko District.

4.3.9 Accessibility to Training on Climate Change Adaptations

Accessibility to training on climate change adaptation was assumed to influence livestock farmer's choice of adaptations to climate change. Data collected on this variable was analyzed and the results are presented in Table 4.34.

Table 4. 34: Have you ever had training on adaptation to climate change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	31	9.9	9.9	9.9
	No	320	90.1	90.1	100.0
	Total	351	100.0	100.0	

Source: Field Data.

The findings presented in table 4.34 show that only 9.9% of the respondents had received training on adaptation to climate change. The remaining 90.1% of the respondents reported having never received any training on climate change. This implies that a large number of livestock farmers have no access to training on adaptation to climate change. To determine whether training on climate change adaption influence the choice of adaptations, data was further analyzed and the findings are presented in Table 4.35.

Table 4. 35: Relationship between access to training on climate change and farmers' adoption of adaptation practices (no =351)

Access to training on climate change adaptation		Adaptation practices								
		Stocking of animal drugs	Tree planting	Rearing mixed cattle breeds	Mixed animal rearing	Rainwater harvesting	Selling of animals during shocks	Herd mobility	Rearing manageable number of animals	Total
Yes	Number	08	3	04	05	02	03	06	04	35
	%	22.9	8.6	11.4	14.3	5.7	8.6	17.1	11.4	100.0
No	Number	143	34	0	79	0	0	60	0	316
	%	44.7	10.6	0.0	24.6	0.0	0.0	20.0	0.0	100.0
Total	Number	151	37	04	84	02	03	70	04	351
	%	42.5	10.4	1.1	23.7	0.6	0.8	19.7	1.1	100.0

Source: Field Data.

As observed in Table 4.35, 22.9% out of 35 respondents who have access to training on climate change practice stocking of animal drugs, 8.6% plant trees, 11.4% practice mixed cattle breeds, 11.4% practice rearing the manageable number of animals, 5.7% rainwater harvesting, 8.6% selling of animal during shocks, 14.3% mixed animal rearing and 17.1% practice herd mobility. This implies that access to training on climate change adaptation influences the adoption of different adaptations to climate change. On the other hand, findings further show that 44.7% out of 320 respondents who have no access to training adopted stocking of animal drugs, 10.6% practiced tree planting, 24.6% practiced mixed animal rearing, 4.5% adopted selling of animals during shocks and 20.0% herd mobility. However, none of the adopters who have no access to training practiced selling animals during shocks, rearing mixed cattle breeds, rearing the manageable number of animals, and rainwater harvesting. More so, although the number of those who had access to training on climate change was small, the results in Table 4.35 show that those who accessed training on climate change adopted more than those who did not. It was therefore concluded that access to training influences the choice of adaptations to climate change. The researcher, therefore, recommends that climate change experts should be employed to train farmers on more sustainable adaptation practices to climate change in Ntoroko District.

4.4 Multivariate Regression Model for Factors Influencing the Choice of Adaptations to Climate Change

To determine the most significant factors influencing the choice of adaptations to climate change among the livestock farmers, a Multivariate regression model was used. The results are presented in Table 4.36.

Table 4. 36: Results of Multivariate Regression Model for factors influencing the choice of adaptations to climate change

Factors influencing the choice of adaptations	**Adaptation practices**															
	Tree planting		**Mixed animal rearing**		**Rainwater harvesting**		**Selling animals during shocks**		**Herd mobility**		**Stocking animal drugs**		**Rearing manageable number of animal**		**Mixed cattle breeds**	
	Coeff	P value	Coeff	P value	Coeff	P value	Coeff	P value	Coeff	P value	Coeff	P value	Coeff	P value	Coeff	P value
Education status	-0.002	0.928	0.021	0.461	0.003	0.893	-0.031	0.222	-0.012	0.675	-0.015	0.217	-0.077	**0.008*** **	-0.047	**0.018** **
Land ownership	-0.053	0.581	0.085	0.382	0.018	0.806	-0.060	0.493	-0.068	0.483	0.030	0.482	0.014	0.890	-0.049	0.484
Monthly income	0.023	0.526	0.012	0.757	0.374	**0.047***	-0.026	0.447	0.057	0.125	0.004	**0.003** **	0.108	**0.006*** **	0.019	**0.032***
Farming experience	0.059	0.072	0.001	0.970	0.034	0.158	0.049	0.100	-0.010	0.774	-0.003	0.815	-0.003	0.931	0.066	**0.006** **
Membership to social group	-0.011	0.903	0.406	**0.023***	0.007	0.924	0.008	0.921	0.024	0.801	0.028	**0.041***	-0.129	0.189	0.134	**0.027***
Access to extension services	-0.030	0.644	0.018	0.794	-0.214	0.770	-0.070	0.250	0.043	0.525	0.550	0.064	0.033	0.634	0.006	0.907
Access to training	0.045	0.597	0.560	**0.005** **	0.048	**0.019***	0.021	0.795	0.042	0.630	0.055	**0.039***	0.098	**0.021***	0.105	**0.044***
Access to information on climate change	0.151	**0.002** **	0.167	**0.041***	0.121	**0.024***	-0.047	0.606	-0.053	0.595	0.004	**0.031***	-0.090	0.389	0.009	**0.001** **
Access tocredit	0.079	0.300	0.191	**0.015** **	0.034	**0.043***	-0.119	**0.030***	0.158	0.143	0.009	0.784	0.021	0.792	-0.146	**0.009** **

***, * = significant at 1 and 5% probability level*

*Likelihood Ratio =0.001***   Number of observations = 351   Prob Chi Square 0.0107***

Table 4.36 shows that the LR chi-square and Prob > Chi-Square were used to determine whether this model was the most suitable. As observed, the LR chi-square = 0.001 and prob Chi-Square = 0.0107 were all significant, an indication that it was the best model for this study.

This study assumed that access to training on climate change adaptation has a positive and significant influence on the choice of particular adaptation practices used by livestock farmers to adapt to climate change. The model results in table 4.36 show that access to training on adaptation to climate change positively and significantly influences the choice of having mixed animals raring (p = 0.005), rainwater harvesting (p = 0.019), stocking animal drugs (p = 0.039), mixed cattle breeds (p = 0.044) and rearing the manageable number of animals (p = 0.051). The findings further reveal a positive but insignificant influence on tree planting, selling animals during shocks, and herd mobility. The positive coefficient values associated with this factor imply that access to training on climate change adaptation increases the probabilities of adapting to climate change. The largest influence of training on climate change was on the adapting of mixed animal rearing with the coefficient value of 0.560 implying that training increases the odds of adopting mixed animal rearing by 5.6%, keeping other factors constant.

The study further reveals that monthly income has a positive significant influence on the adoption of stocking of animal drugs (p = 0.003) rearing a manageable number of animals (p = 0.006) mixed animal rearing (p = 0.032) and rainwater harvesting (p = 0.047). The results further revealed a positive but insignificant influence on herd mobility, mixed cattle breeds, tree planting, and mixed animal rearing. The positive coefficient values associated with this factor imply that monthly income increases the likelihood of adapting to climate change. The largest influence of monthly income was on the adoption of rainwater harvesting with the coefficient of 0.374 means that a unit increase in the farmer’s income increases the odds of adopting rainwater harvesting by 37.4 %, keeping other factors constant. On other hand, monthly income reveals a negative and insignificant influence on the choice of adopting selling animals during shocks meaning that monthly income has no relationship with this adaptation practice.

The results shown in Table 4.36 further indicated that access to information on climate change positively and significantly influences the choice of tree planting (P = 0.002), rainwater harvesting (P = 0.024), stocking of animal drugs (P = 0.031), and mixed animal rearing (P = 0.041). Further analysis revealed that this fact positively but insignificantly influences the choice of mixed cattle breeds and herd mobility. The positive coefficient values associated with this factor imply that access to information on climate change increases the likelihood of adapting to climate change. The largest influence of access to information on climate change was on the adoption of mixed animal rearing with the coefficient of the value of 0.167 meaning that access to extension services increases the odds of adopting stocking of animal drugs by 16.7%, considering other factors constant. On the other hand, access to information on climate change has a negative but insignificant influence on the choice of selling animals during shocks and rearing the manageable number of animals. The negative coefficients mean that information on climate change decreases the likelihood of adaptation to climate change considering other factors constant.

The model reveals that membership to social groups positively influences the choice of adopting mixed animal rearing (p = 0.023), stocking of animal drugs (p = 0.041), and mixed cattle breeds (p = 0.048). The results further revealed that this factor has a positive but insignificant influence on the choice of selling animals during shocks, rainwater harvesting, and herd mobility. The positive coefficient values associated with this factor imply that membership to a social group increases the likelihood of adapting to climate change while the negative coefficient means that membership to a social group decreases the likelihood of adaptation. The largest influence of membership to the social group was on adoption of mixed animal rearing with the coefficient of value 0.406 implying that being a member of a socio group increases the odds of adopting mixed animal rearing by 40.6%, considering other factors constant. Further analysis indicated that membership to a social group has a negative and insignificant influence on the practice of tree planting and rearing a manageable number of animals.

Access to credit was presumed to influence livestock farmers' choice of particular adaptation practices to climate change. This is because access to credits provides various opportunities to finance adaptation options. The results in the table show that access to credit has a positive and significant influence on the choice of mixed animal rearing ($p = 0.015$) and rainwater harvesting ($p = 0.043$). The result further indicates that this factor has a positive but insignificant influence on stocking of animal drugs, rearing the manageable number of animals, tree planting, and herd mobility. The greatest influence of access to credit was on mixed animal rearing with the coefficient value of 0.191 implying that an increase in access to credit increases the odds of mixed animal rearing by 19.1% considering other factors constant. Access to credit on the other hand reveals a negative but significant influence on the choice of mixed cattle breeds ($p = 0.009$) and selling of animals during shocks ($p = 0.030$).

Furthermore, the results in the table indicate that farming experience positively and significantly affects the choice of only mixed cattle breeds ($p = 0.006$). The model further reveals that the farming experience has a positive but insignificant influence on the choice of rainwater harvesting, selling animals during shocks, tree planting, and mixed animal rearing. The largest influence of farming experience was on the adoption of mixed cattle breeds with the coefficient value of 0.066 means that an increase in farming experience increases the odds of adopting herd mobility by 6.6%, considering other factors constant. On the other hand, farming experience has a negative but insignificant influence on herd mobility, rearing the manageable number of animals, and stocking of the animal.

Access to agricultural extensional services as shown in table 4.36 did not reveal any significant influence on the adoption of any adaptation practice. This could be due to limited agricultural extensional services offered by extension workers. However, the model revealed that access to agricultural extensional services has a positive but insignificant influence on the choice of stocking of animal drugs, mixed cattle breeds, mixed animal rearing, herd mobility, and rearing the manageable number of animals. The largest influence of access to extension services was on the adoption of stocking of animal drugs with the coefficient value of 0.550 meaning that access to extension services increases the odds of adopting stocking of animal drugs by 55%, considering other factors constant. It was further revealed that access to agricultural extensional services has a negative influence on tree planting, rainwater harvesting, and selling animals during shocks. The positive coefficient values associated with this factor imply that access to extension services increases the likelihood of adapting to climate change while the negative coefficient means that access to extension services decreases the likelihood of adaptation

Landownership was assumed to have a significant influence on the choice of particular adaptation practices. The model reveals that Land ownership did not significantly influence farmers' choice of any climate change adaptation. However, results reveal that Land ownership has a positive but insignificant influence on the adoption of mixed animal rearing ($p = 0.382$), stocking animal drugs ($p = 0.482$), rainwater harvesting ($p = 0.806$), and rearing the manageable number of animals ($p = 0.890$). On the other hand, Land ownership reveals a negative insignificant influence on the choice of adopting tree planting, selling animals during shocks, herd mobility, and mixed cattle breeds. The positive coefficient values associated with this factor imply that monthly income increases the likelihood of adapting to climate change and vice versa. The largest influence of Land size was on the adoption of mixed animal rearing with the coefficient of 0.085 implying that a unit increase in the land size increases the odds of adopting rainwater harvesting by 8.5%, keeping other factors constant.

Although education was presumed to have a strong effect on the choice of particular adaptation practices, results reveal that education status has a negative significant influence on rearing the manageable number of animals ($p = 0.008$) and mixed cattle breeds ($p = 0.018$). The model also reveals that education status negatively but insignificantly influences tree planting, herd mobility selling animals during shocks, and stocking animal drugs. Education status was on the other hand found positive but insignificant on the choice of mixed animal rearing and rainwater harvesting. Therefore, the hypothesis that the "level of education of the household head rather than income level does not significantly influence adaptation to climate change among the livestock farmers" was accepted.

In conclusion, the most significant factors that were found to have a positive and significant influence on the livestock farmers' choice of most adaptations to climate change in Ntoroko District include; access to training on climate change, income levels, access to information on climate change, membership to the social group, and access to credit facilities. On the other hand, farming experience and land ownership revealed a positive but insignificant influence on the farmers' choice of most adaptation options to climate change whereas education status has a negative significant influence on the choice of most adaptations to climate change. Therefore, it was recommended that the emphasis should focus on the most significant factors in designing adaptation practices to climate change in Ntoroko District.

CHAPTER FIVE

DISCUSSION OF THE RESULTS

5.0 Introduction

This chapter discusses and presents the findings of the study. It presents a discussion of findings on trends in climate variability, adaptation practices to climate change, and the factors influencing livestock farmers' adaptations to climate change.

5.1 Trends in Climate Variability

5.1.1 Rainfall Variability

The trend in mean annual rainfall amounts for Ntoroko District portrayed a decrease for the period 1988 to 2018. The mean rainfall amounts fluctuated from 95.8mm to 43.8mm averaging 70.7mm. A statistical analysis found out that the decrease was not significant implying that the area is presently experiencing more varying rainfall than a change. Generally, the area receives a sufficient mean annual rainfall amount of over 70mm that can sustain livestock farming. The findings of the study conform to ACCRA's (2010) report on climate trends in Uganda that revealed high annual rainfall variability in Bundibugyo and Gulu Districts between 1972 and 2015. Similar findings were reported by previous studies conducted by Omondi (2014) in North-Western Kenya, George (2013) in Paicho Sub County, Gulu District who concluded that rainfall is highly characterized by variability with insignificant change.

The analysis of seasonal rainfall results presented a decreasing rainfall trend for March-May rainy season, while the September to November rainy season experienced an increasing trend for the period 1988-2018. Results of statistical analysis revealed a decrease in rainfall for the MAM season that was not significant while the increase in rainfall for the SON season was significant. It was also revealed that Ntoroko experiences two rainfall seasons that occur in

March to May as the short rainy seasons with 94.8mm average rainfall, and a long rainy season experienced in September to November with 102 mm recorded between 1988 to 2018. The findings of this study were in line with findings by Omondi (2014) who established that in the semi-arid land of Kenya more reliable rainfall is received in September to December compared to the March to May rainy season.

On the other hand, December to February, and June to August are dry seasons with high rainfall variability. These seasons recorded below normal average rainfall of 39.9mm and 46.8mm respectively between 1988 and 2018. Statistical analysis reveals that the DJF season experienced a negative (decreasing) rainfall trend that was significant, while the JJA season revealed an insignificant increasing trend. Therefore, this rainfall shortage supplemented with high maximum temperature has led to lack of water and pasture, animal pests, and diseases, and ultimately leads to high animal mortality rates that occur in dry seasons of every year as most respondents reported it across the area of study.

5.1.2 Temperature Variability

The analysis of the mean annual maximum temperature for Ntoroko District between 1990 and 2018 indicated a statistically significant increasing trend. In terms of seasonal maximum temperature trends, results revealed that the DJF recorded an increase that was strong and statistically significant. MAM, JJA, and SON revealed increasing trends that were not strong and were statistically insignificant. This denotes that there was an overall increase in seasonal maximum temperature in Ntoroko District between 1990 and 2018. The presence of a significant increase in mean maximum temperature, and the DJF season in the study period, indicates the occurrence of climate change in Ntoroko District. The findings of this study agree with the findings by IPCC (2007) which observed that temperature has shown a greater warming trend in Africa since the 1960s.

The annual minimum temperature results reveal a decreasing trend for the period 1990 to 2018 for Ntoroko District that was statistically insignificant. This means that the annual minimum temperature did not depict the proof of climate change but fluctuating progression in Ntoroko District for the study period. Seasonal results revealed that DJF, JJA, and SON minimum temperatures for Ntoroko between 1990 and 2018 exhibit decreasing trends with time, while MAM exhibits positive trends. However, none of these was statistically significant. These findings are in contrast with Bernbabuccier et, al., (2013) in Ethiopia who observed a slight increase in minimum temperature than maximum temperature between 1961 and 2000. These findings are also in disagreement with Omondi (2014) who observed a significant rise of 0.2^{o}C in minimum temperature between 1979 and 2012 in North-Eastern Kenya.

5.2 Climate Change Adaptation Practices

The data collected presented that stocking of animal drugs was the most dominant adaptation practice to climate change adopted by livestock farmers in Ntoroko District. Most of the respondents reported having preferred this practice as an adaptation to climate change largely for regular spraying and treatment of animals to control pests and diseases caused by high temperatures. Others reported that animal drugs are stocked for maintaining animal health during heavy rains, while others indicated that stocking animal drugs helps to reduce animal mortality rates during harsh climatic conditions.

Herd mobility was reported as the second most dominant climate change adaptation practice used by livestock farmers. Hard mobility involves the movement of livestock farmers with their animals to various places during the dry season in the search for water and pasture. The livestock farmers who had used herd mobility reported that they moved with their animals during the dry season in the search for water and pasture; while others indicated that they moved with their animals during heavy rains to escape floods. These findings agree with

Dadi (2007) who revealed that livestock farmers in the highlands of Ethiopia migrate a couple of times in a year in search of pasture for their animals. Whereas they may be having permanent farms in some places, they move their families and their livestock to other areas in some months of the year, and then come back several months later.

Mixed animal rearing was reported as the third most dominant climate change adaptation practice adopted by livestock farmers in Ntoroko District. Findings show that the mixed animals reared include cattle, goats, and sheep. The types of livestock kept mainly consist of local breeds such as small East African zebu cattle and small East African goats. Most livestock farmers choose to practice mixed animal rearing especially goats and sheep for being tolerant to high temperatures compared to cattle. Others reported that the practice was preferred because of the low maintenance costs of goats and sheep during harsh climatic periods compared to cattle. On the other hand, others reported that the goat and sheep are tolerant to animal diseases caused by harsh climatic conditions compared to cattle. The findings of this study confirm with Omondi, (2014) who found out that rearing of mixed species of animals was one of the coping and risk management strategies employed by many pastoral households in the Turkana region, Kenya to boost the use of heterogonous ecosystem and meeting different socioeconomic requirements.

Rearing manageable numbers of animals was the fourth most dominant adaption practice to climate change. Findings further indicate that this practice is progressively adopted because livestock farmers are changing from communal land tenure to individual tenure system. It is increasingly becoming costly and causing clashes over grazing lands to those with large herds who go to graze in other people’s lands especially during drought periods when pasture and water become scarce. It was revealed that farmers who choose to rear the manageable number of animals do it to avoid high expenses incurred in maintaining animals' health during harsh climatic conditions; and others do it due to lack of enough land for grazing, while the rest indicated that they were encouraged by animal health workers.

Tree planting was found to be the fifth climate change adaptation practice undertaken by livestock farmers. Findings revealed that the most common types of tree species planted and maintained were the acacia and sliver fan palm trees. Most of the households who choose tree planting reported that trees provide shade to animals during the dry season which helps to reduce the heat that mat strain the animals. This conforms with Feleke, Berhe, & Hoag (2016) whose study found that tree planting was one of the major methods used by farmers to adapt to climate changes in the Nile Basin of Ethiopia.

Selling or marketing of animals during harsh climatic conditions was found to be the sixth climate change adaptation practice adopted by livestock farmers. This practice involves the selling of animals at the start of the dry season and then replaces after the dry season when pasture has taken up again. The livestock farmers who select this practice reported that they sell animals at the start of the dry season when pasture and water are increasingly becoming scarce. This is done since weak animals cannot endure dry seasons. This practice, as reported by some farmers, is therefore done to avoid heavy animal losses caused by heat stress; other farmers reported that they sell off some of the cattle to reduce their numbers to manageable ones during the dry season. These results conform with Feleke, Berhe, & Hoag (2016) whose study revealed that selling of animals during shocks was one of the most dominant adaptation strategies practiced by livestock farmers in Southern and Central Tigray, Ethiopia.

Rainwater harvesting was shown to be the seven most dominant climate change adaptation practice that was reported to be undertaken by livestock farmers. This practice involves the use of metallic and plastic water tanks that are installed on iron sheet roofed houses to collect rainwater. Respondents who practice rain harvesting reported that this practice helps to provide water for drinking to animals when temporary water sources dry up during dry seasons. Similar findings were reported by Nordic Development Fund, (2013) and FAO, (2011) who wrote that rainwater harvesting in various parts of Africa is one of the main strategies for living with climate variability. The same study quoted that “rainwater harvesting increases resilience to climate change impacts on water availability, facilitates local business development, improves urban livelihood, and increases water availability in selected households and schools”.

The rearing of mixed cattle breeds was found to be the least climate change adaptation practice undertaken by the livestock farmers in Ntoroko District. This practice involves the rearing of local and cross-cattle breeds. Most of the livestock farmers who choose rearing of mixed cattle breeds reported that they choose to keep the indigenous cattle breed because they are more resilient to harsh climatic conditions than crossbreds. Others reported that local cattle breeds could walk a long distance in search of water and pasture compared to crossbreds. On the other hand, it was revealed that rearing of crossbreds of cattle was adopted due to high milk and meat production while others reported that the rear cross cattle because were supplied by the government under wealth creation.

5.3The Factors Influencing the Livestock Farmers’ Choice of Different Adaptations to Climate Change

This subsection presents the discussion of findings on the factors that influence the choice of adaptations to climate change in Ntoroko District. In line with this, therefore, access to credit facilities was found influencing livestock farmer’s choice of adaptations to climate change. It was found that the respondents who have access to credit, practiced various adaptations in response to climate change which include stocking of animal drugs, trees planting, mixed cattle breeds, rearing the manageable number of animals, rainwater harvesting, and herd mobility. This implies that access to credit influences the adoption of different adaptations to climate change. On the other hand, findings show that farmers who had access to credit did not practice selling animals during shocks and mixed animal rearing. This means that access to credit does not influence these adaptation practices. The findings further show respondents who have no access to credit adopted only stocking of animal drugs, mixed animal rearing, and selling of animals during shocks. It was, however, showed that those who accessed credit facilities adopted varied practices more than those who did not. It was therefore concluded that access to credit influences the choice of adaptations to climate change. These findings agree with Turavinga, Visser & Zhou (2016) whose study concluded that the availability of credits gives several options to finance adaptation strategies like supplementary irrigation improved hybrids and fertilizer application.

The results of Multivariate analysis further showed that access to credit positively and significantly influences the choice of mixed animal rearing and rainwater harvesting. The result further indicates that this factor has a positive but insignificant influence on the stocking of animal drugs, rearing manageable numbers of animals, tree planting, and herd mobility. Access to credit on the other hand reveals a negative but significant influence on the choice of mixed cattle breeds and selling of animals during shocks. The analysis further revealed that mixed animal rearing was an adaptation practice to climate change that was highly influenced by access to credit. The positive relationship of this factor with various adaptations is attributed to the fact that access to credits gives several alternatives to sponsor the adoption of adaptation practices. Yirga (2007) & Pattanayak et al., (2003) also found that access to credit facilities eases the cash constraints and allows farmers to buy inputs such as fertilizer, improved varieties, and irrigation facilities. In addition, Turavinga, Visser & Zhou (2016) whose study revealed a positive relationship between the levels of adaptation and the availability of credit further supported these results.

The analysis of membership to social groups revealed that the existing social groups to which farmers belonged include Livestock Farmers' Association, Savings and Credits Associations, and Women Groups Associations. It was found that livestock farmers who belong to social groups practice stocking of animal drugs, practice mixed cattle breeds, and or mixed animal rearing, practiced rainwater harvesting, selling of animal during shocks, and herd mobility. This implies that membership in a social group influences the adoption of different adaptations to climate change. The findings further show that respondents who did not belong to any social group adopted stocking of animal drugs, tree planting, mixed cattle breeds, mixed animal rearing, and herd mobility. However, though the number of those who belong to social groups was small, the results showed that respondents who belong to social groups adopted more adaptation practices than those who did not. This implies that membership in a social group influences the choice of adaptations to climate change in Ntoroko district.

The Multivariate model revealed that membership to social groups positively influences the choice of adopting mixed animal rearing stocking of animal drugs and mixed cattle breeds. The results further revealed that this factor has a positive but insignificant influence on the choice of selling animals during shocks, rainwater harvesting, and herd mobility. The positive coefficient values associated with this factor imply that membership to a social group increases the likelihood of adapting to climate change while the negative coefficient means that membership to a social group decreases the odds of adaptation. The largest influence of membership to the social group was on the adoption of mixed animal rearing. The analysis further indicated that membership to social groups negatively but insignificant influences the adoption of tree planting and rearing the manageable number of animals.

Whereas membership to the social group was found to significantly influencing livestock farmers' decision to adapt to climate change, it was revealed that only 7.8% out of 351 respondents were members of social groups and 92.1% are not members of any social group.

This calls for support of the existing local institutions by supporting social groups such as the livestock Farmers' Association, Savings and Credits Associations, and Women Groups Associations. When the existing social groups are supported, they can help to increase and the new livestock farming techniques, and management of risks and uncertainties. This should focus to achieve community collective action that can help to decrease susceptibility and increase resilience to climate change and variability.

This study categorized education as not educated and educated whereby the respondents who were under the category of not educated were those who had primary seven and below, and those who were above primary seven were considered as educated. Regarding the education status of a household head, findings revealed that respondents who were not educated practiced stocking of animal drugs, planting trees, practicing mixed cattle breeds, rearing the manageable number of animals, rainwater harvesting, and practicing herd mobility, selling of animals during shocks, and mixed animal rearing. The findings further show that respondents who are educated equally adopted all the above-mentioned adaptation practices apart from the selling of animals during shocks. This implies that the education status of a livestock farmer has no much influence on the choice of adaptations to climate change in Ntoroko District.

The Multivariate analysis revealed that the education status of a household head has a negative and significant influence on rearing the manageable number of animal and mixed cattle breeds. These results are consistent with Osasogie & Omorogbe, (2018) whose study revealed that education negatively and significantly influenced adaptation in Benue state, Nigeria.

The model also reveals that education status negatively but insignificantly influences tree planting, herd mobility, selling animals during shocks, and stocking animal drugs. These results agree with Osasogie & Omorogbe, (2018) Benue state, Nigeria whose study revealed a negative relationship between education and adaptation to climate change. Education status was on the other hand found positively but insignificant on the choice of mixed animal rearing and rainwater harvesting. On the other hand, these findings agree with the study conducted by De Rensis & Scaramuzzi (2003) and Maddison, (2006) who concluded that there is a positive association between the education level of the household head application of improved technologies and adaptation to climate change.

Concerning land ownership, findings revealed that respondents who own land, practice stocking of animal drugs, tree planting, mixed cattle breeds, practice mixed animal rearing, rainwater harvesting, practice herd mobility, and rearing the manageable number of animals. This implies that land ownership influences the adoption of different adaptations to climate change. The findings further show that respondents who did not own land, adopted stocking of animal drugs, selling of animals during shocks, herd mobility, and rearing the manageable number of animals only. Results indicate that farmers who own land adopted more than those who did not. This implies that land ownership influences the choice of adaptations to climate change in Ntoroko District. The findings of this study confirm with the findings by Timothy, (2013) who conducted a study in Southern Kalahari and reveals that the well-off livestock farmers who owned large pieces of private land and large herds of livestock used to land and livestock as collateral to access loans.

Results of the multivariate analysis revealed that land ownership did not significantly influence farmers' choice of any of the climate change adaptations. However, results reveal that land ownership has a positive but insignificant influence on the adoption of mixed animal rearing, stocking animal drugs, rainwater harvesting, and rearing the manageable number of animals, On the other hand, land ownership reveals a negative insignificant influence on the choice of adopting tree planting, selling animals during shocks, herd mobility and mixed cattle breed. The largest influence of land ownership was on the adoption of mixed animal rearing. The negative association of land size and climate change adoptions can probably be associated with a lack of land management skills by most livestock farmers. The findings of this contrast with Timothy, (2013) in Southern Kalahari whose study revealed that the well-off livestock farmers who owned large pieces of private land and large herds of livestock used to land and livestock as collateral to access loans. The findings contradict Taruvinga, Visser & Zhou, (2016) in Eastern Cape Province, South Africa, and George (2013) in Gulu District, Uganda who reported that households that have more land are more likely to adapt than their counterparts that have small landholdings.

In terms of incomes levels, results revealed that the livestock farmers who earned a monthly income of less than 100,000/= practiced only stocking of animal drugs, mixed animal rearing, herd mobility, and rearing the manageable number of animals to respond to climate change. Results further show that respondents whose monthly income was100,000-300,000/= adopted stocking of animal drugs, tree planting, mixed animal rearing, selling animals during shocks, herd mobility, and rearing the manageable number of animals. Further analysis showed that respondents who earned monthly income between 300,001-500,000= practiced stocking of animal drugs, practiced mixed cattle breeds mixed animal rearing, rainwater harvesting, selling animals during shocks, herd mobility, and adopted rearing manageable number of animals. Participants whose monthly income was above 500,000/= adopted stocking of animal drugs, plant trees, mixed animal rearing, practiced rearing mixed cattle breeds, herd mobility, selling animals during shocks, and rearing the manageable number of animals practiced. It was observed that the livestock farmers who earn a monthly income of 300,000/= and above were found adopting more climate change adaptations than those who earn less than that implying that higher-income earners adopted more than lower-income earners. This means that high-income levels greatly influenced the adoption of various adaptations to climate change in Ntoroko District.

The results of the multivariate analysis revealed that monthly income has a positive significant influence on the adoption of stocking of animal drugs, rearing the manageable number of animals, mixed animal rearing, and rainwater harvesting. The results further reveal a positive but insignificant influence on herd mobility, mixed cattle breeds, tree planting, and mixed animal rearing. On other hand, monthly income reveals a negative insignificant influence on the choice of selling animals during shocks. The largest influence of monthly income was on the adoption of rainwater harvesting. The positive association of income with the adoption of multiple adaptation options to climate change could attribute to the fact that farmers with higher incomes may be at less risk of bad climatic conditions and use the income to finance various climate change adaptations. These findings agree with Omondi (2014) who reported a positive correlation between income and adaptation to climate change. It was therefore concluded that farmer's income influence the adoption of various adaptations to climate change. As a result of this, livestock farmers should therefore be encouraged to engage themselves in diversified income-generating activities in addition to livestock farming to improve their income levels to enhance adaptability to climate change.

Results further revealed that the farming experience influences the adoption of different adaptations to climate change. respondents whose farming experience was below 10 years practiced only stocking of animal drugs, and herd mobility while respondents with farming experience of 10-30 years adopted stocking of animal drugs, mixed animal rearing, selling animals during shocks, rainwater harvesting, herd mobility, and rearing the manageable number of animals. Participants with 30 years and above of farming experience adopted stocking of animal drugs, plant trees, mixed animal rearing, practiced selling animals during shocks, practiced rearing the manageable number of animals practiced herd mobility. It can be observed that adoption of more adaptations increases with many years of farming experience implying that more years in livestock farming influences the adoption of multiple adaptations to climate change in Ntoroko District. This is accredited to the fact that a farmer with many years in livestock farming is expected to acquire more competence in weather forecasting. This helps to increase the likelihood of practicing different adaptations to climate change. The findings of this study confirm with Feleke, Berhe, & Hoag (2016) who conducted a study in Southern and Central Ethiopia and reported that farmers with longer periods of experience were more likely to understand climate change and its negative consequences, and are more willing to respond to these effects through different adaptation practices.

Results of Multivariate analysis shown that farming experience positively and significantly affects the choice of only mixed cattle breeds. The model further reveals that the farming experience has a positive but insignificant influence on the choice of rainwater harvesting, selling animals during shocks, tree planting, and mixed animal rearing. On the other hand, farming experience has a negative but insignificant influence on herd mobility, rearing the manageable number of animals, and stocking animal drugs. The largest influence of farming experience was on the adoption of mixed cattle breeds. This could be attributed to the fact that a household head whose more experienced in livestock farming is expected to acquire more competence in weather forecasting. This helps to increase the likelihood of practicing different adaptations to climate change. These results conform with Osasogie& Omorogbe, (2018) in Benue state, Nigeria who found a positive coefficient between farming experience and adaptation to climate change. This implied that the more years in livestock farming, the more the farmer is likely to use multiple adaptation options against climate change hazards.

Findings regarding access to extension services revealed that respondents who have access to extension services practiced stocking of animal drugs, planting trees, rainwater harvesting, and mixed animal rearing in response to climate change. This implies that access to agricultural extension services influences the adoption of different adaptations to climate change. On the other hand, findings show that farmers who had access to extension services did not practice selling animals during shocks, herd mobility, and rearing the manageable number of animals. This means that access to extension services does not influence these adaptation practices. The findings further show that respondents who have no access to extension services adopted stocking of animal drugs, mixed animal rearing, and herd mobility only. These results imply that farmers who have access to extension services adopted more than those who did not. This implies that access to extension services influences the choice of adaptations to climate change. These findings confirm with Turavinga, Visser & Zhou (2016) and Nomcebo et al., (2017) who reported that access to agriculture extensional services assist farmers through training that helps them to improve their farming methods and techniques through the provision of updated information. Therefore, efforts should focus on increasing accessibility to extension services to enhance adaptability to climate change among the livestock farmers in Ntoroko district.

Results of the Multivariate model indicated that access to agricultural extensional services did not reveal any significant influence on the adoption of any adaptation practice. However, the model revealed that this positive but insignificant influence on the choice of stocking of animal drugs, mixed cattle breeds, mixed animal rearing, herd mobility, and rearing manageable numbers of animals. It was further revealed that access to agricultural extensional services has a negative influence on tree planting, rainwater harvesting, and selling animals during shocks. The largest influence of access to extension services was on the adoption of stocking animal drugs. The implication of the positive influence of this factor on the adoption of multiple adaptations is that access to agriculture extensional services promotes farmer's use of various adaptations. Contrary to the findings of this study, Mutunga, Ndungo & Muebo (2018) who conducted a study in Kitui County, Kenya revealed that access to agriculture extensional services have no significant influence on climate change adaptation among the smallholder farmers.

In terms of access to information on climate change, findings revealed that radio programs were the major source of information on climate change across the area of study. Other sources of information on weather and climate updates that were reported include; farming groups, local council meetings, and religious institutions and NGOs such as world vision and save the children. Findings further revealed that respondents who have access to information on weather and climate update practiced stocking of animal drugs, planting trees, mixed cattle breeds, mixed animal rearing, rainwater harvesting, selling of animal during shocks, and herd mobility. This implies that access to information on climate change influences the adoption of different adaptations to climate change. The findings further show that respondents who have no access to information on climate change adopted stocking of animal drugs and adopted herd mobility only. These results imply that livestock farmers who had access to information on climate change adopted more than those who did not. This implies that access to information on climate change influences the choice of adaptations to climate change. It is therefore concluded that access to information greatly influences the application of different adaptations to climate change. Similarly, Madison (2006) also reported similar also wrote that access to information through extension services increase the likelihood to adapt to climate change. Therefore, the government should use various communication channels to convey information on climate change such as mobile phones radio, TVs, bulletins, farmer-participatory climate workshops, and creating climate information centers to increase accessibility to information that can help to enhance livestock farmers' resilience to the climate in Ntoroko District. Multivariate analysis revealed that access to information on climate change positively and significantly influences the choice of tree planting, rainwater harvesting, stocking of animal drugs, and mixed animal rearing. Further analysis revealed that this fact positively but insignificantly influences the choice of mixed cattle breeds and herd mobility. On the other hand, access to information on climate change has a negative but insignificant influence on the choice of selling animals during shocks and rearing the manageable number of animals. The largest influence is access to information on climate change that influences the adoption of mixed animal rearing. The positive influence of access to information on climate change on multiple adaptations implies that an individual exposed to climate information is more likely to take immediate actions to cope with risks related to climate change. These findings are in agreement with the results of the studies conducted by Madison, (2006), Philip & Mario, (2012) who revealed that access to information might increase the likelihood of adapting to climate change. Various studies in developing countries report a strong positive relationship between access to information and the adaptation behavior of farmers (Patz, Campbell-Lendrum, Holloway & Foley, 2012 Madison 2006, and Philip & Mario 2012).

The analysis of the accessibility to training programs on climate change adaptations revealed that respondents who have access to training practiced stocking of animal drugs, plant trees, practice mixed cattle breeds, rearing the manageable number of animals, rainwater harvesting, selling of animals during shocks, mixed animal rearing, and herd mobility. This implies that access to training on climate change adaptation influences the adoption of different adaptations to climate change. On the other hand, findings further show that respondents who have no access to training adopted stocking of animal drugs, tree planting, mixed animal rearing, selling of animals during shocks, and herd mobility only. These findings indicate that livestock farmers who had access to credit training programs on climate change adaptations adopted more than those who did not. It was therefore concluded that access to training influences the choice of adaptations to climate change. It is therefore recommended that climate change experts should be employed to train farmers on more sustainable adaptation practices to climate change in Ntoroko District to enhance adaptability to climate change among the livestock farmers in Ntoroko District.

Multivariate analysis revealed that access to training on climate change adaptation has a positive and significant influence on the choice of having mixed animals raring, rainwater harvesting, stocking animal drugs, mixed cattle breeds, and rearing manageable numbers of animals The results further revealed a positive but insignificant influence on tree planting, selling animals during shocks, and herd mobility. The largest influence of training was on the adoption of mixed animal rearing. This is attributed to the fact that through training on climate change, farmers improve their farming methods through accessing updated information concerning climate change and livestock farming. This finding conforms to Turavinga, Visser & Zhou (2016) and Nomcebo et al., (2017) whose studies concluded that access to training on climate has a significant influence on climate change adaptation in Eastern Cape Province, South Africa.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The Mean Annual Rainfall amounts show a decreasing trend that was not significant for the period 1988 to 2018.

Seasonal rainfall amounts show a statistically insignificant decreasing trend, for the season of March to May, and an increasing trend that is significant, for the season of September to November (SON) for the period 1988-2018.

December to February seasonal rainfall shows a decreasing trend that was significant while JJA season reveals an insignificant increasing trend.

The mean annual maximum temperature, together with the DJF Seasonal Maximum Temperature trends for the period 1990 to 2018 increased significantly. On the other hand, MAM, JJA, and SON seasonal maximum temperature reveal increasing maximum temperature trends that were statistically insignificant.

The Annual Minimum temperature and the seasonal minimum temperature reveal an insignificant decreasing trend for the period 1990 to 2018 for Ntoroko District except for the season of MAM that exhibits positive insignificant trends.

Stocking of animal drugs, herd mobility, and mixed animal rearing are the most dominant climate change adaptation practices adopted by livestock farmers in Ntoroko. The least dominant is the rearing of mixed cattle breeds.

The most significant factors that positively and significantly influence the livestock farmers' choice of multiple adaptations to climate change in Ntoroko District include access to training on climate change, income levels, access to information on climate change, and membership to the social group.

6.2 Recommendations

This study revealed that there is high variability in both annual and seasonal rainfall and temperature trends. Thus, the study recommends that farmers be accessed to scientific meteorological information on rainfall and temperature trends necessary for better planning and designing of adaptations, aimed at increasing resilience to climate variability and change in Ntoroko District.

There is a need to support livestock farmers' adaptation practices to overcome future scenarios of climate variability and change. More efforts should focus on reducing climate change risks and expanding opportunities for diversification of livelihoods in Ntoroko District.

Leaders should emphasize and prioritize farmers' access to training on adaptation and information on climate change, monthly income, and membership in the social group. This should focus on achieving community collaborative action that can help to enhance livestock farmers' use of various adaptation practices to climate change.

6.3 Recommendation for Further Research

The researcher recommend the following to be researched further.

Further study should be on the effectiveness of climate change adaptation practices used by livestock farmers.

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APPENDICES

Appendix A: Observation Check List

1. Climate change adaptation strategies

I. Tree planting

II. Mixed animal rearing

III. Improving feeding practice

IV. Changes in animal breeds

V. Rain water harvesting

VI. Selling of animals during shocks

VII. Herd mobility

VIII. Rearing manageable number of animals

IX. Stocking animal drugs

Appendix B: Questionnaire for Livestock farmer Household Head

Dear Respondents,

I am Wahimba Joseph a student of Kyambogo University undertaking a Master of Arts in Geography. I am carrying out a study entitled **"Cimate change adaptation by livestock farmers in Ntoroko District''** as part of my degree requirements. Am currently collecting data and I would be grateful if you could provide me with relevant information that support this study. The responses provided will be kept confidential and used for this study only.

Questionnaire No………………… Date……………………………..

Name of respondent…………………………………

Sub- County……………………… Parish……………………..

Village…………………………..

Introduction:

Kindly answer all the questions by ticking the correct and / or writing in the space (s) provided.

Part A: Demographic and socio-economic Characteristics Respondents

1. Gender male [ ] Female [ ]
2. Age bracket in years 20 – 39 [ ] 30 – 49 [ ] 40 – 39 [ ] 50 and above[ ]
3. Highest level of education: None formal [ ] primary PLE [ ] secondary [ ], tertiary [ ]
4. Marital status: [ ], Married [ ], Widow [ ], Separated [ ], others specify……………………………………………
5. Type of family: monogamous [ ], Polygamous [ ]
6. Household size……………………………………………………

7. What is your occupation? A. Self-employed [ ] B. Officially employed [ ]

   C. Casually employed [ ], others specify……………………………

PART B: Trends in rainfall and temperature between 1988– 2018.

1. For the last 20 – 30 years (1988 – 2018) have you experienced any of the following

   1= Heavy rains and hails, 2= drought 3=animal disease, 4= water scarcity.

   Responses, strongly disagree [ ] disagree [ ] Not sure [ ] Agree [ ] strongly agree [ ]

2. From your own experience, how have rainfall and temperature changes been between 1988 and 2018?

   Rainfall increased [ ] Decreased [ ], No change [ ]

   Temperature: Increased [ ], Decreased [ ], No change [ ]

3. For the last20 – 30 years (1988 – 2018) which year did you experience severe;

   Heavy rains………………………………………………………………..

   Floods…………………………………………………………………..

   Drought……………………………………………………………

4. In the above situation did you experience loss of livestock?

Yes [ ], No [ ]

Kindly explain your answer

……………………………………………………………………………………

5. Did you receive any assistance for loss of the animals? Yes[ ], No [ ]

Part C. climate change Adaptation Practices adopted by Livestock Famers

1. Do you adapt to climate change? Yes [ ], NO [ ]

2. Which of the following adaptation practice to climate change have undertaken?

Adaptation practice	Yes	No	Reasons for choosing the practice	Challenges
1. Tree planting				
2. Mixed animal rearing				
3. Changes in animal breeds				
4. Rain water harvesting				
5. Selling of animals during shocks				
6. Herd mobility				
7. Stocking animal drugs				
8. Rearing manageable number of animal				
No adaptation				

5. Among the adaptation strategies mentioned above what is the most used on your farm?

6. How has adaptation helped you to overcome the effects of climate change?

....

....

7. If you did not adopt what made you not to adopt adaptation measures? (Optional)

……………………………………………………………………………………………

……………………………………………………………………………

Part D. Factors influencing livestock farmers' adaptation to climate change

Socio-economic factors

Land ownership

1. Do you own land?

a) Yes

b) No

2. If yes, how big is it? (Tick the correct answer)

a) 1 – 3 acres [ ]

b) 4 - 7 acres [ ]

c) 8 - 11 acres [ ]

d) More than 11 acres [ ]

3. How much of your land is allocated to livestock farming?

…………………………………………………………………

4. Which form of ownership is your land?

a) Leased land

b) Rented land

c) Customary land

5. For rented land why do you rent it?

………………………………………………………………………………

6. How do you pay the owner of the land?

a) In cash

b) In farm produce

   a. How much in cash or farm produce do you pay per season?

………………………………………………………………………………

7. Do you think you will still be in possession of this land in fifteen years to come?

a) Yes

b) No

Income of the farmer

…………………………………………………………………………..

8. How much money on average do you earn from the sale of animal farm products in a month? (Tick the correct answer)

a) Less than 100,000 [ ]

b) 100,000 - 300,000 [ ]

c) 300,001- 500,000 [ ]

d) More than 500,0001 [ ]

……………………………………………………………………………..

9. Do you engage in any other activity other than livestock farming?

a) Yes

b) No

10. If yes, which activities?

…………………………

…………………………

11. How much do you earn from them in a month in shillings?

……………………………………………………………………………………

12. Which type of animals do you rear?

Animal type Number

…………………. ………………….

…………………. …………………..

13. How much on average do you earn from all your activities per month?

(Tick the correct answer)

a) Less than 100,000 [ ]

b) 100,000 - 300,000 [ ]

c) 300,001- 500,000 [ ]

d) More than 500,0001 [ ]

…………………………………………………………………………….

14. How much on average do you spend on the climate change adaptation strategies that you use on your farm?

1 = Less than 50000 [ ]

2=50000-100000 [ ]

3=10001 -150000 [ ]

4=150000 and above [ ]

15. What is the main source of funds spending on climate change adaptation strategies used on your farm?

………………………………………………………………………………………………

Labor availability and Off-farm employment opportunities

16. What is the labor force on your animal farm?

	Type		Number
	Male	Female	Children
Family	…………..	………….	……………
Hired	…………..	………….	……………
Others (specify).	……………	…………..	……………

17. For hired labor, how much do you pay each worker per month on average?

………………………………………………………………………..

18. Why do you use hired labor on your farm?

…………………………………………………………………………..

19. For family labor, do all your family members help you on your farm?

a) Yes [ ]

b) No [ ]

If not, why?

………………………………………………………………………………………

Farming experience

20. How long have you been a livestock farmer?

a) Less than 10 years [ ]

b) 10 - 19 years [ ]

c) 20-29 years [ ]

d) More than 30 years [ ]

Membership to a local social group

21. Do you belong to any social group?

A) Yes

B) No

22. If yes, which one?

…………………..

23. What is it all about?

…...……

…………………………………………………………………………………………………

If No why?

………………...

24. How have you benefited from being a member of such a group?

………………………………………………………………………………………………..

………………………………………………………………………………………………..

Access to extensional services

25. Do you receive any agricultural inputs or any investment subsides?

a) Yes

b) No

26. What subsides?...

……………………………………………………………………………..

27. If yes, from whom do you receive these services?

……………………………………………………………………………………

28. Has your access to these services benefited you?

a) Yes

b) No

29. If yes, state how…………………………………………………………………

…………………………………………………………………………………………

30. If no, state why they have not benefited you

……………………………………..…………………………………

…………………………………………………………………………………………

Training

31. Have you ever had training about adaptation to climate change?

a) Yes

b) No

32. If yes, what was the training about?

……………………………………………………………………………………

33. Who conducted the training? ………………………………………………

34. How did you benefit from the training?

……………………………………………………………………………………

Access to information

35. Do you have access to information about weather and climate change updates?

a) Yes

b) No

36. If yes, from which organization?

a) NGOS [ ]

b) Local councils [ ]

c) Religious organizations[ ]

d) Farming groups [ ]

e) Radio [ ]

f) Social media [ ]

37. How has information about climate change helped to adopt the strategies to cope with climate change?

…………………………………………………………………………………………

………………………………………………………………………………………..

Access to credit

38. Do you have access to credit for adaptation to climate change?

a) Yes

b) No

39. If yes, how often do you obtain credit and from which financial institution?

……………………………………………………………………………………………

40. How much credit are you permitted to obtain?

....

41. How does the credit/ loan obtained help you to adapt to climate change

……………………………………………………………………………………………

…………………………………………………………………………………………

42. Is the credit you get enough for your needs?

a) Yes

b) No

43. If you don't, why don`t you access credit facilities?

……………………………………………………………………………………………

……………………………………………………………………………………………

In your view, what are the constraints to adoption of climate change adaptation strategies practiced by livestock farmers?

…………………………………………………………………………………………………

………………………………………………………………………………………………..

44. How do those limitations affect the application of adaptation strategies to climate change on your animal farm?

…………………………………………………………………………………………………

…………………………………………………………………………………………………

What do you think should be done to improve your adaptive capacity as livestock farmer to climate change?

…………………………………………………………………………………………………

……………………………….......................………………………………………….

45. What do you think you can do in future to be able to adapt better to climate changes if they persist?

………………………………………………………………………………………

THANK YOU

Appendix C: Table Showing Monthly Average Rainfall from 1988-2018

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
1988	19.4	35.5	58.2	136.5	147.3	35	39	40.1	145.3	55.7	71.8	74.7
1989	3.2	55.1	65.6	72.7	113.2	17.9	8.4	78	170.8	56.3	124.5	167.9
1990	35.6	81.2	77.8	59.5	76.1	71.2	16.4	21.8	38	67.1	116.8	77.1
1991	36.5	25.6	15	57.7	67.4	32.6	55.7	32.6	111.5	136.5	51.1	52.4
1992	4.1	3.7	54.9	89.1	56.3	31.4	29	71.6	131.1	30.6	72.9	113.8
1993	86.5	52.2	98.7	147.6	212.8	46	0.3	75.9	61.1	130.8	90.5	147.3
1994	10.7	2.1	71.7	181.9	153.2	26.3	24.2	49.4	23.5	103.9	163.7	63.1
1995	23.5	21.5	114.8	181.2	60.7	35	33.6	18.5	77.6	54.2	75.5	51
1996	88.4	27.2	132.2	68.5	115.9	52.6	17.8	98.6	119.8	233.6	94.3	27.8
1997	59.7	0.09	98.6	229.1	81.2	18.7	34	8	51	86.2	191.2	79
1998	38.4	22.9	77.4	127.4	152.1	21.7	6	3.1	55.2	107.7	130.5	69
1999	37.6	4.2	123.6	39.4	66.3	22	5	122.1	71	121.6	115.2	93
2000	17.8	23.5	49.1	148.3	63.3	38.7	50.2	65.4	61.7	138.7	149.1	73.3
2001	4.6	31.1	102.3	223.3	109.3	47.7	50.3	79.2	77.3	138.9	95.4	66.2
2002	5	17.9	142.3	109.7	87.7	22.8	31.1	90.4	44.8	107.7	107.3	61.4
2003	19.4	8.9	44.3	66.9	145.4	96.2	8.8	37.7	59.4	61.4	62.9	30.9
2004	63.4	36.7	92	179.8	42.8	6.3	23.3	45.1	88	147.1	180.5	67.4
2005	64.5	23.2	107	149.4	95.6	92	28.6	85.6	116.4	76.2	80.2	54.4
2006	22.8	76.1	64.1	107.9	64.9	5.8	16.7	33	40	53.2	168.4	62
2007	45.8	24.5	16	66.4	82	31	77.4	78.9	109.8	119.5	115.9	52.5
2008	47.6	27.4	125.8	84.3	42.2	53.6	22.9	67	56.1	138.3	89.7	28
2009	28.2	48.2	86.8	75.7	152.9	91.7	31.4	75.7	92.2	114.2	31.8	44.5
2010	22.4	40.3	68.9	43.1	98.5	160.9	24.7	73	95.2	113.3	25.7	48.3
2011	4.2	10	99.8	76.4	24.6	125.8	56.7	93.6	140.8	99	192.5	58.3
2012	0.7	51.6	110.9	93.6	12.4	13.8	22.9	36.6	51.3	27.7	93.2	11.8
2013	17.1	52.5	65	177.2	10.9	8.7	8.4	76.8	97.4	89.3	129.7	27.5
2014	25.8	29	107.1	64.5	49	25.4	18.1	125.8	167.3	124	200.5	16.7
2015	0.8	15.2	35.6	113.4	80.1	73.1	19.7	21.9	122.2	85.1	134.2	49.8
2016	18.2	5.8	72.8	141.4	86.5	114.1	17.7	151.2	45.3	143.4	123.3	21
2017	3.7	53.3	81.7	32.3	71.9	14.6	23.9	74.9	133.5	147	113.6	12.3
2018	16.5	32.4	150.8	200.3	99	30.3	12.1	47.8	76.9	99.3	124.1	40

Source: Kasese weather station statistics

Appendix D: Table Showing Monthly Average Maximum Temperature from 1990-2018

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1990	30.6	29.6	29.9	30.6	31.8	31.4	31.2	30.8	31.1	30.2	29.9	29.3
1991	29.9	31.5	32.2	31.4	30	30.9	29.3	30.1	31.1	29.3	29.6	29.2
1992	31.4	32.4	33.4	31	30.7	30.3	30	30.7	30.5	30	29.8	29.3
1993	30.2	30.3	30.6	30.5	30.1	29.6	31.1	30.7	31.4	30.6	30.1	29.4
1994	30.9	31.7	31.1	31	29.9	29.7	29.6	29.9	31.2	30	28.3	29.4
1995	31.3	31.2	30.4	29.9	29.9	30.4	29.1	31.4	30.4	29.3	30	29.3
1996	29.9	29.9	29.9	30.5	30.1	28.5	29.4	30.9	30.3	29.6	28.7	30.2
1997	30.1	32.7	31.8	29.5	30	30.6	30.2	31.4	32.5	30.4	29	29
1998	30.2	31.5	31.8	31.9	30.7	31.3	30.5	31.1	31.4	30.5	30.6	30.8
1999	30.9	34.1	30.5	31.2	30.6	31.7	31.6	29.5	30.4	29.6	28.5	29.6
2000	30.9	32	31.9	30.8	30.6	30.9	31.1	30.9	31.4	29.5	28.8	29.1
2001	29.7	32.9	30.2	30	30.1	29.8	29.9	30	29.9	29.7	29.9	30.7
2002	30	33.1	30	30.2	30.1	31.6	32.1	30.7	31.4	30.1	28.9	29.4
2004	31.4	32.6	30.9	29.8	31.5	31.3	32.1	31.5	31.8	29.7	29.9	30.5
2005	32.4	34.3	31.4	31.5	30.6	30.7	30.3	29.9	30.4	30.5	30.2	32.2
2006	32.6	33.3	30.4	30.5	30.7	31.8	31.6	31.3	31.7	31.4	28.5	29
2007	30.8	31.6	31.7	31.8	31.2	29.4	29.8	29.7	30.2	29.7	28.5	30.2
2008	30.5	31.4	29.9	29	30.9	30.1	30	30.4	31.1	30.1	30.6	30.9
2009	31.2	31.8	31.9	31.3	30.4	31.3	31.6	31.2	31.4	29.4	30	30.9
2010	32	31.4	31.5	32	30.7	31	31.5	31.7	30.8	29.5	30	30.3
2011	31.5	33.8	31.2	30.9	30.2	29.9	29.2	29.2	29.2	29.3	30	29.4
2012	32.6	33.3	30	30.5	29.1	30	30.5	31.3	31.7	31.4	28.5	29
2013	31.2	32	29.5	30.4	29.9	30	31.2	30.3	30.3	29.4	29.5	30.8
2014	31.1	32.2	30.9	30.3	30.3	30.8	30.9	29.7	29.7	30.4	29.5	30.6
2015	32.5	33.2	32.3	30.2	30.4	30	31.6	32.6	31.3	29.4	29.1	31.1
2016	31.1	33.5	34.1	30.2	31.5	30.6	31.4	31.7	31.8	31.5	29.9	31.8
2017	33.5	32.1	31.9	31.5	31.2	32.6	31.5	31.1	29.7	30.7	29.4	31.9
2018	31.9	33.6	29.7	29.1	30.3	30.4	31.6	31.2	31.4	30.7	30	30.1

Source: Kasese weather station statistics

Appendix E: Table Showing Monthly Average Minimum Temperature from 1990-2018

YEARS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
1990	15.9	18	18.5	18.6	18.3	17.3	16.8	18.6	17.4	17.6	17.4	17.4
1991	16.9	16.9	18	18.2	18.6	18.2	17.1	17.6	17.6	16.9	17.1	16.9
1992	17.1	17.6	18.8	19	18.1	18.1	17.7	17.5	17.5	17.9	17	16.9
1993	17	17.3	17.2	18.2	18.6	18.3	16.3	17.9	16.8	16.7	17.1	17.4
1994	16.8	17.3	17.7	18.5	18.4	17.9	17.6	17.8	17.4	17.1	17.4	17.3
1995	16.8	17.3	18.2	18.5	17.9	17.5	17.5	17	17.7	17.6	17.8	16.8
1996	16.4	17.1	17.7	17.7	18.2	17.7	16.8	17.1	17.4	17.3	17.4	16.9
1997	16.9	15.8	18	18.2	17.2	17.1	17.4	18	17.7	18.2	18.7	18
1998	18.2	18.3	18.6	20	19.5	17.7	18	18.7	17.8	18.5	17.8	16.5
1999	17.3	16.8	18.1	18.2	18	18.2	18	18.3	17.1	17.3	17.3	17.1
2000	16	16.5	17.5	18.3	18.1	17.6	17.7	17.7	17.3	17.3	17.4	17.2
2001	16.5	17	17.3	18.4	18.3	16.9	17	17.3	17.2	17.7	17.8	17.2
2002	17.4	18.2	18.4	19.1	19.2	17.5	18	18.9	17.9	18	18	17.7
2003	16.7	18	18.6	19.4	19.2	18.3	17.8	18.6	18.5	18.1	18.1	17.3
2004	18.5	18.6	19.4	19.3	18.7	18.2	17.3	19.1	18.2	18.6	18.5	17.9
2005	17.7	18.1	19.5	19.1	19.1	18.5	17.4	18.5	17.9	17.9	17.5	17.6
2006	17.8	19.7	18.2	18.7	19	18.1	19.5	18.8	18.6	18.8	18.7	18.3
2007	17.8	18.2	18.4	19.2	19.2	18.6	18.5	18.5	18.4	17.6	17.9	17.1
2008	17.8	17.6	18.2	18.1	18.1	18.1	17.6	18.5	18.4	18.3	18.1	17.2
2009	17.8	18.3	18.8	19.1	19.4	18.5	17.7	17	18.7	19	18.6	16.8
2010	18	20.1	19.4	19.9	20.1	19.3	17.9	19.1	18.7	18.6	17.7	17.4
2011	17.4	17.6	18.4	18.8	18.6	18.5	17.6	18.1	18.5	17.6	18.6	17.8
2012	17.8	19.7	18.2	18.7	18.5	17.5	17.5	18.8	18.6	18.8	18.7	18.3
2013	17.8	17.1	18.1	18.7	17.6	17.5	16.5	17.1	16.9	19	17.4	16.4
2014	16	16.2	17.7	18.2	18.2	17.9	16.8	17.2	17.3	17.2	16.5	16.5
2015	16.4	16.4	18.2	18.6	18.1	18	17.6	17.2	18	18.6	18.5	18
2016	18.5	18.8	19.7	19.5	19.5	17.9	16.9	17	16.7	16.7	17	15.1
2017	15.5	16.8	16.4	17.2	16.6	15.5	14.7	14.8	13.7	13.4	12.5	12
2018	12.3	16.1	18.9	19	18.4	17.4	16.5	17.1	16.5	17.7	17	16.9

Source: Kasese weather station statistics

Appendix F: Sample Size

Table for Determining Sample Size of a Known Population									
N	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

Note: N is Population Size; S is Sample Size *Source: Krejcie & Morgan, 1970*