DETRMINANTS OF CHOICE OF PASTORALISTS CLIMATE VARIABILITY ADAPTATION STRATEGIES: A CASE OF BORENA ZONE, SOUTHERN ETHIOPIA.

HABTAMU TAMENE

A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY COLLEGE OF DEVELOPMENT STUDIES CENTER FOR FOOD SECURITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN FOOD SECURTY AND DEVELOPMENT STUDIES

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DECLARATION

I, **Habtamu Tamene Belay**, the under signed declare that this thesis entitled "DETRMINANTS OF CHOICE OF PASTORALISTS CLIMATE VARIABILITY ADAPTATION STRATEGY: A CASE OF BORENA ZONE, SOUTHERN ETHIOPIA" is my original work. I have undertaken the research work with the guidance and support of the research advisor. This study has not been submitted for any degree or diploma program in this or any other institutions and that all sources of materials used for the thesis has been surely acknowledged.

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This is to certify that the thesis prepared by **Habtamu Tamene Belay**, entitled "DETRMINANTS OF CHOICE OF PASTORALISTS CLIMATE VARIABILITY ADAPTATION STRATEGY: A CASE OF BORENA ZONE, SOUTHERN ETHIOPIA" submitted in partial fulfilment of the requirements for the degree of Master of Science in Food Security and Development study compiles with the regulation of the University and meets the Accepted standards with respect to originality and quality.

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Acronyms and Abbreviations

ACSF	Atkinson Center for a Sustainable Future
AR4	Fourth Assessment Report
BIC	Bayesian Information Criterion
BZFEDO	Borena Zone Finance and Economic Development Office
CBD	Convention on Biological Diversity
CBPP	Contagious Bovine Pleuropneumonia
CIESIN	Center for International Earth Science Information Network
CO_2	Carbon dioxide
COP	Conference of Parties
CSA	Central Statics Agency of Ethiopia
CSPro	Census Survey Programming
DA	Development Agent
EPCC	Ethiopia Panel on Climate Change
FGD	Focus Group Discussion
FMD	Foot-and-Mouth Disease
GDP	Gross Domestic Product
GHGs	Green House Gases
HM	Hausman-McFadden
ICPAC	IGAD Climate prediction and Application Center
IIA	Independence Irrelevant Alternative
ILRI	International Livestock Research Institution
IPCC	International Panel on Climate Change
KII	Key Informant Interview
LDCs	Least Developed Countries
MARD	Ministry of Agriculture and Rural Development
MNL	Multinomial Logistic
MNLM	Multinomial Logistic Model
MoA	Ministry of Agriculture

MoFED	Minister of Finance and Economic Development
NAPAs	National Adaptation Programmes of Action Ethiopia
NGOs	Non-governmental Organizations
NMA	National Metrology Agency of Ethiopia
NWP	Nairobi Work Programme
ONRS	Oromiya National Regional State
PPR	Peste des Petits Ruminants
SH	Small-Hsiao
SNNP	Southern Nations Nationalities and People's
TLU	Tropical Livestock Unit
UNCCC	United Nations Convention on Climate Change
UNCED	United Nations Conference on Sustainable Development
UNDP	United Nation Development Program
UNEP	United Nation Environment Protection
UNFCCC	United Nations Framework Convention on Climate Change

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Abstract

Climate variability and extremes adversely affect the livestock sector directly and indirectly by aggravating the prevalence of livestock diseases, distorting production system and the sector profitability. This paper aims to describe the effect of climate variability and extremes on livestock production and investigate the basic factors that affect the choice of climate variability adaptation strategies of pastoralists in Borena zone southern Ethiopia.

Data were collected through a combination of quantitative and qualitative methods using household questionnaire, focus group discussions and key informant interviews. Areal grid dikadal rainfall and temperatures data from 1981 to 2016 were collected from national meteorological agency. The quantitative and qualitative data were analyzed and interpreted using appropriate analytical tools and procedures.

The result revealed that the the presence of very high differences of annual and seasonal rainfall amount between the highest and lowest volume of rainfall across the years, high variability of annual and seasonal rainfall and the unpredictable starting and stopping time of rainfall could create favorable environment for livestock diseases and adversely affect the livestock system.

Majority of the pastoralists have been highly encountered the intensity of climate related problem like water quality and availability, shortage of grazing land, high risk of livestock diseases. Some of the sample respondents in the study area have not taken the appropriate adaptation measures to climate variability due to different constraint. These includes: lack of knowledge, lack of capital, lack of credit access, lack of information and unobserved climatic related problems are the major ones. Besides this, lacks of support from the governmental and non-governmental bodies as well as not giving emphasis by the pastoralists and agro-pastoralists themselves are also among the barriers to climate variability adaptation in the study area.

Keywords- Adaptation Strategy, Climate Variability, Multinomial Logit Model, Borena zone

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CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Global climate variability is a major threat facing humanity. According to IPCC (2007), the manifestations of climate variability has observed as an increase in global average air and ocean temperatures, melting of snow and ice and rising global mean sea level. At continental and regional levels, numerous long term variation in climate have been observed such as precipitation amounts and distribution, ocean salinity, change in wind patterns, droughts, heavy precipitation, heat waves and tropical cyclones (Watson *et al.,* 1998; O'Brien and Leichenko, 2000).

Ethiopian is characterized by a history of climate extremes, such as drought and flood, and increasing temperature and decreasing precipitation trends (NMA, 2007). The history of climate extremes, especially drought, is not a new phenomenon in Ethiopia; moreover, the frequency of drought has increased, especially in the lowlands (Lautze *et al.,* 2003). Additionally, annual minimum temperature has been increasing and average annual rainfall has recently shown a very high level of variability (NMA, 2007).

Climate variability is a global concern as it severely affects the livelihoods of the world community in general and agricultural production and food security of the pastoral community in particular. Climate extremes affects agricultural production and productivity of the rural community both directly and indirectly (Seid *et al.,* 2016). Pastoralists and agro-pastoralists are one of the most vulnerable groups to climate variability and extremes. Increased climate variability could decrease herd sizes as a result of increased mortality and poorer reproductive performance of the animals. This decrease in animal numbers would affect food security and would compromise the only dependence of pastoralists on livestock and their products, as well as the additional benefits they confer (Herrero *et al.,* 2016).

Pastoralists in Ethiopia are mainly found in four lowland regions, Afar, Oromiya, Somali and the Southern Nations Nationalities and People's (SNNP) regional states. The Oromiya regional state, the Borana pastoralists are believed to be the dominant. Pastoralists in Ethiopia in general and in the Borana plateau in particular have the highest incidence of poverty and the least access to basic services compared with other areas (Oxfam, 2010), they are also among the most affected by climate variability.

Pastoral communities in Ethiopia represent 10 % of the country's population: approximately 60 % of the land area is considered to be under pastoral production. Ethiopia's livestock are believed to comprise the largest herd in Africa and the 10thlargest in the world (Yacob, 2000).

In Ethiopia, agricultural development is considered a priority by the government for stimulating overall economic growth, reducing poverty and achieving food security. The agricultural sector of Ethiopia accounts for about 42% of GDP and between 80–85% of employment (MoFED, 2013).

Within agriculture, the livestock subsector provides an opportunity for further development. The total size of the national livestock herd, one of the largest in Africa, makes it a resource with potential to contribute significantly to national development, including poverty reduction. The central statistical agency (CSA) survey of 2011/12 showed that the total cattle population of Ethiopia is about 52 million. Moreover, about 24.2 million sheep and 22.6 million goats are estimated to be found in the country, while the total poultry population is estimated to be about 45 million chickens (CSA 2011/12).

The livestock system among the Borena pastoralists is highly prone to climate variability and extremes to which they have limited adaptive capacity (Ayal *et al.,* 2017). The livelihood of pastoralists in Borana is adversely affected by climate variability and extremes (Hurst *et al.,* 2012). The ability of their adaptation strategies are compromised by climate extremes and associated risks (Hurst *et al.,* 2012; Aklilu *et al.,* 2009).As a result, today the livelihood in Borana zone is highly suffering from the recurrent impacts of climate extremes, especially drought and flash flooding. Thus, to shape the future adapting capacity of the pastoralists, it is important to notices factors affecting the decision to choose the ongoing adaptation strategies.

1.2 Statement of the Problem

According to Ayal *et al.,* (2018) the livestock sector has a key role in alleviating poverty in developing countries and it is a mainstay of the economy for pastoral communities. Ethiopia is among the least developed and the most vulnerable countries to climate variability because of its geographical location, low adaptive capacity and weather sensitive economy (NMA, 2007).

The livestock subsector is a major contributor to the overall economy. It contributes 19% of the GDP, and 16–19% of the foreign exchange earnings of the country (MoA, .compared with other areas (Oxfam, 2008).

Climate variability and extreme events have a deep effect on livestock diseases and well-being of Borena pastoralists. Increasing temperature and variations in the behavior of rainfall lead variations in the spatial and temporal distribution of climate sensitive livestock diseases (Ayal *et al.,* 2018).

The rainfall variability effects and unpleasant temperature favors outbreak of livestock diseases and depletion of pasture and water resources. Consequently, the Borena pastoralists are more vulnerable to climate variability (Akililu *et al.,* 2009; Maddison 2007).

Drought has extremely worrying the livestock resource basis of the pastoralists, particularly the water bases for livestock; pond and deep well, declining forage availability, decreasing the prices of livestock and livestock supply, in addition to the deprivation of rangeland resources and ultimately the consequence of drought is higher in decreasing the production performances of the livestock (Dirriba 2016; Ayal *et al*., 2015).

The ability of pastoral and agro-pastoral households to adapt is inhibited by many factors including land degradation, limited education, poor access to financial resources and markets to diversify their livelihoods, gender inequalities and marginalization and so on. It indicates that pastoralists have come under increasing pressure and their traditional coping and adaptation strategies have become insufficient to sustain their livelihoods (Oxfam, 2008).

On the other hand, studies undertaken on Borena pastoralists mainly focused on impact of climate variability and it extreme effects like frequency and severity of drought, rangeland degradation and ranking of coping strategies (Gemedo *et al.,* 2006), Cattle-rangeland management practices and perceptions of pastoralists towards rangeland degradation in the Borena zone of Southern Ethiopia (Solomon *et al.,* 2007) , Rangeland suitability analysis for livestock production using GIS and remote sensing (Fikadu, 2011).

Thus past studies have ignored factors that affect the choices of adaptation strategies (like changing species composition of livestock, grazing based on rotation in wet and dry seasons, diversification of livestock herds, livestock mobility and so on) , which are driving force to enrichment of the adapting capacity of pastoralists.

Therefore to build the future adapting capacity of Borena pastoralists it is important to analyze factors that affect the decision to choose ongoing adaptation strategies for climate variability.

Hence this research was proposed to analyze the determinant factors that affect the choice of climate variability adaptation strategies of Borena zone pastoralists'.

1.3 Objectives of the Study

The general objective of the study was to investigate the basic factors that affect the choice of climate variability adaptation strategies of Borena zone pastoralists'.

1.3.1 Specific Objectives

Under the general objective, the specific objectives desired to:

1. observe the trends and variability of rainfall and temperature (1981-2016) Borena zone Arero and Yabello Woredas.
2. describe the effect of climate variability and extremes on livestock production of Borena zone pastoralists
3. identify the current climate variability adaptation strategies practiced by Borena zone pastoralists.

1.4 Research Questions

This research intended to answer the following basic questions which are results of the above mentioned research objectives

1. How has climate variability affect the livelihood of Borena pastoralists'?
2. What are the adaptation strategies practiced by Borena pastoralists to overcome the effect of climate variability?
3. What are the basic factors that assist or inhibit Borena pastoralists' to choose their adaptation strategies to climate variability and extremes?
4. What are the roles of government institution and non-governmental organizations in developing the adaptive capacity of the Borena pastoral community and how has their involvement affected the community?

1.5 Limitation of the Study

The limitations of this study are mainly threefold. The first and the main limitation of the study was the area that covered by this study. The Borena zone is made from 13 Woredas (districts). Because of financial and time constraints the study area limited in two Woredas (Arero and Yabelo) and their representative Kebeles (Hallona and Dikale).

The second limitation was the issue that raised on this study. Even if the concept of climate variability and adaptation strategy to climate variability is wide the study focused on the five main adaptation strategies currently practiced by pastoralists in the study area and the basic factors that affect pastoralists to choose these adaptation strategies.

The third limitation of this study was during the household survey the respondents were expected to recall memories of their livelihood conditions from five years back. Although they found it practically hard, severe attempts were made to crack the pastoralists' memories about their prior livelihood situations.

1.6 Delimitation of the Study

Regarding its delimitation, this study is distinct out to two pastoralism sites in Borena zone with the intention of serious investigation and analysis so as to come up with intuitive recommendation. As the core concern of this study is to analyze the determinant factors that affect the choice of pastoralist's climate variability adaptation strategy in Borena zone. The pastoralists and agro-pastoralists' current socio-economic status, resource ownership position, access to basic natural resources, infrastructure and land use/land cover changes were investigated broadly and carefully.

1.7 Significance of the Study

As we know that the Ethiopian economy mainly depend on rain feed agriculture. Due to this, large proportions of the country's population are vulnerable to climate variability and related shocks. Pastoralists are the most vulnerable to climate variability as their livelihoods is heavily dependent on agricultural production. Therefore this study will help to understand the ongoing adapting strategy and factors that affecting the choice of adaptation strategies for climate extremes. It will also help the local government, donor organizations, NGOs and other international organizations in Borena zone. Additionally it provides evidences for further research and policy interventions to enhance the coping capacity.

1.8 Organization of the Paper

This thesis was categorized in to five chapters. Chapter one include the introduction, which focused mainly on the background information, statement of the problem, objectives, the limitations, delimitations and significance of the study. Review of the theoretical and empirical literature related to the concern of the study were presented in chapter two. Chapter three describes the research methodology that include a brief description of the study area, data collection procedures and analytical techniques. Chapter four reports on results of the study along with discussion. Finally, conclusion and recommendation were presented in chapter five.

CHAPTER TWO

2. RELATED LITERATURE REVIEW

2.1 Definitions and Theoretical Review

2.1.1 Definition of Climate Variability

Climate variability refers to variations in the mean state and other climate statistics (standard deviations, the occurrence of extremes, etc.) on all temporal and spatial scales beyond those of individual weather events (Keller *et al.,* 2007). Variability may result from natural internal processes within the climate system (internal variability) or from variations in natural or anthropogenic external forces (external variability) (IPCC 2007).

2.1.2 Climate Extremes

Extreme event - the occurrence of a value of a weather variable above (or below) a threshold value near the upper (or lower) ends of the range of its observed values in specific region.

"Every year, disasters related to weather, climate and water hazards cause significant loss of life and set back economic and social development by years, if not decades."

"From 1970 to 2012 ; 8,835 disasters, 1.94 million deaths and US$ 2.4 trillion of economic losses were reported globally as a result of droughts, floods, windstorms, tropical cyclones, storm surges, extreme temperatures, landslides and wildfires, or by health epidemics and insect infestations directly linked to meteorological and hydrological conditions (WMO, 2014).

2.1.3 Concept of Adaptation to Climate Variability

There are different definitions of adaptation to climate variability. These definitions are given as follows:

Adaptation - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploit advantageous opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC, 2001).

Adaptation - Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate variability. For example, flood walls should be built and in numerous cases it is probably advisable to move human settlements out of flood plains and other low-lying areas…" (UNFCCC, 2018).

Adaptation - is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented (UNDP, 2005).

All these three definitions differ from one another in several ways. First, all are used different words to describe the definition of adaptation. The first key words in the definition that express adaptation as 'adjustment', 'practical steps' and 'process' can be interpreted differently by various participants. 'Process' seems to be a very broad and open ended term that does not include any particular time or subject references and can easily incorporate 'steps' and 'adjustments'. 'Adjustment' seems to imply a process that leads toward some standard or goal.

These seemingly small differences might create different expectations from different stakeholders, depending on the meaning of the term that they decide to use.

2.1.4 Adaptive Capacity

Adaptive capacity can be defined as the ability of people to adjust to new circumstances individually or collectively for the reduction and mitigation of risk by changes in practices, processes or structures of systems (Cooper *et al.*, 2008). In the contexts of climate variability, IPCC define adaptive capacity as the ability of a system to adjust to climate variability and extremes to moderate potential damages, to take advantage of opportunities, or to familiarize with the consequences (IPCC, 2007). The extent to which communities are able to respond to a new set of circumstances that they have not experienced before would depends upon their adaptive capacity.

2.1.5 Overview of Climate Variability

Over the last century (between 1906 and 2005), the average global temperature rose by about $0.7^{\circ}c$ this has occurred in two phases, from 1910s to 1940s and more strongly from the 1970s to the present and causing severe problem over the world, widely accepted that climate variability is already happening and further to be anticipated (IPCC, 2007) .

Many studies into the detection and attribution of climate variability have found that most of the increase in average global surface temperature over the last 50 years is attributable to human activities (IPCC, 2001).

It is estimated that, for the 20^{th} century, the total global mean sea level has risen 12-22 cm, this rise has been caused by the melting of snow cover and mountain glaciers (both of which have decline on average in both hemispheres). The IPCC also notes that observations over the past

century shows, changes are occurring in the amount, intensity, frequency and types of precipitation globally (IPCC, 2007).

2.1.6 Cause and Impacts of Climate Variability

According to IPCC (AR4), human activity has significantly increased the concentration of carbon dioxide (CO_2) and other greenhouse gases (GHGs) in the atmosphere. Because the atmosphere's ability to capture and recycle energy emitted by the Earth's surface is essential to a stable climate, increasing emissions of GHGs lead to higher temperatures and introduce a destabilizing influence on global weather patterns and long-term climate. Global warming is recognized as having a significant impact on conditions affecting agriculture.

Global climate variability is the burning environmental issue today and will continue in the future. It is not a new occurrence, but the warming that is occurring today is uncommon with respect to the rate of change**.** This is caused by both natural factors such as volcanic eruption, variations in the earth's orbital characteristics and variations in solar output, and human induced causes mainly by the emission of greenhouse gases **(**Getachew *et al.,* 2014**).**

Global climate variation brought by liberating greenhouse gas concentration has been widely accepted by international community (IPCC, 2007). Scientists are observing the global climate show a collective picture of a changing climate and a warming world. The global mean surface air temperature has greater than before by 0.6˚C over the 20^{th} century. It is predictable to rise between 1.4 ˚C - 5.8 ˚C by 2100 depending largely on the level of fossil- fuel combustion. (IPCC, 2007)**.**

Climate variation now-a-days is assumed as one of the most challenging and complex problem facing the agricultural development globally. However, the prone to climate variability on this sector in Africa is more than any other socioeconomic activities. The production of crop yield in Africa will decrease up 50% due to climate variation. These effects vary from region to region in particular the risk in Ethiopia becomes more severe since more than 85% of the country's economy dependent on rain fed agriculture (Gedefaw *et al.,* 2018).

Climate variability and extreme events have a deep effect (impact) on livestock diseases and the well-being of the pastoralists and agro-pastoralists. Increasing temperature and changes in the behavior of rainfall lead to changes in the spatial and or temporal distribution of climate-change sensitive livestock diseases (Ayal *et al.,* 2018).

2.1.7 Climate and Vulnerability to Climate Variability in Ethiopia

Climate is often described by the statistical interpretation of precipitation and temperature data recorded over a long period of time for a given region or location. Mean annual rainfall distribution over the country is characterized by large spatial variation which ranges from about 2000 mm over some pocket areas in the Southwest to less than 250 mm over the Afar and Ogaden low lands (NMA, 2001).

Rainfall during a year occurs in different seasons. Unlike most of the tropics where two seasons are common (one wet season and one dry season), three seasons are known in Ethiopia, namely Bega (dry season) which extends from October-January, Belg (short rain season) which extends from (February-May), and Kiremt (long rain season) which extends from June-September. Temperatures are also very much modified by the varied altitude of the country. In general, the country experiences mild temperatures for its tropical latitude because of topography. Mean annual temperature distribution over the country varies from about 10°C over the highlands of northwest, central and southeast to about 35° C over north-eastern lowlands Ethiopia is heavily dependent on rain fed agriculture. Its geographical location and topography in combination with low adaptive capacity entail a high vulnerability to adverse impacts of climate variability. Regional projections of climate models not only predict a substantial rise in mean temperatures over the 21st century, but also suggest an increase in rainfall variability with a rising frequency of both extreme flooding and droughts due to global warming. The agricultural sector also affects performance in other sectors of the economy. Hence, there is a strong observable link between climate variations and overall economic performance (NAPA, 2007).

Vulnerability is the degree to which a system is susceptible to, or unable to cope or adapt with, adverse effects of climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed relative to its sensitivity and its adaptive capacity (NAPA, 2007).

Ethiopia is especially vulnerable to climate variability and extremes because large portions of the population are poor and depend on agricultural income, which is highly sensitive to rainfall variability and change in temperature. The farmers/pastoralists have low access to education,

information, technology, and basic social and support services, and as a result, have low adaptive capacity to deal with the consequences of climate variability (Oxfam, 2010).

Ethiopia is among the least developed and the most vulnerable countries to climate variability due to its geographical location, low adaptive capacity and weather sensitive economy (NMA, 2007; World Bank, 2010). Rainfall is highly irregular and there is a high degree of variability in both time and space (NMA, 2007; EPCC, 2015).

Ethiopia is historically prone to extreme weather events. Rainfall in Ethiopia is highly irregular, and most rain falls intensively, often as convective storms, with very high rainfall intensity and extreme spatial and temporal variability. Since the early 1980s, the country has suffered seven major droughts, five of which led to famines in addition to dozens of local droughts (Diao and Pratt, 2007). Survey data show that between 1999 and 2004 more than half of all households in the country experienced at least one major drought shock (UNDP, 2007). Major floods occurred in different parts of the country in 1988, 1993, 1994, 1995, 1996, and 2006 (ICPAC, 2007).

2.1.8 Overview of Pastoralism in Ethiopia

Pastoralism is the major livelihood system, in most of arid and semi-arid areas of the horn of Africa in general, and specifically in the lowland arid and semi-arid areas of Ethiopia. In Africa, it has been expected that between 20 and 40 million agro-pastoralist and pastoralist people depend on livestock as their major source of food and money (Gebremichael *et al.,* 2010).

More than 10 million of Ethiopian are pastoralists (CSA, 2008), herding their livestock in the arid and semi-arid lowlands that constitute about 61% of the country's land mass. These areas are prone to rainfall variability, extreme drought and flash floods. In pastoral areas of Ethiopia, climate variability increased the burden of those who are already poor and at risk by affecting their livelihood pattern and activating feed, water and social insecurity (MARD, 2008).

Pastoral areas in Ethiopia are characterized by frequent drought with high livestock mortality which often results in threatening viability of pastoral livelihood, famine and deaths in human population. For example, the 1973/74 drought that affected the pastoral areas in general and the Afar pastoralist in particular decimated 72% of the cattle herd, 45% of sheep, 34% of goats and 37% of camels. In both the 1983-5 and 1990-2 droughts the Borana pastoralists in southern Ethiopia lost 50 to 60% of their livestock inventory (Solomon and Coppock, 2004).

The Borana are one of the well-known East African pastoral groups who settle southern Ethiopia and northern Kenya. The Borana pastoralist grazing territory in Ethiopia accounts for about 9 % of the county's total landmass. The area is agro-ecologically comprised of arid and semi-arid ecological zones with bi-modal rainfall pattern of average range of 400-700 mm. The arid and semi-arid agro-climatic characteristics of the Borena district somewhat clearly suggest the importance of pastoralism as the single most important livelihood source to the growing human population in the area (Berhanu, 2011).

Borana pastoralism is mainly characterized by milk dependent cattle herding and also keep small stock and camel. The household pastoral herds are divided into Warra and Fora herd units. The Warra unit is comprised of milking cows and weak animals kept in semi-settled camp site with women, children, and the elderly. The Fora splits are mobile herd units that migrate to remote territories with able male herders (Berhanu, 2011).

2.1.9 Livestock Production

Livestock is the main backbone of Borena pastoral economy including Yabello district. Most commonly, cattle, sheep, goats and camels are the major livestock the pastoral depends on (BZFEDO, 2010). During severe drought periods, the cattle stock would wipe out, compounding food scarcity otherwise forced to move longer distance for search of water and forage (Senait *et al.,* 2010). Droughts depleted the population of cattle through heightening mortality and forced off-take (Megersa, 2013).

In southern Ethiopia, it is the greatest threat to livestock production system, which recurrently erodes the livestock asset before full recovery achieved (Angassa and Oba, 2007). As a result, Borena pastoralists are much poorer today than they were in decades, as livestock per capita bas declined from 4.1-2.3 TLU' and more recently found 1.9 (Desta, 1999; Bekele, 2011).Additionally, the mean figure of three TLU per capita was reported only for 12% of the Borena pastoralists (Homann *et al.,* 2007). The decline in livestock per capita and resultant shifts in households' wealth ranks over a period of years reflect the erosion of the pastoral economy (Little *et al.,* 2006).

Now days, the productivity of livestock was reduced in which 10-20 animals, as compared to forty years ago when one or two lactating animals was sufficient to sustain the livelihood of pastoral households (Hurst *et al.,* 2012). The standard livestock per capita for self-sufficiency by agro-pastoral households is accepted to be 3-4.1 TLU per person, and 7 TLU per person for a pure

pastoral community (Sandford, 1983; Lybbert *et al.*, 2004). However, in Borena the numbers of poor pastoral households are increasing overtime (Lybbert *et al.*, 2004). Another study indicated that the poor classes constitute 80% of the total household composition, while the very rich, rich and self-sufficient together constitute 20% (Tache and Sjaastad, 2008).

2.1.10 Crop Production

Pastoralists were largely depend on livestock husbandry to make a living whereas agro pastoralists depending on both growing crops and raising livestock (Coppock, 1994). However, sometimes most agro-pastoral households did not get any harvest due to rain shortages and subsequent crop failures because of climate variability. The climate variability has clearly increase the frequency of drought beyond the expectation of the pastoral households. Droughts usually kill more livestock, which accelerated a decline in pastoral production system and welfare in the face of increasing population density (Markus, 2013).

As a result, opportunistic cultivation is become one of the few alternatives that pastoralists have partially compensate for such a long-term trend. Increased cultivation was attributable to a declining ratio of livestock to people as exacerbated by human population growth and drought (Tache, 2008). Thus, drought was found to be elicit at least a temporary reliance on cultivation by pastoralists until livestock productivity and numbers recover (Skinner, 2010). In most cases, the depletion of smaller herds from the poor pastoralists induces the permanently shift into farming unfortunately.

2.2 Empirical Literature Review

2.2.1 Adaptation Strategies and Determinant to Adaptations

Hassan and Nhemachena (2008) analyze the determinant of farm level climate adaptation measures in Africa using multinomial choice model fitted to data from a cross-sectional survey from 11 countries. The results indicate that specialized crop cultivation (mono cropping) is the agricultural practice most vulnerable to climate variability in Africa. In this study better access to markets, extensions and credit services, technology and farm assets (labor, land and capital) are critical for helping African farmers adapt to climate variability.

Juana *et al.,* (2013) study on farmers' perception and adaptation to climate variability in sub-Sahara Africa using a survey date from farmers in sub-Sahara Africa. His finding revealed that most of farmers in sub-Sahara Africa are aware that the continent is getting warmer, and precipitation or rainfall patterns have changed. In addition the precipitation patterns in are different for different regions in Africa. The result indicates crop diversification, planting different crop varieties, changing planting and harvesting dates, irrigation, planting tree crops, water and soil conservation techniques are the major adaptation to the changing of pattern of precipitation. In this case the year of farming experience, household size, year of education, access to credit, access to extension service and off-farm income are among the significant determinant of adopting climate variability adaptation measures.

Temesgen *et al.,* (2009) used MNLM to analyze factors affecting the choice of adaptation methods to climate variability based on a cross-sectional survey in the Nile basin of Ethiopia. The results indicated that household's characteristics such as education, farm and nonfarm incomes have significant impact on adaptation to climate variability. The study further revealed that institutional factors such as extension on crop and livestock production, access to information on climate variability and access to credit enhanced adaptation to climate variability.

Ajao and Ogunniyi (2011) used MNLM to analyze the strategies used by farmers for adopting to climate variability based on a cross-sectional survey of 150 farming households from Ogbomoso agricultural zone of Oyo State, Nigeria. The results indicate that household's characteristics such as age, education, household size and nonfarm incomes, which could enhances through policy intervention, have significant impact on adaptation to climate variability. The study further revealed that institutional factors such as extension on crop and livestock production and access to information on climate variability enhancing adaptation to climate variability.

Ringler *et al.,* (2009) they studied on adaptation to climate variability in Ethiopia and South Africa: options and constraints. Based on the finding they pointed out that, climate variability is expected to adversely affect agricultural production in Africa. Because agricultural production remains the main source of income for most rural communities in the region, adaptation of the agricultural sector is imperative to protect the livelihoods of the poor and to ensure food security. A better understanding of farmers' perceptions of climate variability, ongoing adaptation measures, and the decision-making process is important to inform policies aimed at promoting successful adaptation

strategies for the agricultural sector. They were used data from a survey of 1800 farm households in South Africa and Ethiopia. The study presented the adaptation strategies used by farmers in both countries and analyzes the factors influencing the decision to adapt. They find out that the most common adaptation strategies include: use of different crops or crop varieties, planting trees, soil conservation, changing planting dates and irrigation. However, despite having perceived variability in temperature and rainfall, a large percentage of farmers did not make any adjustments to their farming practices. The main barriers to adaptation cited by farmers were lack of access to credit in South Africa and lack of access to land, information, and credit in Ethiopia. Factors influencing farmers' decision to adapt include wealth, and access to extension, credit, and climate information in Ethiopia; and wealth, government farm support, and access to fertile land and credit in South Africa. They are used a pooled dataset to analysis the factors affecting the decision to adapt to perceived climate variability across both countries reveals that farmers were more likely to adapt if they had access to extension, credit, and land. Food aid, extension services, and information on climate variability were found to facilitate adaptation among the poorest farmers. They conclude that policy-makers must create an enabling environment to support adaptation by increasing access to information, credit and markets, and make a particular effort to reach small scale subsistence farmers, with limited resources to confront climate variability.

Zivanomoyo and Mukarati (2013) used MNLM to analyze the determinants of choice of crop variety as adaptation options for climate variability in arid regions of Zimbabwe. The result suggested level of education of farmers and credit availability as the key determinants of choice of crop variety as adaptation option.

2.3 Definition of the Dependent and Explanatory Variables for Multinomial Logit Model

2.3.1 Dependent Variables

The dependent variables or the five main adaptation options that the pastoralist and agro-pastoralists employed in response to climate variability for this study were:

Livestock Diversification: - is referring to the shift from the regional dominance of one livestock to regional production of a number of livestock's (which takes in to account) the economic returns from different value added livestock's.

Changing Species Composition: - Species composition is the identity of all the different organisms that make up community, changing species composition means adjusting the identity of the organisms with the community or surrounding for better survival.

Destocking: - is a strategy that used to reduce the livestock holding when there is a shortage of forage and water or disease outbreak. The household may consider identifying an "A" herd (animals he/she will keep) and a "B "herd (animals that can be sold during drought).

Livestock Mobility: - Regarding livestock breeding, it refers to herds moving seasonally or occasionally over small or long distances.

Grazing Based on Rotation between Dry and Wet Season: - is the shifting of livestock to different units of pasture or range in regular sequence to permit the recovery and growth of the pasture plants after grazing.

2.3.2 Independent (Explanatory) Variables

The independent variables are the factors that affect choice of adaptation methods to climate variability. Different literatures were reviewed on the factors that affecting pastoralists' choice of adaptation method to climate variability. Majority of them have been focused on household characteristics, institutional factors and environmental factors. Accordingly, the researcher was conceded the following as exogenous variables i.e. factors influence pastoralists choice of adaptation strategies to climate variability.

Age of the Household Head: - This is a continuous variable and represents the experience of the household in the pastoral activities. This variable was likely to have a positive sign.

Gender of the Household Head: - Gender is a dummy variable which indicate 1 if male household head and 0 otherwise. The expecting sign of this variable was uncertain.

Level of Education of the Household Head: - This is the number of years spent by the head of the household for acquiring education and the anticipated sign was positive. As the level of education of the household head increased the pastoralists' closeness for new information and the probability of accepting new technology also increase.

Household Size: - Household size is the total family member of the household. Large number of family member can adopt the effect of climate variability easily. Therefore, it was expected that household size has a positive sign for the pastoralists' who are used adaptation method to climate variability. This variable is also a continuous variable.

Off Farm Income: - This is an income of household obtains from outside of pastoral activities. For example trade, remittance and governmental employer are among others. Such income is makes the pastoralists not to follow up or motives properly to livestock raring. Therefore, the expected sign of this variable was negative for the pastoralists' who are used adaptation method to climate variability and it is a continuous variable. This variable also measure in Ethiopian Birr.

Access to Credit Service: - The availability of credit is important for the pastoralists' in order to make adaptation strategies. Credit can be used as pastoralists to introduce new technology, to buy modernize livestock and medicine. As a result this was expected a positive sign for the pastoralists' who are used adaptation method to climate variability and is a dummy variable indicating 1 if the pastoralists has access to credit 0 otherwise.

Availability of Extension Service Provider: - This service is crucial to make pastoralists' to adopt strategies. The extension service provider helps as a source of information and sharing of experience among pastoralists'. This variable was a continuous variable which shows the frequency of contact between extension service provider and pastoralists. The expected sign of this variable was a positive.

Livestock Holding: - Livestock holding is the total livestock that pastoralist can own on the livelihood. Livestock is a vital instrument in the case of climatic variability to adopt. This implies that pastoralist with more numbers of livestock is the richer and can respond to the adverse impact of climate variability through adaptation method. This is a continuous variable and expected a positive sign for the pastoralists' who were used adaptation method to climate variability.

Distance to the Market: - This is a continuous variable which measures in terms of distance covered from the residence of pastoralist's household to the market area. The residences of pastoralists' are nearest to the market they get a lot of opportunities as compare to the far ones. Because the nearest one obtains agricultural inputs, information's and experiences. Therefore, this variable was expected a negative sign for the pastoralists' who were used adaptation method to climate variability.

Access to Climate Information: - This is dummy variable indicating 1 if the household head access to climate information 0 other wise. This variable is also expected a positive sign for the pastoralists' who were used adaptation method to climate variability.

Access to Training: - It refers to an intensive awareness creation both by government and non-governmental organizations to promote alternative income-generating activities, livestock management and managements of climate related risks. It is a dummy variable which can take 1 if get training and 0 otherwise. In this study, access to training was expected to be positively influence the decision to choose strategies.

CHAPTER THREE

3. DESCRIPTION OF THE STUDY AREA AND RESEARCH METHODS

3.1 Description of Study Area

This study was conducted in southern Ethiopia in the Borena zone of Oromiya regional state in the districts of Yabelo and Arero which lies between 4˚41' – 5˚03' N and 38˚ 17' – 38˚ 33' E. The zone is made up of 13 Woredas / districts covers a total area of 48,743km^2 with an average altitude of 1,500m above sea level. It is an arid and semi-arid area, with pockets of sub humid zones. Rangelands are dominated by tropical savannah vegetation with varying proportions of open grass lands and perennials woody vegetation (NAPA, 2007).

Borena's climate is basically divided into two; namely the one for the mid-highland and highland areas, and the other for lowland areas. The former is represented by Abaya, Galena and Bule Horra Woredas while the latter by the rest 10 Woredas falling in the lowlands. The former shows quite similar climate to that of the highland areas of Ethiopia while the latter is rather different. As is well-known, bimodal rainy seasons in Ethiopia; and early rainy seasons in a year provides less rainfall than that of late rainy seasons of the highland areas while the reverse takes place for the lowland areas of Borena (NAPA, 2007).

The lowland areas of Borena severely affected by recurrent droughts. Looking at the rainfall pattern in the lowland area, about 50% of annual rainfall occurs in the long rainy season (Ganna), which covers from March to May, while about 30% falls in the short rainy season (Haggaya) from September to November, The long dry season (Bona) occurs from December to February, and the short dry season (Adolessa) occurs from June to August. Variable rainfall results in great variability of pasture availability (NAPA, 2007).

Pastoral production provides an immense contribution to the national economy by raising 40 % of the country's cattle, 75% of goats, 25% of sheep, 20% of equines and 100% of camels (Yacob Ararso 2000). The total direct economic contribution of pastoralism to the economy (through the production of milk, meat, hides and other items) was estimated at more than US $1.5 billion (Birhanu and Feyera 2011).

In Borenal zone alone, it is estimated that more than 40% of income derived from the sale of livestock (ACSF-Oxfam, 2014); livestock exports from this region contribute significantly to national foreign exchange earnings. Agriculture, as a whole accounts for 90% foreign exchange earnings (Ethiopia Country Report, 2012).

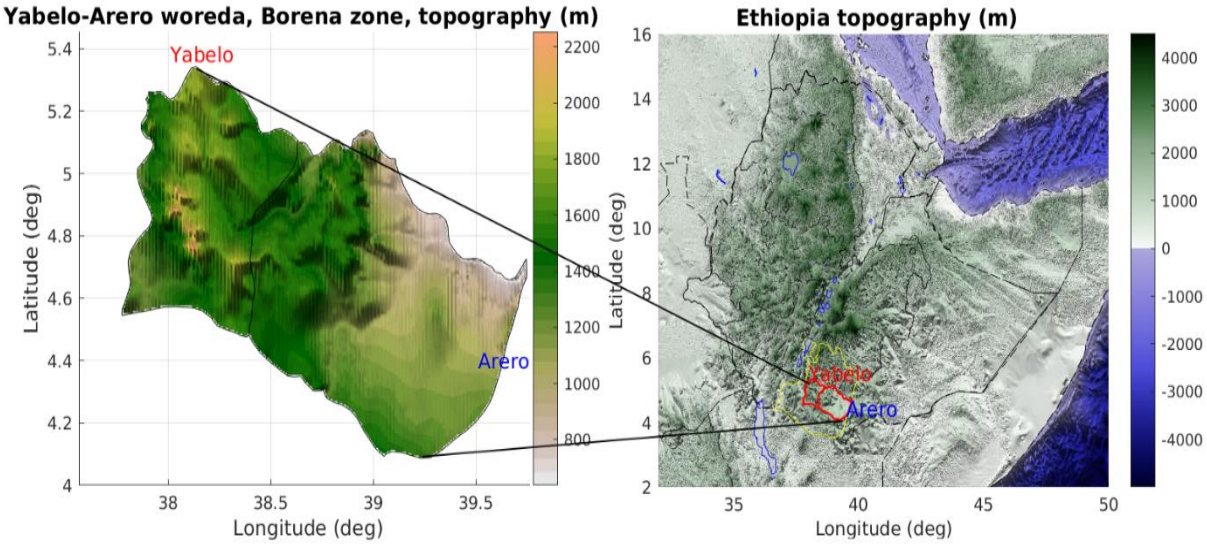

Figure 2: Map of the Study Area
Source: Own survey result, 2019

3.2 Research Design

The study used mixed research approach. Both the qualitative and quantitative methods that applied for this studies were cross-sectional (it used the time moment data which collected during data collection). Using qualitative and quantitative research methods enables the researchers to explore a research problem better (Creswell, 2008). In addition to this the study used a longitudinal research design (which means it used thirty consecutive years' metrology data to analyze the climatic trend of the study area).

3.3 Sample Size and Sampling Techniques

Determining an appropriate sample size is very important in any research as samples that are too large can waste resources; while too small samples may scarcely represent the population and lead to wrong findings and recommendations. Sample size is determined by several factors such as homogeneity/heterogeneity of the population, acceptable sampling error (level of precision) and

confidence (risk) level.

By consulting the representative professionals working on climate and related issues in Borena zone Arero and Yabelo Woredas were selected by experts because of their physical accessibility and the occurrence of climate variability with direct and indirect impacts on the pastoral livelihoods as compared to the rest Woredas. As a result of this the study purposively select Dikale and Hallona Kebeles to represent Arero and Hallona Woredas respectively.

3.3.1 Sample Size Determination

The total numbers of households in the selected Kebeles were 240 and 230 households respectively for Yabelo and Arero Woredas, by using (Yamane 1967) formula the sample size described as:

Sample Size (n) = $\frac{N}{1+N(e)2}$ where, n = the sample size

N = the population size

e = the level of precision (0.05)

Sample Size (n) = $\frac{N}{1+N(e)2}$

Sample Size of Hallona = $\frac{230}{1+230(0.05)2}$ = 146 households.

Sample Size of Dikale = $\frac{240}{1+240(0.05)2}$ = 150 households

Hence, by applying Yamane's (1967:886) sample size determination formula, (at 5 % level of precision), only 296 respondents (146+150) were drawn from the two Kebeles. The population in the study area were not purely pastoralists it compromise both pastoralists and agro-pastoralists households. The proportion were nearly 70% and 30 % pastoralists and agro-pastoralists respectively. Therefore the sample size of this study was classified in their percentage proportion. Therefore total number of pastoral and agro-pastoral respondents selected for this study were 202 and 94 respectively.

3.4 Tools of Data Collection

The research was applied structured household interview, focus group discussions (FGDs), and key informant interviews (KIIs).

3.4.1 Structured Household Interview

Another vital data acquisition tool employed for this study was household interview. This enabled the researcher to capture multiple attributes like demographics, socio-economic characteristics, climate variability effects on different resources, their means of livelihoods and adaptation strategies. Sample household heads were requested to respond in the questionnaire under a close supervision of the researcher and/or trained field enumerators.

Moreover, the questions were translated into Afan Oromo (Oromo Language) for simplicity and precision purposes. In order to reduce the paper work the study applied tablets which contain data template designed by CSPro 7.1 (Census Survey Programming version 7.1 software) to register the responses of sample respondents.

3.4.2 Key Informant Interview (KII)

Key informant interviews were carried out with the intention of capturing more firsthand socio economic and biophysical data for the study. The key informants were 8 experts from each Kebele from each different administrative levels like development agents from livestock and crop experts, health extension, food security disaster risk prevention and preparedness, from gender and land & environmental protection offices were interviewed. Chairmen and managers of each Kebele were also key informants for the study. Each interview was carried out by the researcher with the aim of making further investigations on the basis of the information received from the respondents.

The key informants were asked questions on the experiences they had on climate variability in Yabello and Arero and what they have witnessed on early warning of droughts, floods and rain among the Borona communities' livelihoods and their social well-being. They were also asked to give the effects of climate variability on the Borona community and the determinant factors that influence pastoralists to choose their adaptation strategies to climate variability.

3.4.3 Focus Group Discussion (FGD)

Two focus group discussions were carried out with representatives from different economic status gender, age group (youth, adult and elderly) community members were considered in the focus group discussions.

The issues discussed were the people's understanding of climate variability, the indicators of climate variability, the adaptation strategies that community used and factors that determine to choose the ongoing adaption strategies to climate variability and extremes.

3.5 Method of Data Analysis

In this research both descriptive and econometric methods of data analysis were used. Descriptive statistics such as mean, standard deviation, coefficient of variation, percentage were used to analyze household socioeconomic and demographic characteristics and determine trends and variability of temperature and rainfall at different time interval. Multinomial Logit model (MNL) was employed to identify factors influencing choice of climate variability and extremes adaptation strategies by sample households. Analysis of temperature and rainfall data involved characterizing long term mean values, and calculations of indices of variability and trend at seasonal and annual time steps. Standard anomaly was calculated to assess rainfall and temperature variability. Mann–Kendall test as described by Sneyers (1990) was used to detect trends. The significance level of the slope was estimated using Sen's method. Nonparametric Mann– Kendall test and Sen's method are less affected by outliers (Salmi et al., 2002).

3.6 Theoretical Model

In this study it is interesting and necessary to develop theoretical framework on pastoralist household. This theoretical framework draws on adopting a version of model based on the random utility model as specified by (Green, 2003). This random utility model is commonly used as a framework in determining of pastoralists' choice for different adaptation strategies. I can specify a common formulation of linear random utility model as;

$$U_{ij}=\beta j\, X_{ij} + \varepsilon_{ij} \qquad \text{for } j \in \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Following Greene (2003) we can modify it to adapt the objective of the study. Where, i =1,…, N are the individual pastoralist and j = 1,…..J are the alternative adaptation methods, X_{ij} vector are the factors that influence pastoralists' choice an adaptation method to climate variability and ε_{ij} is the random error term /disturbance term. To elaborate the model, let me assume that pastoralists' are rational decision makers who maximize the utility from adaptation strategies in their activities. And also assuming that pastoralists face climatic variability in their activities was looked for adaptation strategies.

If pastoralists i make choice j adaptation in particular, then assume that U_{ij} is the maximum utility among the J adaptation methods.

$$\text{Prob}\ (U_{ij} > U_{ik}) \qquad \text{for all other } k \neq j.$$

The probability of that a particular pastoralist will choose a particular alternative j is given by the probability that the utility of that alternative to the pastoralist is greater than the utility to that pastoralist of all other alternative J.

3.7 Econometrics Model

In order to achieve the objective, the study employed multinomial logit model. Multinomial logit was used to determine factors that influence pastoralists' choice of adaptation method to climate variability and identifying the pastoralists' adaptation strategies in response to climate variability. The mathematical specifications of this model are given as below.

3.7.1. Multinomial Logit Model

The MNL model is easy, simple in calculating the choice probability and expressible in analytical form (Tse, 1987). The main limitation of the model is the independent of irrelevant alternative (IIA) property, which states that the ratio of the probability of choosing any two alternatives is independence of the attributes of any other alternative in the choice set (Hausman and McFadden, 1984). The multinomial probit (MNP) model specification for discrete choice model does not require the assumption of the IIA (Independence Irrelevant Alternative) (Hausman and Wise, 1978). Due to the fact that this MNP model an inconvenient specification test as compared to the MNL model (Hausman and McFadden, 1984).

The MNL model was used by many researchers to the model climate variability adaptation practices of smallholder farmers (Deressa *et al.*, 2009, Nhemachena and Hassan, 2008).

Therefore, the multinomial logit model is appropriate to the model of climate variability adaptation practice of pastoralists and agro-pastoralists in the study area.

To describe the multinomial logit model, let Y denoted vector of adaptation options for climate variability to chosen by pastoralist household. Assuming the adaptation option pastoralists' choice are depends on climatic factors, institutional factors and socioeconomic characteristic of the farmers'.

The Multinomial logit model for the adaptation choice can be specified as in the following relationship between the probability of choosing option and a set of explanatory variables X (Greene, 2003).

$$\text{Prob } (Yi = j) = \frac{e^{\beta' j x_i}}{\sum_{K=0}^{5} e^{\beta' K x_i}} \quad , j= 0, 1, 2, \ldots, 5 \ldots\ldots\ldots\ldots..(1)$$

Equation (1) is normalized to remove indeterminacy in the model by assuming $\beta = 0$ and the probabilities can be estimated as:-

$$\text{Prob } (Y_i = j/x_i) = \frac{e^{\beta' j x_i}}{1+\sum_{K=0}^{J} e^{\beta' K x_i}} \quad , \quad j = 0, 1, 2\ldots J, \quad \beta\ldots\ldots\ldots\ldots(2)$$

Maximum likelihood estimation of equation (2) yields the log-odds ratio

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x'_i (\beta_j - \beta_k) = x'_i \beta_j \quad , \text{if } K = 0\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

The dependent variable of any adaptation option is therefore the log of odd in relation to the base alternative

According to Greene (2003), the MNL coefficients are difficult to interpret and associating the with the j^{th} outcome is attractive and misleading. Marginal effect is useful to interpret the effect of independent variable on the dependent variable in terms of probabilities

$$\frac{\partial P_j}{\partial X_i} = P_{j(\beta j - \sum_{k=0}^{J} P_K \beta_J) = P_j(\beta_j - \beta)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The marginal effects, measure the expected change in probability of a particular choice being made with respect to a unit change in explanatory variable (Greene, 2003).

3.8 Statistical and Specification Tests

Before carry out the final model regressions, all the explanatory variables were checked for some statistical problems such as the issue of multicollinearity. Basically, multicollinearity problem may arise due to a linear relationship among explanatory variables and the problem is that, it might cause the estimated regression coefficients to have wrong signs, smaller t-ratios for many of the variables in the regression and high R-square value. Besides, it causes large variance and standard

errors with a wide confidence interval. Hence, it is quite difficult to estimate accurately the effect of each variable on the dependent variable (Gujarati, 2004).

There are different methods suggested to detect the existence of multicollinearity problem between the model explanatory variables. Among these methods, variance inflation factor (VIF) technique is commonly used and is also employed in the present study to detect multicollinearity problem among the explanatory variables (Gujarati, 2004).

Gujarati (2004) defined that VIF shows how the variance of an estimator is inflated by the presence of multicollinearity. Larger value of the VIF is an indicator for presence of the problem of multicollinearity among the explanatory variables. If the VIF of a variable exceeds 10 then that variable is said be highly collinear. Correlation Matrix method was also used to detect the degree of association explanatory variables. These variables are said to be collinear if the value of the coefficient correlation Matrix is greater than 0.75.

In addition, the model specification test was conducted for Multinomial login model. In this case three models were estimated and the model comparison was undertaken using Bayesian Information Criterion (BIC) and chi-square statistics and the model with lowest BIC was selected. Following the model specification test, the validity of assumption of independence from irrelevant alternative (IIA) tests was also conducted and ended up with accepting the null hypothesis of IIA holds. This indicates that, the multinomial logit model is appropriate.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1. Trend and Variability of Rainfall and Temperatures

4.1.1 Annual and Seasonal Rainfall Trends

Figure 2 illustrates seasonal and annual rainfall variability and trend in Yabelo-Arero Woreda. The yearly trend of spring/ **Ganna** (Z= - 0.016 mm/year, p =0.34), summer/ **Adolessa** (Z=-0.03 mm/year, p=0.06) and winter/ **Haggaya** (Z= 0.026 mm/year, p=0.1). For all seasons $p \geq 0.05$ signifies rainfall has no trend. The rainfall variability is very high as illustrated in Figure 3 (d) and (e). Out of 35 years 16 years are marked by above normal **Ganna** rainfall record whereas 16 years had below normal rainfall. Throughout the study period 15 years each above normal and blow normal **Adolessa** rainfall was observed. 22 years below normal **Haggaya** rainfall was recorded during the study period. Some of them have extreme values which may have drought conditions. However, some years have extreme rainfall condition, for instance 1985, 2003, 2010 during **Ganna** season and 1982, 1997 and 2011 during **Haggaya.** These events indicate the occurrence flood in the district.

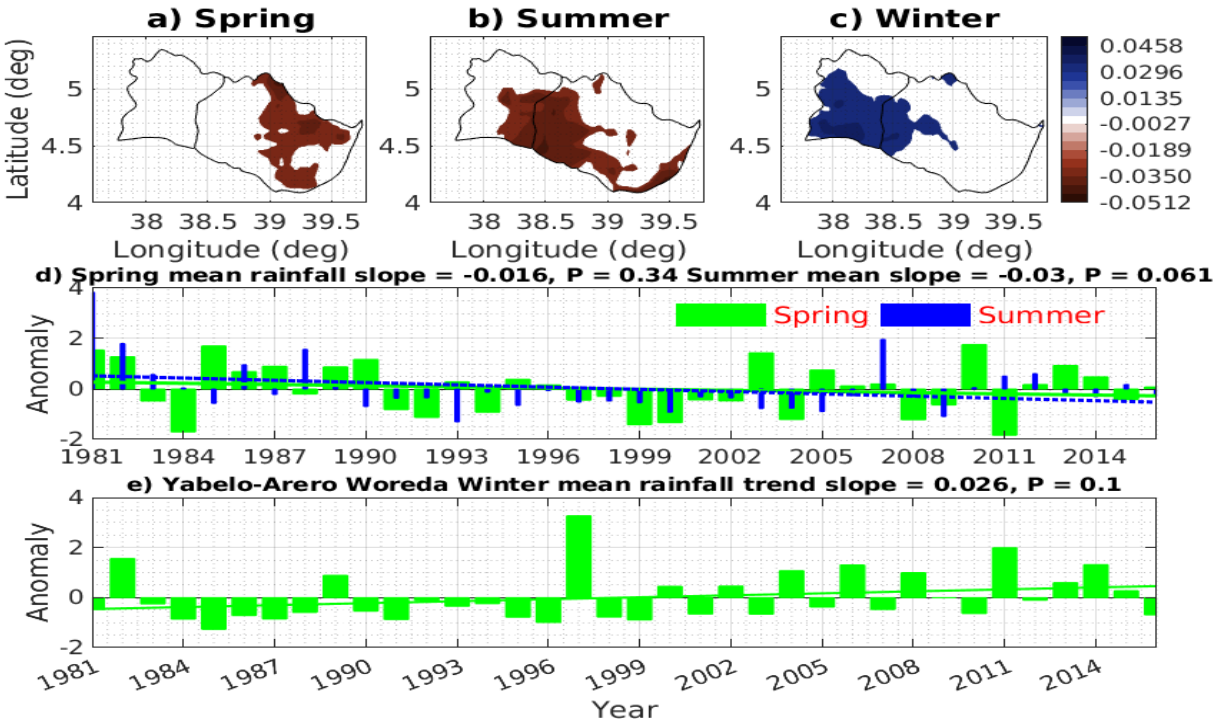

Figure 2 Special trends of (a) Spring (b) Summer and (c) Winter seasons (d) Spring and summer anomaly and trend of rainfall (e) Annual rainfall anomaly and trend during 1981-2016.

4.1.2 Annual and Seasonal Rainfall Variability

From the table 1 we can see that, the long-term average mean for annual rainfall, main rainy season /**Ganna** , moderately small rainy season/ **Haggaya** rainfall and very little rainy season Summer/ **Adolessa** was 78.5, 42.63 and 19.32 mm with standard deviation of 22.4, 21.9 and 13.5 coefficient of variation 0.285, 0.513 and 0.7 respectively. The highest coefficient of variation is for the smaller rainy season with highest fluctuation of rainfall distribution followed by the small rainy season. This is consistent with previous studies, for example, Nicholson (1996) and Pohl and Camberlin (2006) that conclude the greater rainfall variability is experienced during the small rainy season than the main rainy season.

Table 2: Monthly and seasonal rainfall variability

Mon	Mean	Median	Variance	STD	CV	R2	MAD	IQR	Range	Skewness	Kurtosis
Jan	13.75	11.18	280.7	17	1.236	21.7	11.27	15.1	75.65	2.131	7.509
Feb	15.98	8.334	444.6	21.4	1.338	26.5	14.48	22.5	112.8	2.749	12.66
Mar	57.55	51.69	1815	43.2	0.751	71.6	34.73	61.8	184.6	0.8827	3.561
Apr	153.3	161.9	3106	56.5	0.369	163	48.09	85.2	223.5	0.2088	2.257
May	87.16	85.35	2225	47.8	0.549	99.1	37.3	68.4	190.3	0.626	2.928
Jun	12.74	9.035	127.6	11.5	0.899	17	9.339	17.9	42.77	0.9162	2.728
Jul	18.07	14.38	268.9	16.6	0.92	24.4	11.32	16.6	75.6	2.06	7.635
Aug	16.76	8.158	429.6	21	1.254	26.7	14.19	18.7	95.05	2.237	7.862
Sep	29.71	25.39	569.8	24.2	0.815	38.1	18.51	28.7	102	1.199	4.214
Oct	84.42	83.63	2347	49.1	0.582	97.3	36.85	53.5	212.1	0.8675	3.539
Nov	55.15	40.52	2186	47.4	0.86	72.3	34.55	50.4	200.1	1.659	5.591
Dec	17.22	10.29	485.9	22.4	1.298	28	15.41	22.2	115.2	2.569	11.34
spring	78.5	80.84	486.1	22.4	0.285	81.5	18.61	34.6	80.58	0.01617	2.063
summer	19.32	15.33	177.6	13.5	0.7	23.5	9.284	10.5	69.53	1.971	7.57
winter	42.63	34.7	465.5	21.9	0.513	47.8	17.27	27.1	99.36	1.327	4.512

Source: Own survey result, 2019

4.1.3 Trends of Minimum and Maximum Temperature

The maximum and minimum temperature of Yabelo-Arero Woreda is shown in Figure 3. Temperature increments in all seasons were observed in Arero which is lowland area of Yabelo-Arero Woreda. Spring minimum temperature increment was 0.046 ^{0}c/year, p=0.0025, 0.059 ^{0}c

/year, p =0.002, 0.047 ^{0}c/year, p = 0.002 for spring, summer and winter seasons respectively. Similarly, the maximum temperature trend was 0.043 ^{0}c/year, p=0.0051, 0.062 ^{0}c/year, p=0.002 and 0.013, p=0.43 for spring summer and winter seasons respectively. Apart from winter maximum temperature others are statistically significant. Generally speaking both maximum and minimum temperatures of the study area show an increasing trend.

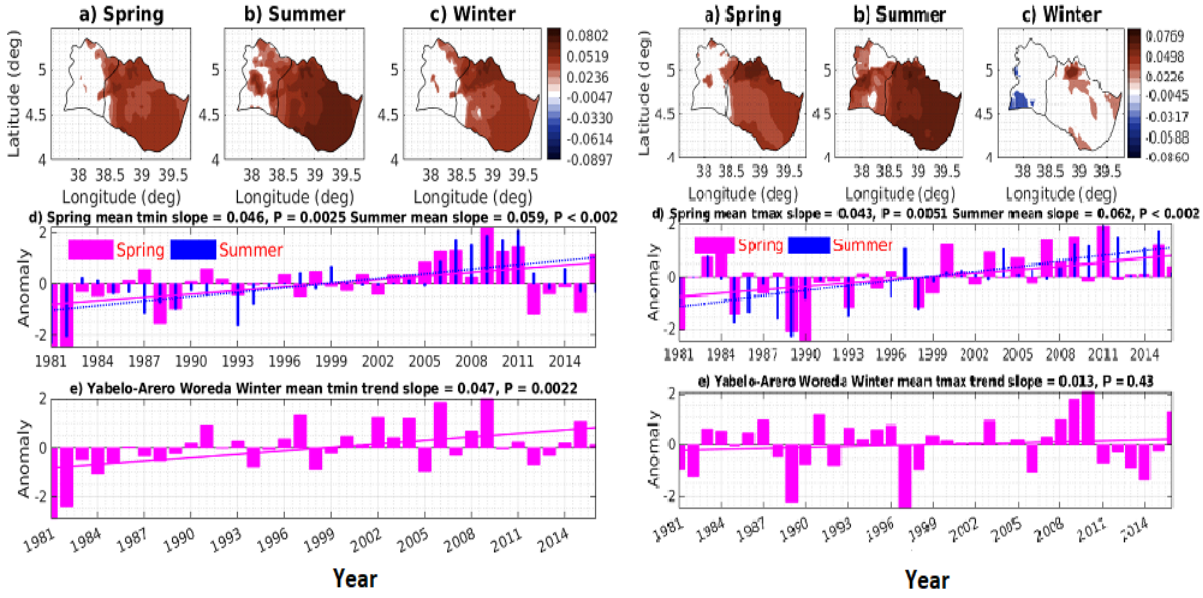

Figure.3 Spatial temperature trend of minimum (left panel) and maximum temperature (right panel) respectively (a) spring (b) summer (c) winter seasons mean temperature (d) Temperature anomaly of Spring and Summer and (e) winter season anomaly in the years 1981-2016.

4.1.4 Inter-annual Rainfall Variability Analysis

The standardized precipitation index (SPI) (Mckee, T.B, 1993) is a tool recommended by the World Meteorological Organization (WMO) and widely used for quantifying the precipitation deficit over different timescales (3 to 48 months). For the selected timescale, rainfall records are fitted with a probability distribution which is then transformed into a normal distribution so that the mean SPI for the location and desired period is zero. Figure 4 illustrates the SPI values computed using Gamma method (right panels) and Pearson method (left panels).

As can be seen form Figure 4, Gamma and Pearson methods have similar SPI values. All the three panels (Figure 4 a, b, c) show both precipitation deficit and surplus years especially for summer and winter seasons, the main and small rainy seasons of Yabelo-Arero Woredas.

Referring all the three panels in Figure 4, the values from the Standard precipitation index, precipitation surplus years are 1982,1985,1990,2003,2010,2013,2014 and precipitation deficit year are 1984, 1986, 1991, 1998, 1999,2000,2011,2015. Similar values are shown in Figure 2. This values indicates that the study area is frequently affected by both drought or flooding events.

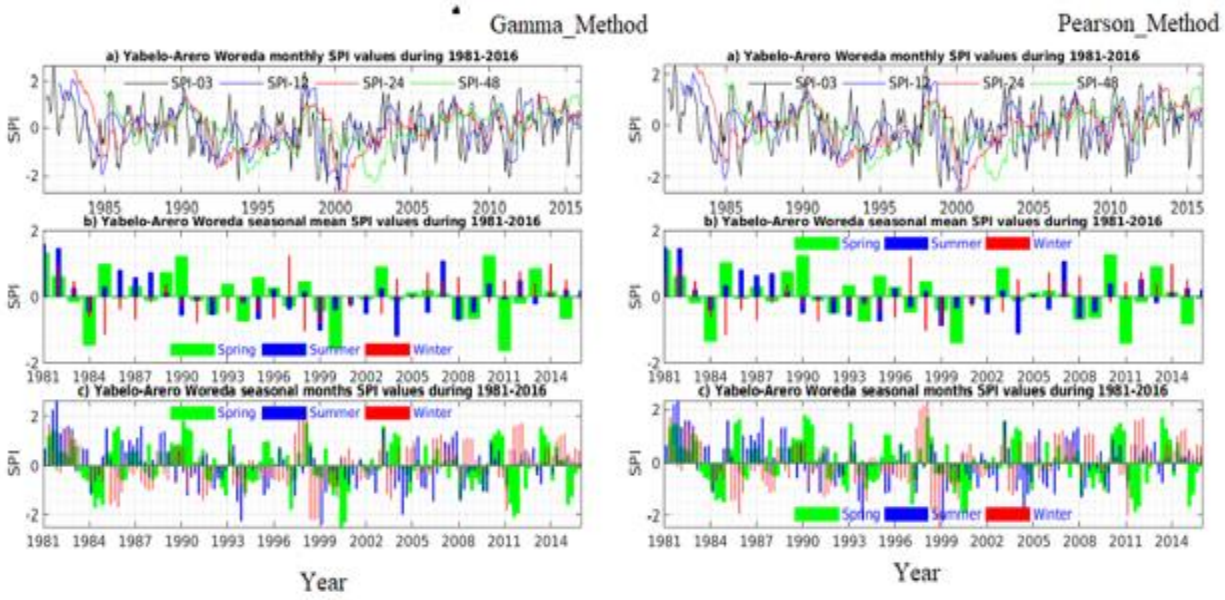

Figure 4. SPI values computed using Gamma method (right panels) (a) Monthly (b) seasonal mean and (c) Seasonal months; SPI values computed using Pearson method (left panels) a) Monthly (b) seasonal mean and (c) Seasonal months 1981-2016.

Ayal et al., (2018) also observed the presence of inter-annual climate variability in Ethiopia and this variable trend of behavior could create favorable environment for livestock diseases and adversely affect the livestock system.

4.2 Socio-economic and Demographic Characteristics of Respondents

Table 2: Sex composition, educational and marital status of the household head

Item		Pastoralist N=202 Frequency	Agro-pastoralist N=94 Frequency
Sex	Male	78.7	83
	Female	21.3	17
Educational status	Formal Education	5.9	12.8
	Adult Education	1.5	0
	Religious education	22.3	19.1
	Illiterate	70.3	68.1
Marital status	Female Headed	17.8	3.2
	Male Headed	82.2	90.4
Income source		68.3	31.7

Source:-Own survey Result, 2019

Table 2 shows that about 78.7% and 21.3% of respondents were male and female pastoralists whereas, 83% and 17% of respondents were male and female agro-pastoralists respectively. The rate of illiteracy is very high in the study area and there is no adult education experience among agro-pastoralists. Among 202 sample households 68.3% income was depend only from livestock production and 31.7% income was crop and livestock production. Key informants also explained that like that of crop production rearing of camel is introduced recently in response to drought and high economy return. Key informants underlined that in the study site only those pastoralist who affected by drought and the poor were involved in crop production as coping strategy. In the study sites crop production is not viable and crop failure due to recurrent drought a norm. Crops are produced along pockets of high pasture potential part of the rangeland and blamed as cause for rangeland degradation and restriction of livestock mobility. It is evident that female households involved in crop production were low (3.2%) compared the proportion pastoralists (17.8%). However, in general from both categories of respondents study sites are dominated by male headed households (see Table 2 for the details).

Table 3. Illustrates that average age of pastoralists and agro-pastoralists household heads were 39 and 41 years respectively. The age of household head varies from 27 to 63 years for pastoralists and 27 to 57 for agro-pastoralists. The mean age variation among pastoralists and agro-pastoralists proves that more likely aged pastoralists have been affected by drought (see key informants response under Table 2). Family size proportion of pastoral and agro-pastoral households were established approximately in a comparable ratio with the mean of 5 and 6 persons on average respectively. In each household on average a minimum of 2 persons for pastoral and 3 for agro-pastoral households; and a maximum of 9 persons for both households.

Table 3: Family size and age composition

Target population		Pastoralist	Agro-pastoralist
		N=202	N=94
Age	Mean	39	41
	SD	7	7
	Maximum	63	57
	Minimum	27	27
Family size	Mean	5	6
	SD	1	2
	Maximum	9	9
	Minimum	2	3

Source:-Own survey Result, 2019

4.3 Climate Related Effects in Borana Zone

There is a consensus among scientific community and practitioners that climate variability and extremes preceded by other secondary disasters (IPCC, 2019). Therefore, understanding micro level direct and indirect impact of climate variability based on pastoralist and agro-pastoralists could help to draw well conversed and context specific concussion and practicable recommendation of adaption responses. To this effect rainfall & temperature condition, availability and accessibility of water and pasture and prevalence rate livestock diseases observation of sample households (see Fig.6), key informants and FGD participant's presented as follows:

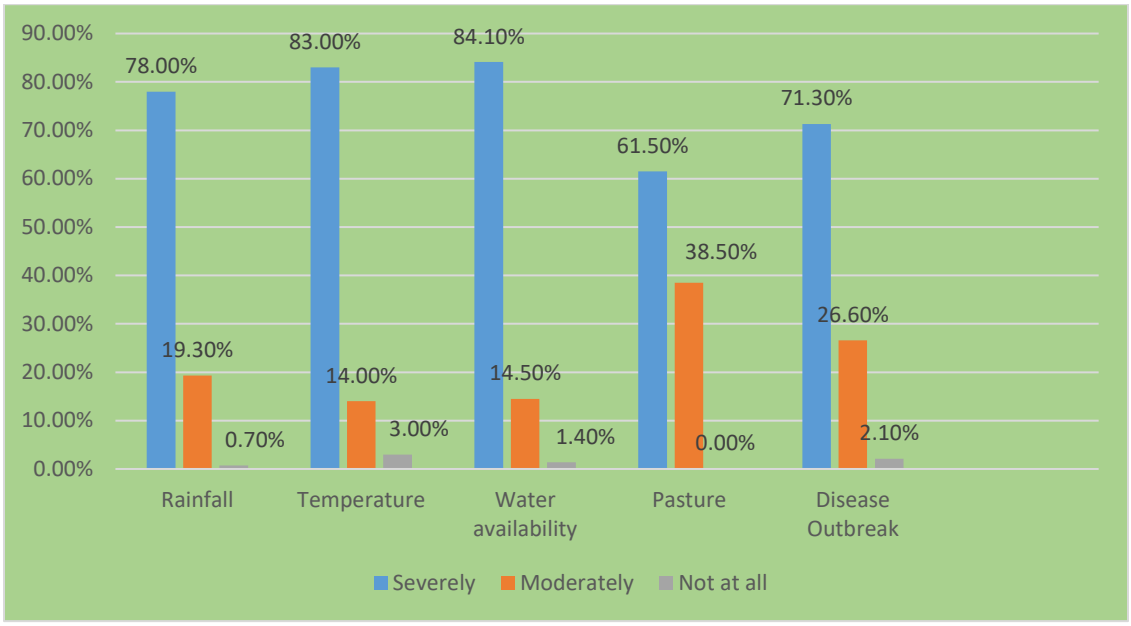

Figure 5: Level of effects on climate variability
Source: Own survey result, 2019

4.3.1 Rainfall Condition

Majority of pastoral and agro-pastoral households felt uniformly the erratic behavior of rainfall in onset, cessation and amount (see Fig. 6). This result was also confirmed by key informants and FGD participants. Key informants also underlined that the unpredictable rainfall distribution increased the frequency and magnitude of drought in their locality. In line with this finding pervious research reports e.g. Ayal, Desta and Robinson (2019), Gebremeskel *et al.* (2019), IPCC (2014), Oxfam (2010) reaffirmed that rainfall become more erratic in pastoral areas. However, we argue that as suggested by ONRS (2011) the sample households' response (78%) could be connected with their rainfall amount and timing expectations vis-à-vis the adverse impact of drought.

4.3.1 Temperature

Figure 6 shows that great majority (83%) of sample households, key informants and FGD participants were aware of the rise of seasonal and annual minimum and maximum temperature and assonated adverse effects on the livestock sector. As depicted in Fig. 6 the combined effect of erratic rainfall and increase of temperature the study sites experienced shortage of water (84.1%),

reduce the accessibility and palatability of pasture (61.5%), outbreak of new and old livestock diseases (71.3%).

FGD participants emphasized that study sites are devoid of perennial surface water. The number of water points e.g. artificial ponds, Cisterns, and Ellas have decreased from time to time. To access water (livestock and cooking) people should travel on average 7.5 kilometers per day and spent 4 to 5 hours round trip. Twenty years ago households used to travel a maximum of 2 kilometers to access water for domestic purpose during hot dry season. It seems clear that water for domestic purpose becomes a critical community problem. Sample households (78%) responded recurrent drought and ever rise of temperature aggravated the degradation of the rangeland and hence, shortage of pasture. About 71.3% of sample households observed the situation of climate variability and extreme also reduce pasture palatability and livestock pasture demand, aggravate the prevalence of livestock diseases. Key informants highlighted that the livestock sector has been affected by climate variability sensitive such as CBPP, Coenurosis, Tick and FMD, PPR and Trypanosomosis are common in the study sites. The far reaching impact of climate variability and extremes were also acknowledged by other researchers (e.g Ayal et al., 2018; Nkedianye, et al., 2010; Huho et al., 2011). Climate variability is responsible for weaken the livestock resilience for diseases, affect growth performance, extended reproduction period and decreasing production and productivity. Hence it worsens food security of pastoralists and agro-pastoralists (Gebremeskel et al. 2019; Coppock et al., 2008).

4.4 Econometric Estimation Results

As we discussed in the method of data analysis section this study applied both descriptive and econometric data analysis techniques to address it objectives. In order to determine the factor that influences pastoralists' and agro-pastoralists choice of adaptation strategies in response to climate variability multinomial logit model is a best tool as stated former studies in review of literature section.

The key assumption in the MNL is that the mistakes are independently and identically distributed with a risk of extreme value distribution. To eliminate this problem independence of irrelevant alternatives (IIA) tests were done. In addition to that the existence of multicollinearity problem was checked by using Variance Inflating Factor (VIF) and correlation matrix methods prior to

running the final regression analysis. The results of the test indicate that no severe problem of multicollinearity among the explanatory variables. Since, the VIF for each explanatory variable is less than 2 with mean of 1.22.

4.4.1 Independence of Irrelevant Alternative (IIA) Test for MNL Model

The MNL model requires the fulfillment of the assumption of the Independence of Irrelevant Alternatives (IIA), otherwise the model will be inappropriate. Different literatures suggest different ways to handle the problem of IIA and to test the fulfillment of the assumption. For instance, McFadden (1973) forwarded that models with independence of irrelevant alternative assumption should be used in cases where the alternatives can possibly be assumed to be distinct and weighted independently in the eyes of each decision option. Moreover, Multinomial login models are work well when the alternatives are dissimilar. Additionally, two most common methods that are used to test Independence of irrelevant alternative (IIA) are Hausman-McFadden (HM) test and Small-Hsiao (SH) test and are suggested to test the IIA by Hausman & McFadden, and Small & Hsiao, respectively.

In this model five categorical outcome tests of IIA are reported here. Then the study computed the model using no adaptation as a base category. The study was used Hausman-McFadden test of independence of irrelevant alternatives. The chi-square results along with the degrees of freedom and probability values are presented in (Table 4). Although none of the tests reject the Ho that IIA holds, the results differ considerably, depending on the outcome considered

Table 4: Chi^2 result of MNL model

Omitted	Chi^2	Df	$P>Chi^2$	Evidence
Strategy 1	425.824	7	.000	For Ho
Strategy 2	415.134	5	.000	For Ho
Strategy 3	298.054	6	.000	For Ho
Strategy 4	410.196	7	.000	For Ho

Source: Own survey result, 2019

Tests of the IIA involve comparing the estimated coefficients from the full model to those from the restricted model that excludes at least one of the alternative adaptation strategies. If the test statistics is significant, the assumption of the IIA is rejected indicating that the multinomial logit

model is inappropriate. The Hausman-McFadden tests results from the above table indicate that we fail to reject the null hypothesis indicating that our assumption for independence of irrelevant alternatives (IIA) is satisfied.

4.4.2 Tests for Multicollinearity

The variance inflation factor (VIF) is a popular measure of multicollinearity. If the VIF greater than 10 the variables is said to be highly collinear (Gujarati, 2003). It is defined as

$$VIF\ (X_i) = (1\text{-}R_i^2)$$

Where, R_i^2 is a multiple correlation coefficients between explanatory variables, the larger R_i^2 value is the higher value of VIF (X_i) causing higher collinearity in the variables (X_i). From the result of VIF, there is no problem of multicollinearity.

The results of MNL model showed how factors that influence pastoralist' choice of adaptation measures in the study area. The MNL adaptation model with these restructuring choices was run and showed some significant levels of the parameters estimates. Table 5 represented the results of MNL regression model. The likelihood ratio statistics as indicated by ch^2 statistics (LR chi-square (56) = 152.01 are highly significant $P < 0.000$), suggesting the model has a strong explanatory power. In all cases, the estimated coefficients should be compared with the base category livestock mobility. Therefore, Table 5 presents the MNL results along with the levels of statistical significance.

4.4.3 Interpretation of Significant Determinant Factors of Adaptation Strategies from the Marginal Effect Result

Table 5: Marginal effect of the MNL model

	Strategy 1			Strategy 2			Strategy 3			Strategy 4		
	ME	Stand. Err	P-value	ME	Stand. Err	P-value	ME	Stand. Err	P-value	ME	Stand. Err	P-value
Age of HH	0.152	0.058	0.009	0.079	0.043	0.068	0.046	0.034	0.181	-0.002	0.037	0.962
Livestock inTLU	0.059	0.075	0.429	0.008	0.059	0.892	-0.057	0.045	0.208	-0.014	0.042	0.744
Access to credit	-0.003	0.321	0.992	0.000	0.000	0.043	0.000	0.000	0.255	0.000	0.000	0.025
Family size	-0.262	0.316	0.408	-0.808	0.226	0.000	-0.358	0.165	0.029	-0.344	0.173	0.046
Off-farm income	-0.001	0.001	0.253	0.000	0.000	0.406	0.000	0.000	0.955	0.000	0.000	0.487
Distance to LivestockMkt	0.142	0.303	0.640	0.127	0.158	0.419	-0.057	0.125	0.649	-0.258	0.132	0.051
AcesstoTraining	-1.072	0.823	0.193	0.880	0.489	0.072	0.397	0.361	0.272	0.168	0.376	0.655
Contactwith DA	16.628	2840.226	0.995	-0.496	0.984	0.614	-0.050	0.740	0.947	-0.126	0.732	0.862
Educational Status	-15.606	3069.957	0.996	-0.091	0.832	0.913	0.498	0.708	0.482	0.951	0.770	0.217
SexofHH head	-0.884	1.038	0.394	1.260	0.856	0.141	0.905	0.540	0.093	0.342	0.517	0.508
WeatherInfor.	16.94 0	0.062	0.021	-1.080	0.928	0.245	0.113	0.806	0.888	-0.857	0.798	0.282

Base Category Grazing based on Rotation

Number of Observation 296

LR Chi^2 (56) 152.010

Log likelihood 684.433

Prob > Chi^2 0.0000

Pseudo R-Square 0.4020

Note:

Strategy 1= Livestock Diversification

Strategy 2= Changing Species Composition

Strategy 3= Destocking

Strategy 4= Livestock Mobility

Note *, **, * = significant at 1 %, 5 % and 10 % probability level respectively**

Source: Own survey result, 2019

Age of the Household Head: - is one of a significant explanatory variable in which its coefficient has a positive sign. A one year increase in age of the household head, the probability of pastoralists and agro-pastoralists' use adaptation strategy livestock diversification and changing species composition increases by 15.2 % and 7.9 % respectively holding other variable constant. This means that the likelihood of taking up climate adaption measures was higher among older Pastoralists and agro-pastoralists. This might be attributed to the experience of older pastoralists or farmers perceiving variability in climatic elements. This result is in line with the findings of Deressa *et al.,* (2009); Nhemachena and Hassan (2007).

Credit Access - The result from Multinomial logistic regression indicated that the credit access has significant and positive influences on the choice of adaptation strategy changing species composition and livestock mobility. As compared to the pastoralists and agro-pastoralists who has no access to credit, the probability of using adaptation strategy destocking and livestock mobility to climate variability for the pastoralists' and agro-pastoralists who has credit access increases by 0.7 % and 0.4 % respectively, keeping other variables constant. To adapt the variation in climate variability needs money; to purchase livestock medicine, supplement food for livestock's, improved or purchase better breeds improved inputs such as fertilizer and so on. The result of this study is similar with the finding of (Deressa *et al*., 2009).

Family Size: - family size also has significant and negative effect on adaptation strategies to climate variability. A one unit increase in the family size, the probability of pastoralists and agro-pastoralists use adaptation changing livestock mobility, destocking and livestock mobility decrease by 30.8 %, 35.8 % and 34.4 % respectively, keeping other variables constant. This is because of that the expenditure or consumption of extended family size is very high and it irritates the adapting capacity of climate variability.

Contact with DA: - The result from Multinomial logistic regression result indicated that the frequency of contact with development agent has significant and positive influences on the choice of adaptation strategy changing species composition and livestock mobility. As compared to the pastoralists and agro-pastoralists who has no or less contact with development agent , the probability of using adaptation strategy changing species composition and livestock mobility to

climate variability for the pastoralists' and agro-pastoralists who has at least two contact with DA in a year increased by 49.6 % and 12.6 % respectively, keeping other variables constant.

Educational Status of the Household Head

Education is a gradual process which brings positive changes in human life and behavior. Education also defines as a process of acquiring knowledge through study or communicating the knowledge by way of instructions or other practical method.

The Multinomial logistic regression result indicated that the educational status has significant and positive influences on the choice of adaptation strategy changing species composition and livestock mobility. As the household educational level increase the probability of choosing adaptation strategy changing species composition and livestock mobility increase by 9.1 % and 9.5 % respectively holding other variables constant. Educated households chooses permanent establishment by improving its access to resources around their environment than illiterate households. This finding supports other empirical study (Tizale, 2007).

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the survey results, the presence of very high differences of annual and seasonal rainfall amount between the highest and lowest volume of rainfall across the years, high variability of annual and seasonal rainfall and the unpredictable starting and stopping time of rainfall could create favorable environment for livestock diseases and adversely affect the livestock system.

Additionally the uneven increase in annual and seasonal maximum and minimum temperature may have an effect on making the area dry by increasing the evapotranspiration of water from the ground and this would bring about shortage of water and pasture availability for the livestock and weaken livestock resistance to diseases.

The pastoralists in the study area have been highly encountered the intensity of climate related problem like water quality and availability, shortage of grazing land, high risk of livestock diseases. Some of the sample respondents in the study area have not taken the appropriate adaptation measures to climate variability due to different constraint. These includes: lack of knowledge, lack of capital, lack of credit access, lack of information and unobserved climatic related problems are the major ones. Besides this, lacks of support from the governmental and non-governmental bodies as well as not giving emphasis by the pastoralists and agro-pastoralists themselves are also among the barriers to climate variability adaptation in the study area.

5.2 Recommendation

On the basis of the conclusions made, the following recommendations are suggested: The study shown that there was low level of literacy when the overall level of education increased the household adaptation to climate variability is increased therefore, the findings suggest that pastoral and ago-pastoral level of understanding on the basic factors of climate variability is low and there is a need to educate and show the available adaptation options. Access or contact with agricultural and pastoral extension services were found to be significantly affecting their climate variability adaptation choices therefore strengthen extension advice which plays a great role in promoting adaptation. In this regard, awareness raising and training on the issues of climate variability is fundamental.

The study also revealed that access to credit and household head age has significant contribution on the choices of climate variability adaptation strategies therefore, the researcher suggests that enhancing financial mechanisms and promoting sustainable development through mainstreaming age issues in the overall livelihood diversification is vital.

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Appendix

Appendix A: The Variance Inflation Factors for MNL

Variable	VIF
Age of HH head	1.51
Contact with DA	1.08
Access to training	1.01
Credit amount	1.36
Distance to livestock market	1.12
Educational Status	1.16
Family size	1.64
Livestock holding	1.14
Off farm Income	1.02
Sex of HH head	1.34
Weather Information	1.06
Mean VIF	**1.22**

Appendix B: Correlation Matrix

	AdaptStra	AccesstoTra	ContactDA	Accesscred	LivHalTLU	Educ.	FamSize	MKTdist	SexHHH	AgeHH	WeatherInf	Nonfarm
AdaptStra	1											
AccesstoTrai	-0.0547	1										
ContactDA	-0.0311	0.0572	1									
Accesscredit	-0.0336	-0.0308	0.0346	1								
LivHalTLU	0.0340	-0.0915	-0.0842	-0.2200	1							
Educ.	0.129*	-0.0072	-0.2160	-0.0397	-0.0985	1						
FamSize	0.0581	-0.0807	-0.0577	0.0570	0.1016	-0.1490	1					
MKTdist	0.1016	-0.0157	0.147*	0.0329	-0.1300	-0.0484	0.1078	1				
SexHHH	0.128*	0.198**	-0.0306	-0.2750	-0.1710	0.332**	-0.2550	0.129*	1			
AgeHH	0.187**	-0.0850	-0.0257	-0.0192	0.159*	-0.0611	0.588**	-0.0489	-0.2140	1		
WeatherInf	-0.0862	-0.0250	0.1038	-0.1125	0.0165	-0.0096	0.0439	-0.0298	-0.1168	-0.0654	1	
Nonfarm	0.0229	-0.5370	0.0570	-0.0431	0.1027	-0.0341	-0.0543	0.0577	0.0020	-0.0691	0.0868	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix C: FAO Conversion Factor for Tropical Livestock Unit (TLU) for Africa South of Sahara

Species	TLU Conversion Factor
Camels	0.70
Cattle	0.50
Sheep	0.10
Goat	0.10
Chicken	0.01

Appendix D: Household Survey Questionnaire

My name is _____. I am writing a thesis entitled "Determinants of Climate Variability Pastoralists Adaptation Strategies: Case of Borena Zone, Southern Ethiopia" in partial fulfillment for MSc in Food Security and Development Studies. The objective of this study is to understand the determinant factors that affect the choice of pastoralist's climate variability adaptation strategy. Confidently this research has a significant contribution in an effort to reduce the climate variability related problems of the pastoralists of this zone especially. Therefore, your valid contribution by giving accurate information is highly valuable in achieving the objective of this research. The information we will collect from you will serve only for academic purpose and it will be kept confidential. Thus, please feel free to convey the required information honestly.

Thank you in advanced for your cooperation.

Woreda ..... *kebele*.....Questionnaire identity number……

Section I: Households characteristics

Number	Name	Relation to the household head	Age	Religion	Sex	Educational status
1. 2. . . . 30		1. Household head 2. Wife or Husband 3. Son or Daughter 4. Grand child 5. Other relatives 6. Other non-relatives		l. Muslim 2.Waaqeffataa 3. Protestant 4. Catholic 5. Orthodox 6. Other (specify)	1. Male 2. Female	1. Formal Education 2. Adult Education 3. Religious education 4. No Education

Section II: Socio-economic Characteristics and Agricultural Production

3. What is your current main economic activity or occupation?

1. Livestock rearing
2. Farming and livestock raring
3. Farming
4. Employment
5. Trade
6. Others, Specify.....…

4. Which type of livestock did you rear?

Type of livestock	Number of livestock	Amount in Birr
Goat		
Sheep		
Cattle		
Camel		
Poultry		
Other, specify		

5. Which livestock do you prefer to raise most in current situation?
   1. Cattle
   2. Goat
   3. Sheep
   4. Sheep and goat
   5. Camel
   6. Poultry
   7. Equine

6. Why you prefer the one at the first rank above all?

   l. Higher economic value

   2. Drought resistant

   3. Disease resistant

   4. Need low input

   5. More productive

   6. Give birth in short period

7. Do you have additional activity you are participating in besides your main activity?

   1. Yes 2. No if no skip to Q 8

7.1 If yes for Q7 what is the activity

   1. Petty trade

   2. Charcoal sell

   3. Handcraft

   4. Labor work

7.2 Do you have other source of income?

7.3 If yes for Q 7.2 how much in Birr per year?_____

8. Did you shift your livelihood activities from earlier within the last 5years?

1. Yes 2. No if no skip to Q 10

8.1 Pastorals

1. Farming
2. Trading
3. Labor work
4. Handcraft

8.2 Farming

1. Pastorals
2. Trading
3. Labor work
4. Handcraft

8 .3 Trading

1. Farming
2. Pastorals
3. Labor work
4. Handcraft

8 .4 Labor work

1. Farming
2. Trading
3. Pastorals
4. Handcraft

8.5 Handcraft

1. Farming
2. Trading
3. Labor work
4. Pastorals

9. If yes in Q 8, what are the causes or reason to change? _____

10. In recent years (within the last five years), were there any changes in the production of your livestock?

1. Yes
2. No

11. How do you rate the recent trend of your household milk production?

1. Increase
2. Decrease
3. No Change

12. How do you rate the recent trend of rainfall?

1. Increase
2. Decrease
3. No change

13 How do you rate the recent trend of temperature?

1. Increase
2. Decrease
3. No change

14. How do you rate forage availability in recent years?

1 Slightly Increase
2 Increase
3 Highly Increase
4 Slightly Decrease
5 Decrease
6 Highly Decrease

15. How do you rate the recent trend of drinking water availability?

1 Slightly Increase
2 Increase
3 Highly Increase
4 Slightly Decrease
5 Decrease
6 Highly Decrease

16. How do you rate the recent trend of livestock disease occurrence?

1 Slightly Increase

2 Increase

3 Highly Increase

4 Slightly Decrease

5 Decrease

6 Highly Decrease

17. How does the variability in rainfall affects your life?

1. Positively
2. Negatively

17.1 Explain your choice in 17 above.....

18. How do the changes in temperature pattern affect your life?

1. Positively
2. Negatively

18.1 Explain your choice in Q 18 above.....

19. Do you think there is any relationship between changes in the production of your livestock and the rainfall variability?

1. Yes
2. No

Explain your answer (in terms of the relationship).....

20. Do you think there is any relationship between changes in the production of your livestock and the temperature variability?

1. Yes
2. No

Explain your answer.....…

21. Are there strategies you developed to survive or reduce the impact imposed on you by the climate variability?

1. Yes 2. No, if no skip to Q 29

22. If yes, explain your five strategies?

1. Diversification of livestock herd accordingly their feeding habit
2. Separation of livestock herd
3. Give supplementary feeds to livestock's
4. Changing species composition of livestock
5. Shifting to crop cultivation
6. Grazing based on rotation between dry and wet season
7. Migration or mobility
8. Destocking/ Sale of livestock
9. Other specify

23. For how long do you thought you will continue using these strategies?

1. Very short
2. Short
3. Long
4. Very long
5. Unsure

Please explain your answer.....

24. Do you know of any impact that your adaptation strategy may have on the environment?

1. Yes
2. No

25. Do you know if your adaptation strategy (ies) affect(s) your livelihood/survival in future in any way?

1. Yes
2. No

26. If Yes, Are they positive or Negative

1. Positively
2. Negatively

Explain your answer.....…

27. Are there any constraints that inhibit you to develop adaptation strategies to manage with trends in climate variability?

    1. Yes
    2. No skip to Q30

28. If yes, which are the constraints?

1. Age
2. Lack of early warning information
3. Lack of credit
4. Lack of Extension contact (at least three visits with training annually)
5. Lack of perception on climate variability
6. Lack of weather information
7. Lack of non-farm income
8. Local social saving
9. Size of livestock holding
10. Family size
11. Level of education
12. Other specify

Section III: Access to Financial and other Institutional Services

29. Did you face any financial shortage in the past five years?

    1. Yes
    2. No

30. If yes, have you get any credit from other sources?

    1. Yes
    2. No

31. If yes, from where did you get the credit within the last 5 years?

1. Financial institution
2. Safety net

3. NGO
4. Revolving fund
5. Friends/relatives
6. Local money lender
7. Cooperative/union

32. Credit amount in birr (in the last 12 months) _____
33. Interest per Year_____
34. Purpose of loan
    1. For consumption
    2. Livestock Purchase
    3. Social obligation
    4. Schooling
    5. Other (specify)
35. Is there any weather forecast institution in your community?
    1. Yes
    2. No
36. How often do you contact with the development agent within the last 12 months?
    1. Once 2.Twice 3.Three times 4.More than three times
37. Have you got an early warning information during the last five years?
    1. Yes 2. No

Section IV: External Interventions

38. Did you or your family members receive aid during the last five years?
    1. Yes
    2. No
39. If yes, in what form did you or your family members have received?
    1. Food/financial aid
    2. Cash/food for work

3. Other specify

40. If yes in Q 38, what is the most reason that imposes you to receive aid?

1. Conflict
2. Drought occurrence
3. Flood incident
4. Diseases breakout
5. Other specify

Thank you!!!